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January No. 1

AUTHORS........................................ 2
Volcanoes and the Climate ...
Owen B. Toon and James B. Pollack 8
A Naturalist at Large: The Nicaraguan Skin Connection ... Bernard Nietschmann 28
This View of Life: The Problem of Perfection ... Stephen Jay Gould 32
The Many Ways to Beget a Frog ...
Martha L. Crump 38
Brooklyn’s Hasidim ............. Jerome R. Mintz 46
The Great Stone Faces .......... Mark D. Coburn 60
Night Shift for Sloths and Other Sluggards ... G. Causey Whittow 66
A Matter of Taste: High Torte ... Raymond Sokolov 75
Celestial Events ................. Thomas D. Nicholson 80
Sky Reporter: Troublesome Black Holes ...
Robert Jastrow 83
Wildlife Recaptured ... Review by Gerald Carson 90
Letters.................................. 97
Announcements .......................... 98
The Market ................................... 100
Additional Reading ................. 101

February No. 2

AUTHORS........................................ 4
This View of Life: The Continental Drift Affair ... Stephen Jay Gould 12
A Matter of Taste: How to Treat the Common Cole .......... Raymond Sokolov 22
A Naturalist at Large: The Remarkable Replicators ... Richard Dawkins 34
Rock Art and the Power of Shamans ... Dean R. Snow 42
Shotgun Houses ................. John Vlach 50
A Coarrangement of Kingfishers ... Mila Olano and Javier Echevarri 58
Endangered Fish of Kentucky Streams ...
Branley Allan Branson 64
How It Really Was .......... Dorothy Harley Eber 70
The Fly That Would Be King. Robert S. Desowitz 76
Sky Reporter: EUV Makes the Grade ... Stephen P. Maran 85
Celestial Events ................. Thomas D. Nicholson 90
The Market .............................. 92
Announcements .......................... 93
A Sojourn Among the Indians ... Review by Alvin M. Josephy, Jr. 94
Additional Reading ................. 100

March No. 3

AUTHORS........................................ 4
A Naturalist at Large: The Wind Caller ... Bernard Nietschmann 10
A Whooper Rally ................ Rodney Barker 22
Poison in a Monkey’s Garden of Eden ...
Kenneth E. Glander 34
Masked Messages ........ Ann Marie Cunningham 42
Report from Mars .......... Robert Jastrow 48
Life on a Cold Rock .......... Fred Bruemmer 54
Misleading Mantids .......... George F. Rohrmann 66
This View of Life: Twin-engined Spaceship Earth ... Stephen Jay Gould 72
Hidden Treasure ................ Review 79
A Matter of Taste: Strange Fruits ... Raymond Sokolov 84
Ritual Enemas ... Peter T. Furst and Michael D. Coe 88
The Market .............................. 92
Announcements .......................... 93
Celestial Events ................. Thomas D. Nicholson 94
Additional Reading ................. 96

April No. 4

AUTHORS........................................ 2
This View of Life: The 120-Year Bamboo Clock ... Stephen Jay Gould 8
Celestial Events ................. Thomas D. Nicholson 20
The Unnatural History of Tobacco ...
Eric Eckholm 22
Hot Spots .................................. Peter R. Vogt 36
The Enigma of Aztec Sacrifice ... Michael Harner 46
Vest-pocket Turtle ........ Jim Cooper 52
Drums of Calanda .......... Tor Eigeland 58
The Pit and the Antlion ........ Howard Topoff 64
Besieged Reefs of Florida’s Keys ... Phillip Dushman 72
A Matter of Taste: Humble Pie ... Raymond Sokolov 80
The Market .............................. 84
Announcements .......................... 86
Sky Reporter: Let There Be Darkness ... Stephen P. Maran 88
Epidemic! ... Review by Guido Majno 95
Additional Reading ................. 100

May No. 5

AUTHORS........................................ 4
This View of Life: Evolution's Erratic Pace ... Stephen Jay Gould 12
Letters.................................. 20
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2 Authors

8 Volcanoes and the Climate Owen B. Toon and James B. Pollack
A major eruption resulted in beautiful sunsets, a summerless year, and the creation of Frankenstein.

28 A Naturalist at Large Bernard Nietschmann
The Nicaraguan Skin Connection

32 This View of Life Stephen Jay Gould
The Problem of Perfection

38 The Many Ways to Beget a Frog Martha L. Crump
No place can match the diversity of frog species in South America's jungles.

46 Brooklyn's Hasidim Jerome R. Mintz
Every moment of their lives is influenced by moral and legal guides, including the 613 commandments of the Old Testament.

60 The Great Stone Faces Mark D. Coburn
The sculptor carved with dynamite an American metaphor in environmentally bad taste.

66 Night Shift for Sloths and Other Sluggards G. Causey Whittow
The sloth would make a good space traveler.

75 A Matter of Taste Raymond Sokolov
High Torte

80 Celestial Events Thomas D. Nicholson

83 Sky Reporter Robert Jastrow
Troublesome Black Holes

90 Book Review Gerald Carson
Wildlife Recaptured

97 Letters

98 Announcements

100 The Market

101 Additional Reading

Cover The strict observance of Jewish laws from an early age is primarily responsible for the continuing growth of the hasidic community in Brooklyn, New York. Photograph by Allen Rokach.
Story on page 46.
For more than two years Jerome R. Mintz lived among the hasidim in Brooklyn, New York, studying their history, traditions, and beliefs for his doctoral dissertation in anthropology. He subsequently published two books on the subject. Now a teacher of anthropology at Indiana University, as well as an ethnographic film maker, Mintz frequently revisits the community. His present anthropological studies, however, have shifted to Spain, where he is documenting the rural-to-urban population movement. Two articles by Mintz that focus on this latter research—"Trouble in Andalusia" and "Comfortable Old Shrines—Divisive New Visions," appeared in Natural History in May 1972 and April 1974, respectively.

The idea for a second look Mount Rushmore Memorial in South Dakota came to Mark D. Coburn when he was teaching a course on historical and cultural differences in attitudes toward the landscape. A picture postcard of the Memorial sent by a friend did the rest. Assistant professor of English at Fort Lewis College Durango, Colorado, Coburn received his doctorate in English and the humanities from Stanford University. He is a renegade New Yorker who enjoys living amid Colorado’s Sangre de Cristo Mountains and fervently hopes that no one will ever try to improve them by adding eyebrows.

Finding that the slow loris has very low body temperature and metabolic rate, G. Causey Whittow undertook an investigation of the physiological mechanisms that would account for these phenomena. The work, which began while he was serving as a visiting professor at the University of Malaya in 1974, led him to speculate about the adaptiveness of being a slow mammal. A professor of physiology in the School of Medicine at the University of Hawaii, Whittow is now researching the small ecology of the Hawaiian monk seal. Similar work on the California sea lion was the basis of his article "Sun, Sand, and Sea Lions" in the August-September 1974 issue of Natural History.
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Dust particles and sulfur gases ejected into the stratosphere by volcanic explosions cause changes in temperature as well as gaudy sunrises and sunsets.

During April 1815, twelve thousand people in the Dutch East Indies died when the Tambora volcano spewed hot stones and volcanic ash into the sky in the most violent volcanic explosion of recorded history. Halfway around the globe and one year later, record low summer temperatures led New England farmers to name the year 1816, “Eighteen hundred and froze to death.” Throughout the summer of that year, cold waves, snow, and frost killed crops. The price of corn and wheat shot up, and farmers were forced to sell their livestock at a loss. Many people were so discouraged that they left New England for the less-developed but warmer lands of the South and West. In Europe, 1816 was also a “year without summer.” Crops failed to ripen and famine struck Britain, France, and Germany.

Some consequences of the bad weather of 1816 are still with us today. Mary Wollstonecraft Godwin, soon to become Mary Shelley, spent her vacation that dreary summer huddled near a fireplace reading ghost stories with her poet friends Shelley and Lord Byron. A story-writing contest developed and Mary wrote Frankenstein, which was published two years later. So, out of the rain and cold, a monster was born.

Did the Tambora eruption of 1815 cause the bad weather of 1816? Do volcanic eruptions in general cause changes in weather and climate? These questions are receiving increased attention today as meteorologists and climatologists try to understand why the climate changes, so that future variations may be predicted or avoided.

Benjamin Franklin was the first scientist to wonder publicly if volcanic eruptions affect weather. He noted that a “permanent dry fog,” perhaps originating from the smoke of volcanic eruptions in Iceland, covered North America and Europe during the summer of 1783. The fog seemed to dim the sun’s rays, and Franklin believed that the solar heating lost that summer was responsible for the severely cold winter of 1783/84. Franklin advocated that a thorough study be made to see if other years with summer “fogs” had unusually hars winters. The eminent contemporary British climatologist H. H. Lamb has recently completed such a study. He shows that weather worldwide—or at least in the hemisphere of an eruption—is affected by volcanic eruptions and that the first or two years following major volcanic eruptions are slightly cooler than normal.

In Franklin’s time it was believed that local weather, variable from year to year, continually repeated itself over long intervals of time. Today we know that the climate—the average weather over a period of many years—is itself changeable. Twenty thousand years ago the earth had a glacial climate. A mile-high sheet of ice covered the continents, and the North Pole was not far from the equator.

The eruption in 1883 of Krakatoa, an island between Java and Sumatra, is represented in an artist’s rendition. The explosion, which was heard 2,000 miles away in Australia, almost destroyed the island. It propelled clouds of ash to a height of thirty miles, plunging the region surrounding the island into darkness for two and a half days, and triggered tidal waves that killed about 36,000 persons. The volcanic ash drifted around the globe for several years, causing spectacular red sunsets.
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ice then stretched across North America from the Atlantic to the Rockies and from the Arctic to the northern United States. Climate has also varied during the past few centuries. From 1500 to 1900, the earth's average temperature was slightly lower than it is now and small villages in the mountains of Europe were overrun by glaciers. From 1600 to 1700, polar sea ice was so extensive that no European ships could reach Greenland, which had been colonized centuries before.

Most meteorologists and climatologists today believe that a large volcanic explosion can cause bad weather, but they are skeptical about any relationship between volcanic explosions and changes in climate. A single volcanic eruption only affects the weather for a few years. If climatic changes do, in fact, result from volcanic explosions, large eruptions would have to occur every few years. We live in a period of very few large volcanic explosions. The eruption in 1912 of Mount Katmai in Alaska was the next to last. The only major eruption anywhere in the world since then was that of Mount Agung in Bali in 1963, so it is not possible to determine directly if climatic changes are caused by volcanic explosions.

The doubts about a relationship between volcanic eruptions and climatic changes have fostered several new studies based on two different approaches. First, theorists are trying to understand how single volcanic explosions cause changes in weather. With this knowledge they may be able to calculate the number of volcanic explosions required to produce a given climatic change. Pollution of the earth's upper atmosphere by the exhaust of high-flying supersonic aircraft may act to change climate in the same manner as volcanic explosions. Thus a thorough understanding of the effects of volcanic explosions on climate is needed to insure that human kind itself does not inadvertently affect climate. Second, researchers are trying to determine if epochs with cooler climates had significantly more volcanic explosions than those with warmer climates.

In order to understand how the eruption of a remote volcano produces worldwide weather effects, we must first understand volcanic explosions. Volcanoes are little more than cracks in the earth's surface through which molten rock, or magma escapes. The magma is produced mainly at the edges of crustal plates so a global map of the locations of volcanoes shows the crustal plate outlined by volcanic 'rings of fire.' The magma is formed far below the earth's surface, where pressures are very high. The high pressure force gases—the most important being water, carbon dioxide, and sulfur compounds—to dissolve in the molten rock. As the magma reaches the surface through volcanic vents, the pressure is reduced and the dissolved gases are released.

Many volcanoes have magma that is very fluid. When they erupt, the gases in their magma escape easily as lava pours out onto the ground. Such volcanoes produce about twenty or more minor explosions each year which emit volcanic ash and gas into the earth's lower atmosphere, where clouds and rain quickly wash the volcanic pollution from the sky. Some volcanoes, particularly those around the Pacific Ocean, have very viscous magma in which gas bubbles are trapped. When that magma reaches the earth's surface and pressure is reduced, a major explosion occurs. Such an explosion was the eruption of Krakatoa in the Sunda Strait of the Dutch East Indies in 1883, estimated to have been ten times as powerful as the largest hydrogen bomb exploded in the atmosphere by the United States. Krakatoa threw clouds of ash at least thirty miles high, into the earth's atmosphere.

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the nineteenth-century English romantic landscape artist J.M.W. Turner may reflect the many volcanically colored twilights of the period in which he worked. And the phrase “once in a blue moon” may have originated from observations of blue and green suns and moons after volcanic eruptions. Such blue and green colors were seen in the tropics for several weeks following the Krakatoa eruption in 1883.

An even more beautiful phenomenon, occasionally seen after eruptions, is a large ring around the sun reddish at its outer border and blue white toward the center, named Bishop’s ring for the Reverend Sereno E. Bishop of Honolulu, who first described the occurrence ten days after Krakatoa’s explosion. Bishop’s ring was seen throughout the Northern Hemisphere for more than two years following that eruption.

The cause of such phenomena as blue and green moons was a puzzle to which scientists have devoted much speculation. To discover the origin of these optical events, high-flying aircraft and balloons have been used to collect samples of stratospheric air after volcanic eruptions. Tiny sulfuric acid particles and fragments of lava were found in the samples. Their small size and the fact that light behaves like a wave provides the explanation for the optical effects and also for the way in which these particles affect weather.

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summer”—was only a few degrees Fahrenheit lower than normal. Nonetheless, this small summer cool- ing was quite significant for it was accompanied by severe storms. Because of the storms, northern New England had frost during that entire summer except for two periods of slightly more than three weeks each. The cooling after other very large volcanic explosions, averaged over the hemisphere covered by the ash and sulfuric acid particles emanating from the explosion, has also been estimated to be only one or two degrees Fahrenheit.

One interesting sidelight of a comparison between calculated change and observed changes in average temperature caused by volcanic explosions is that a single explosion does not alter the temperature as much as is theoretically possible. The volcanic particles injected into the stratosphere fall out of the sky after one or two years. The earth, however, resists global temperature changes on this small time scale, primarily because it takes a long time to warm or cool the oceans. This means that if many volcanoes explode in rapid succession, temperatures are likely to drop more than they would following a single eruption. Likewise, a series of many small volcanic explosions can, over a long period of time, produce effects whose magnitude is as great as that following a single really large explosion.

Several researchers, H. H. Lamb among them, have investigated the number of volcanic explosions that have occurred in rapid succession within a period of a few years over the centuries. Lamb found that we live in a period that is markedly deficient in moderate and large volcanic explosions as compared to the period from 1500 to 1912. The only notable eruption since 1912 was the aforementioned one of Mount Agung in 1963. Between 1500 and 1912, by contrast, there was, on the average, one eruption of moderate or great intensity every four years. Evidence of the magnitude of most of those eruptions is indirect. For example, in exploring the period prior to 1880, Lamb had to use reports of vivid sunsets and measurements of ash fall near volcanoes to deduce the magnitude of the explosions. Fortunately, in 1880, measurements began to be made of the amount of sunlight reaching the earth. These measurements clearly show the loss of sunlight fol-
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lowing several volcanic explosions—just the information theorists need in order to calculate the difference in average temperature between the present nonvolcanic period and the period from 1880 to 1912. The difference, due to volcanic explosions, is almost 1°F. Observations of temperatures show that the earth has been warmer since 1912 than it was during the period from 1500 to 1912 by just about the same amount.

Climatologists do not agree on the cause of this observed warming. It may be due to factors other than volcanoes, for instance, fluctuations in solar radiation. But the agreement between the calculated temperature change due to volcanic activity and the observed change suggests that the large number of volcanic explosions between 1500 and 1912 played a major role in altering the terrestrial climate. If volcanoes should again explode as often as they did during the period from 1500 to 1912, mountain glaciers and polar sea ice might begin to expand, bringing hardship and suffering to those in climatically marginal areas of the world.

Climatologists also disagree on the cause of ice ages. Some scientists theorize that volcanoes could be the cause of ice advances, or glacial, but there is no consensus about the precise correlation between ice ages and volcanic activity. Although volcanoes might cause glacial, the reverse is also possible—glaciers might cause volcanic explosions. In an ice age, great masses of water are shifted from the oceans to the ice caps. That shift subjects the earth's crust to considerable stress and could lead to enhanced volcanic activity through motion of the crustal plates. Although we do not know whether volcanoes caused the glaciers or vice versa, new evidence about the histories of glaciers and volcanic explosions has established some connection between the two phenomena.

During the last two million years, the approximate span of the human presence on this planet, there have been many glacial, each of which lasted about 100,000 years. Prior to two million years ago, there was a period of more than one hundred million years during which there were no glaciers and the earth was so warm that the Antarctic polar cap did not exist.

The history of volcanic explosions during ice ages is found on the ocean floor, which preserves a record of all the debris that has fallen into the ocean over the millennia, with the youngest material in the top layer. A worldwide study of volcanic ash layers in ocean sediments has found that there were many more volcanic eruptions during the two million years of the ice ages than during the preceding tens of millions of years.

Further evidence comes from the ice sheets in Greenland and Antarc-tica, which contain ice at their bottom layers that originally fell as snow 100,000 years ago at the beginning of the last ice advance. Cores from these ice sheets also contain layers of volcanic dust. The cores show that between 30,000 and 16,000 years ago from the peak of the last glacial to its end, a tremendous number of volcanic explosions took place, perhaps as many as one eruption every two years. Theoretical calculations suggest that these volcanic explosion caused substantial cooling, which contributed to the low temperatures at the height of the last glacial.

Although volcanic activity was common at the peak of the last glacial, there is no evidence of an extended period of volcanic activity at the initiation of the last ice advance about 100,000 years ago. But the available data do not rule out the possibility of a great number of eruptions over a fairly short period of time at the beginning of the glacial. Some climatologists believe that such an intense period of volcanic activity could trigger an ice advance. In fact, a dramatic worldwide cooling, during which the earth plunged for a thousand years from interglacial to full glacial conditions, took place in a single century about 90,000 years ago. This type of sudden cooling, which would be disastrous for modern society, could play a role in starting glacial and could be caused by a short period of intense volcanic activity.

Lamb's work tends to show that abnormal weather follows single large volcanic explosions. Of course, volcanic explosions do not cause all the unusual weather on the earth nor do they account for all the climatic changes. Nevertheless, volcanic explosions probably have caused some of our most remarkable weather. They may have been involved in some of our most important climatic changes. And volcanoes will probably continue to influence climate and weather in the future.
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When I was in graduate school reading papers on ecological research done in the tropics, I often wondered why anyone ventured to foreign places if all investigations were as dry in the process as they often were in the product. The accounts of many studies were written as if the field work took place in a cultural and personal vacuum; as if the researcher had suddenly been teletransported to the site and, by means of clairvoyance or immaculate conceptual perception, had faultlessly initiated and completed the research project in one blinding flash of academic ingenuity.

Let me tell you that field research does not work this way. Even though exorcised from scientific articles and books, there are awkward, stumbling, sometimes agonizing, and often humorous personal encounters and problems that give each research experience a special character and texture. These unusual personal encounters are a significant part of what keeps us going back into the field.

When I returned to the east coast of Nicaragua in 1971 to continue a research project first begun in 1968, one of the first people I saw at the small airport outside of Bluefields was Mr. Seymore (Robinson is his last name, but in this part of the world the surname is usually dropped for informality and the Mr. retained for politeness). He was still the eternal optimist, scanning the passengers for some important but long overdue Godot who was to be the key figure in one of his “strike it rich” business scenarios. Seeing him again recalled one of my more unusual and tragic field experiences.

After we exchanged personal and family news, I could not help but ask him about the house at Cotton Tree. He assured me that it was still there, pretty as ever but wanting a coat of paint. As we talked, I thought of my first trip to the area, of Mr. Seymore, and of the house at Cotton Tree.

In 1968 I went to Nicaragua to study the impact of commercial hunting and fishing on the local fauna and on the subsistence system of the Miskito Indians. With little idea of what I might encounter at the designated research site, I left my wife and son in Managua, the capital, and went on to Bluefields to reconnoiter the situation and rent a house that would be our main study base.

There are two ways to travel to Bluefields from Managua. You can go by air on a one-hour flight or you can spend all day going overland and by river. I chose the latter in the hope of seeing as much of the country as possible. It was September and the rains had started. The 180-mile trip by microbus over the Rama Road was punctuated by constant bouncing and sloshing through mud, rain, and water. During the entire journey, the number two driver hung out the window yelling “Rama, Rama, Rama” in a melodic staccato, hoping to pick up more travelers. By noon we had reached the end of the road and the town of Rama, which was something of a letdown after seven hours of “Rama, Rama, Rama.”

The Rio Escondido was just below flood stage and its muddy, debris-strewn waters lapped at the improvised cobweb wharves. Tied to one of the wharves was a strange, almost amphibianlike craft, which was to be our means of transport for the remaining eighty miles to the coast. The Bluefields Express was a patchwork vessel pieced together from a surplus PT boat with a bus body welded to its deck.

Like a platypus, the town of Bluefields is a bizarre sum of disparate elements that defy characterization. The cascade of my first night’s impressions led to a cross-cultural overdose: loggers, ranchers, pioneer farmers, missionaries, and shrimp boat crews crowded the main streets. Blasts of Jim Reeves country and western music spilled from the open doorways of cantinas named Miami Beach, Tamarindo Number 2, OK Corral, Torpedo Alley, and the Bay of Pigs, drowning out multilingual Spanish, Creole English, and occasional Chinese and Miskito street conversations. Trucks and cars avoided potholes and people as the navigated the few short roads that terminated either at the edge of the lagoon or the surrounding rainforest. Cerveza Victoria and Ron Tropics signs hung from second-floor balconies of British-colonial wooden buildings that sagged from damp rot.

I was directed to Sunshine Down’s “Magestic Saloon” for good green food, said to be the best in Bluefields. It was true. Big, fresh sea shrimp cooked Creole style with plenty of onions, vinegar, lime, garlic, black pepper, and a local salsa picante. Honest bread with a hard crust and a solid feel to it and all the Chontalean ranch butter you wanted. And a huge pitcher of sourspresa fresco—perhaps the best drink in the tropics.

While eating, I watched the sidewalk parade through the open space beneath the saloon doors: bare feet of all sizes and shapes; rubber Tico boots, some split and wire-stitched; men’s pointed, high-heeled, black leather gallo shoes; rubber thongs; and one pair of Sears canvas wedgies, the kind with the little flowers and the toe hole cut out of the front.

After visiting the Supermercado William Woo (one shopping cart from whom knows where) I bought some nails to hang my mosquito net, I took a room at the Hollywood Hotel and fell asleep wondering how—in that cultural maze—I was going to find a house to rent.

The next day it was hard to distinguish the knocking at my door from the drum roll of early morning rain beating on the corrugated tin roof. Standing on the veranda outside my room was an older man, dressed in a wool suit, a hat, and amazingly, a starched white shirt.

“Not to molest you this fine morning,” but I come to engage you in our dealin’ with the skins,” he said in delightful Creole English.

I was sure he had the wrong morning and fairly certain he had the wrong man as well. He mistook my
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hesitation as a sign of acceptance and went on.

"My name is Seymore Robinson, pleased to meet your acquaintance, and I made to understand that you is here to see me."

I explained that I was not there on business and was not looking for him, although I was happy to meet him.

Looking somewhat dejected, he said, "These last days things a little hardish so I is keeping bright eyes for my business contact."

After telling me that he owned a small store and also bought and sold many things on the side, he inquired what had brought me to Bluefields. I told him that I was looking for a house to rent and started to explain about my research project.

Interrupting, Mr. Seymore said, "Then this is your lucky day. You is here on business and you come to the right man. I have me own personal house yonder in Cotton Tree which is available at the moment. This be the proper place for you, and God willin', we'll take a stroll and see it."

While we waited for the rain to let up, Mr. Seymore explained that Cotton Tree was an adjacent neighborhood named for a prominent, large tree on the bluff over the lagoon. He extolled the virtues of his house. "It catch a fine sea breeze that keep the fly from humbugging you."

When the rain stopped, we walked to Cotton Tree, passing several desirable looking houses, all built on stilts, with wooden sides and metal or thatch roofs. But no, Mr. Seymore informed me that these were only ordinary houses and to pay no mind to them. I had to agree with him when he stopped in front of a bright, Shell Station yellow house with a shiny new tin roof. To reach the front porch, eight feet above the ground, Mr. Seymore pointed to a tree house ladder and up we went.

"I'm gon'a fix this to your satisfaction, Mr. Bernard. This be a first-class place for you."

He unlocked the door and pushed it open. "I surely hope we does reach an agreement, God willin'," he added, as he opened the wooden shutters.

It took a moment for my eyes to adjust to the suddenly brightened interior. At first, all I could see was a floor completely covered by dark bumps. I squinted to get a better view. There could be no doubt about it. In the house that we might live in—the place that would serve as a field base while we studied the impact of commercial exploitation on local fauna—were crocodile skins, from wall to wall, neatly rolled like so many loaves of bread, row upon row.

Stunned, I could only muster a weak, stuttering question. "How many hides do you have here, Mr. Seymore?"—as if the exact number would somehow defuse my shock.

Mr. Seymore smiled as he rocked up on his toes, the extra height giving added emphasis to his words. "Mr. Bernard, I got me one thousand nine hundred in this here room and another four or five hundred in the next room. Mostly they is crocodilly but some be alligator that favor the crocodilly. Right now the place have a high scent but don't let these animals worry you none, Mr. Bernard. I'm gon'a fumigate this place and paint it up, pretty, pretty."

Hardly paying any attention to what Mr. Seymore was saying, I stared at the brownish black and light yellow mass of bundles. Twenty-four hundred skins. Think of it. Two thousand four hundred crocodiles and caimans. This place was the Forest Lawn of the reptile world.

Mr. Seymore led me through the skins, pointing to bare spots on the floor where we could place our feet.

"Are these skins fresh?" I asked.

"Why no, man. These skins be prepared. They been salted three, four times. They be all right, I'll fix the place up to your likin'," he remarked with a sweeping gesture, encouraging me to imagine the Bluefields House Beautiful, as if a coat of paint could cover a cemetery.

"Don't do anything until my wife sees the house. I wouldn't want you to go to any extra trouble."

Now more interested in the skins than the house, I asked how he obtained them.

"They come from my little sellin' and buyin' business that I have on the side. I does buy all kinda skins and things: water dog, tiger, tigercat, pe-ludo, 'awksbill, calipee, and such like thing."

Mr. Seymore then went on to explain that he had been buying skins for many years, purchasing them from hunters, loggers, ranchers, and farmers from as far away as the Costa Rican border. These people have to come to Bluefields for supplies, and when they do, they bring the skins to Mr. Seymore or to one of the other buyers.

"But all is gettin' scarce now. Most of these skins here are smallis. Only one, one, be big. So I got to try to get the right price. That is the spe- ulatin' part of the skin dealin'. I'm waiting on a man who is to come Bluefields, check out these skins, an' buy them."

We then launched into a lengthy discussion on the decline of various species, the increase in the mark prices, where the skins were sent, as the survival chances for these animals and for Mr. Seymore's business.

"If I don't buy, then the people gon'a sell to the next man. The market gettin' a little tightish count of titans laws in the States. But I sellin' no to Europe and Japan. They is the only buyin'."

I thanked Mr. Seymore for his help and the information, said goodbye and retraced my steps through the carpet of skins. Even though the rain had stopped, and the sun was now warm and powerful, it was to be a cold and gray day for me.

During the months that followed, Mr. Seymore and I became friends. Strange. While he was trying to export skins, hides, hawksbill shell, another items, I was writing reports to the Nicaraguan government pressin' for new and stronger conservatio laws. The differences in our view points were enormous, but we remained friends and he taught me great deal about his business an' the varieties of wildlife in the area. He would show me his records detailing the types and numbers of wild animal products that he had purchased and exported to distant markets. He knew how I would use this information, yet he offered it to me "You got to know these things, Mr. Bernard, for your work."

No, my family and I never rented that pretty yellow house that was in Serary on the inside. But after studying faunal decline for severa years, we felt that we had lived there nonetheless.

Sometime after my reunion with Mr. Seymore, I asked him if he had ever sold the skins.

"I never get the chance to sell 'em," he replied. "Worm and bug bore hole in them and I had to dash the whole shipment away in the lagoon. The big buyer never come."

Bernard Nietschmann, taking a break from his research on dugongs is traveling around Australia by train, looking for future column ma-terial.
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The Problem of Perfection

The exquisite design of some creatures poses a challenge to Darwin’s theory of natural selection

In 1802, Archdeacon Paley set out to glorify God by illustrating the exquisite adaptation of organisms to their appointed roles. The mechanical perfection of the vertebrate eye inspired a rapturous discourse on divine benevolence; the uncanny similarity of certain insects to pieces of dung also excited his admiration, for God must protect all his creatures, great and small. Evolutionary theory eventually unraveled the archdeacon’s grand design, but threads of his natural theology survive.

Modern evolutionists cite the same plays and players; only the rules have changed. Now we are told, with equal wonder, that natural selection is the agent of exquisite design. As an intellectual descendant of Darwin, I do not doubt this attribution. But my confidence in the power of natural selection has other roots: it does not arise from the existence of “organs of extreme perfection and complication,” as Darwin called them. In fact, Darwin saw truly exquisite design as a problem for his theory. He wrote:

To suppose that the eye with all its inimitable contrivances for adjusting the focus to different distances, for admitting different amounts of light, and for the correction of spherical and chromatic aberration, could have been formed by natural selection, seems, I confess, absurd in the highest degree.

In last month’s column, I invoked gall midges to illustrate the opposite problem in adaptation — structures and behaviors that seem senseless. But “organs of extreme perfection” have an only too evident use; the difficulty lies in explaining how they developed. In Darwinian theory, a complex adaptation does not arise in a single step, for this would confine natural selection to the purely destructive task of eliminating the unfit whenever a better-adapted creature suddenly appeared. Natural selection has a constructive role in Darwin’s system: It builds adaptation gradually, through a sequence of intermediate stages, and brings together, in sequential fashion, elements that often seem to have meaning only as parts of a final product. But how can a series of reasonable intermediate forms be constructed? Of what value could the first tiny step toward an eye be to its possessor? The dung-mimicking insect is well protected, but can there be any edge in looking only 5 percent like a turd? Darwin’s critics referred to this dilemma as the problem of assigning adaptive value to the “incipient stages of useful structures.” And Darwin rebutted by trying to find the intermediate stages and by specifying their utility.

Reason tells me, that if numerous gradations from a simple and imperfect eye to one complex and perfect can be shown to exist, each grade being useful to its possessor...then the difficulty of believing that a perfect and complex eye could be formed by natural selection, though insuperable by our imagination, should not be considered as subversive of the theory.

The argument still rages, and organs of extreme perfection rank high in the arsenal of modern creationists.

Every naturalist has his favorite example of an awe-inspiring adaptation. Mine is the “fish” found in several species of the freshwater mussel Lampsilis. Like most clams, Lamp-silis lives partly buried in bottom sediments, with its posterior end protruding. Riding atop the protruding posterior is a structure that looks for all the world like a little fish. It has a streamlined body, well-designed side flaps complete with a tail and even an eyespot. And, believe it or not, these flaps undulate with a rhythmic motion that imitates swimming.

Most clams release their eggs directly into the surrounding water, where they are fertilized and undergo their embryonic development. But female unionids (the technical name for freshwater mussels) retain their eggs within their bodies, where they are fertilized by sperm released into the water by nearby males. The fertilized eggs develop in tubular within the gills, forming a brood pouch, or marsupium.

In Lampsilis, the inflated marsupium of gravid females forms the “body” of its ersatz fish. Surrounding the fish, symmetrically on both sides, are extensions of the mantle, the “skin” that encloses the soft parts of all clams and usually ends at the shell margin. These extensions are elaborately shaped and colored to resemble a fish, with a definite, often flaring “tail” at one end and an “eyespot” at the other. A special ganglion located inside the mantle edge innervates these flaps. As the flaps move rhythmically, a pulse, beginning at the tail, moves slowly forward to propel a bulge in the flaps along the entire body. This intricate apparatus, formed by the marsupium and mantle flaps, not only looks like a fish but also moves like one.

Why would a clam mount a fish on its rear end? The unusual reproductive biology of Lampsilis supplies an answer. The larvae of unionids cannot develop without a free ride upon fishes during their early growth. The larvae of most unionids possess two little hooks. When released from their
other’s marsupium, they fall to the bottom of the stream and await a passing fish. But the larvae of *Lampsilis* seek these hooks. In order to survive, they must enter a fish’s mouth and move to favored sites on the gills. The salt fish of *Lampsilis* is an animated coy, simulating both the form and movement of the animal it must attract. When a fish approaches, *Lampsilis* discharges larvae from its marsupium; some of them will be allowed by the fish and find their way to its gills.

The stratagem of *Cyprogenia*, a red genus, emphasizes the importance of attracting a host. These muscles “go fishing” in a manner subsequently reinvented by disciples of Izaak Walton. The larvae attach themselves to a bright red “worm” formed by a protein manufactured within the mother’s body and are extruded through the exhalant siphon. Several observers report that fish seek out and eat these “worms,” often pulling them, when only partly extruded, from the female’s siphon.

How could the decoy fish ever have evolved? How did the marsupium and mantle flap come together to effect their ruse? Lucky accident or preordained direction may appeal to our intuition more than gradual construction by natural selection through some intermediate forms that, at least in their initial stages, could not have looked much like a fish. The intricate fish of *Lampsilis* is a classic illustration of a deep dilemma in Darwinism. Can we possibly devise an adaptive significance for the incipient stages of this structure?

The general principle advanced by modern evolutionists to solve this dilemma calls upon a concept with the unfortunate name of “preadaptation.” (I say “unfortunate” because the term implies that species adapt in advance to impending events in their evolutionary history, when exactly

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The success of a scientific hypothesis often involves an element of surprise. Solutions often arise from a subtle re-formulation of the question, not from a brute force collection of new information in an old framework. With preadaptation, we cut through the dilemma of a function for incipient stages by accepting the standard objection and admitting that intermediate forms did not work in the same way as their perfected descendants. We avoid the excellent question, What good is 5 percent of an eye? by arguing that the possessor of such an incipient structure did not use it for sight.

To invoke a standard example, the first fishes did not have jaws. How could such an intricate device, consisting of several interlocking bones, ever evolve from scratch? "From scratch" turns out to be a red herring. The bones were present in ancestral forms, but they were doing something else—they were supporting a gill arch located just behind the mouth. They were well designed for their respiratory role; they had been selected for this alone and 'knew' nothing of any future function. In hindsight, the bones were admirably preadapted to become jaws. The intricate device was already assembled, but it was being used for breathing, not eating.

Similarly, how could a fish's fin ever become a terrestrial limb? Most fishes build their fins from slender parallel rays that could not support an animal's weight on land. But one peculiar group of freshwater, bottom-dwelling fishes—our ancestors—evolved a fin that had a strong central axis and only a few radiating projections. It was admirably preadapted to become a terrestrial leg, but it had evolved purely for its own purposes in water—presumably for scuttling along the bottom by sharp rotation of the central axis against the substrate.

In short, the principle of preadaptation simply asserts that a structure can radically change its function without altering its form as much. We can bridge the limbo of intermediate stages by arguing for a retention of old functions while new ones are developing.

Will preadaptation help us to understand how Lampsilis got its fish? It might if we can meet two conditions: (1) We must find an intermediate form using at least some elements of the fish for different purposes; (2) We must specify functions other than visual decoy that the proto-fish could fulfill while it gradually acquired its uncanny resemblance.

Ligumia nasuta, a "cousin" of Lampsilis, seems to satisfy the first condition. Gravid females of this species do not have mantle flaps, but they do possess darkly pigmented, ribbon-like membranes that bridge the gap between partly opened shells. Ligumia uses these membranes to produce an unusual, rhythmic motion. The opposing edges of the ribbons part to form a gap several millimeters in length at the mid-part of the shell. Through this gap, the white color of the interior soft parts stands out against the dark pigment of the ribbon. This white spot appears to move toward the back of the shell, as a wave of separation propagates itself along the membranes. These waves may repeat about once every two seconds. J.H. Welsh wrote in the May 1969 issue of Natural History:

The regularity of the rhythm is remarkably constant. To a human observer, and perhaps to a fish, the eye-catching feature here is the white spot that appears to move against the dark background of the mussel and the substrate in which it is half buried. Certainly this could be a lure to host fish and may represent a specialized adaptation from which the more elaborate fishlike lure evolved.

"Fish" with eyespot and tail rides atop Lampsilis ventricosa. When a fish nears, the clam discharges larvae; some will be ingested by the fish and find their way to its gills, where they will mature.
We are still dealing with a device to attract fish, but the mechanism is exact, regular motion, not visual mimicry. If this device operated like the flaps were evolving and truly building their resemblance to fish, then we have no problem of apipent stages. Motion of the mantle acted fish from the start; the slow development of a protruding fish only enhanced the process.

*Lampsilis* itself fulfills the second condition. Although no one has denied the significance of visual resemblance as a lure, our leading student of *Lampsilis*, L.R. Kraemer, questions the common assumption that "flapping" of the body serves only to simulate the movements of a fish. She believes that flapping may have evolved either to aerate the larvae within the marsupium or to keep them afloat in the water after their release. Again, if flapping provided other advantages from the start, the fortuitous resemblance of lips to fish might be a preadaptation. If initial, imperfect mimicry could be improved by natural selection while the flaps performed other important functions.

Common sense is a very poor guide to scientific insight for it represents natural prejudice more often than it reflects the native honesty of a small boy before the naked emperor. Common sense dictated to Darwin's critic that a gradual change in form must dictate a progressive building of action. Since they could assign no aptive value to early and imperfect stages of a function, they assumed either that early stages had never existed (and that perfect forms had been created all at once) or that they had arisen by natural selection. The principle of preadaptation—functional change in structural continuity—can resolve this dilemma. Darwin ended his paragraph on the eye with this perceptive evaluation of "common sense":

When it was first said that the sun stood still and the world turned round, the common sense of mankind declared the doctrine false; but the old saying of *Vox populi, vox Dei* [the voice of the people is the voice of God], as every philosopher knows, cannot be trusted in science.

Stephen Jay Gould teaches biology, paleontology, and the history of science at Harvard University.

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PUBLISHER'S NOTE: Dr. Ochsner is one of the outstanding leaders in modern medical progress. Now Emeritus Professor of Surgery at Tulane University School of Medicine, he maintains an active practice at the famed Ochsner Clinic in New Orleans. As a member of our Editorial Board, we have asked him, out of his unique long personal experience with vitamins C and E, to tell you how and why he uses them.

—Richard Stanton

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The Many Ways to Beget a Frog
by Martha L. Crump

A diversity of reproductive strategies enables a vast array of species to coexist in the same area.

Frogs in temperate climates lay their eggs in water; the tadpoles hatch and eventually metamorphose into small replicas of the amphibious adults while still in their aquatic birthplace. This strategy represents a mode of reproduction that has proved successful for many frog species. Things don’t work quite that way in the tropics, however, where frog reproduction is a more complicated and diverse affair.

Clutches of pearl white frog eggs cached under rocks, a brown and iridescent red frog carrying six black tadpoles on its back, dark green frogs depositing eggs on leaves more than three feet above the surface of a pond, a large mass of white foam with wriggling tadpoles inside: these are but a few examples of the many different and highly adaptive reproductive strategies of tropical frogs. Such intriguing adaptations sparked my curiosity and led to a thirteen-month study of reproductive diversity in frogs at Santa Cecilia, Ecuador.

The greatest richness of frog species of any area in the world studied to date is found at Santa Cecilia—a small Quechua village on the north bank of the Río Aguarico, a tributary of the Río Napo, in the upper Amazon Basin—where eighty-one species of frogs live in an area of about two square miles. There are few places in the United States where one can find as many as twenty species of frogs in a similar-sized area.

Eight families of frogs, encompassing twenty-five genera, are represented at Santa Cecilia. Ten of the genera are endemic to South America; the remaining fifteen are also found in Central America. Several of the species are only found in the upper Amazon region, whereas some are widespread throughout the Amazon Basin. The distribution of others is peripheral to the Amazon Basin or restricted to the eastern slopes of the Andes.

One of the first questions that comes to mind about the frogs at Santa Cecilia is, Why are there so many species in this one area? The answer is found in a combination of the geographic location and historical zoogeography. The site is peripheral to both the Amazon Basin and the eastern slopes of the Andes. The result is a composite of species from these two faunal regions. The fact that about 15 percent of the eighty-one species are seemingly rare may indicate that these species are living at or near their ecological limit.

Another possible explanation for the species richness is that the area was probably a forest refugium during the Pleistocene. In 1969, geologist Jürgen Haffer proposed that climatic oscillations during the Pleistocene resulted in alternating series of contractions and expansions of the rain forest in lowland tropical South America. He postulated that during dry phases the forest covered only small, disjunct areas, which would have acted as refugia for forest animals. Local selection pressures would have resulted in intense differentiation among the populations inhabiting the enclaves. During wetter phases, the forests expanded. Where previously isolated populations came together, they formed the present, complex patterns of speciation typical of secondary contact zones. One of the nine refugia postulated by Haffer is the Napo region, in which Santa Cecilia is located.

Of great ecological interest is another question, How are all these species able to coexist? After studying the frog fauna at Santa Cecilia, I have concluded that a major factor enabling coexistence is the high reproductive diversity of the different species. This diversity allows coexistence because of a multidimensional (time and space) partitioning of breeding sites and probably coevolved with extensive speciation during the Pleistocene as a means of coping with the changing environment.

A commonly proposed evolutionary trend regarding reproduction in frogs is that these amphibians have evolved toward greater terrestrialism. This trend can be seen in the reproductive strategies of many of the Santa Cecilia frogs. Many of these frogs utilize specialized oviposition sites on land; some have also eliminated the tadpole stage. These specializations allow for partial or complete independence from an aquatic environment for breeding purposes—as opposed to nearly all North American frogs, which deposit their eggs directly in water and whose larvae develop in an aquatic environment.

The reproductive diversity of the Santa Cecilia frog fauna consists of ten “modes of reproduction.” This term refers to a combination of egg deposition site and type of development—larval or direct. The modes may be divided into three major categories: (1) Eggs and larvae in water (modes 1–3, 36 species); (2) Eggs out of water, larvae develop in water.

A Central American species, Agalychnis callidryas lays its eggs on leaves that hang over water. After hatching, the tadpoles drop into the water to complete their development.
(modes 4–6, 25 species); (3) Terrestrial eggs, eggs attached to dorsum of female, direct development (no free-swimming larval stage), or larvae develop within nest on land (modes 7–10, 17 species). The mode of reproduction is unknown for three of the species.

Thirty-four species (46 percent of the frog species at Santa Cecilia) deposit their eggs directly into standing bodies of water, such as ponds, water-filled ditches, lakes, and swamps (mode 1). This group includes mainly toads, one “true frog” *Rana*, tree frogs, and narrow-mouthed toads. Their tadpoles develop in water, eventually metamorphose, and leave the water for land.

These species deposit many small eggs; clutch sizes range from about 140 to more than 8,500 eggs. Mortality is high for both eggs and tadpoles as evaporation often causes the water body used to dry up. In addition, the unguarded eggs and larvae typical of some species are subject to predation by aquatic insects, fish, snakes, and birds. For these reasons, larvae of some species of mode 1 frogs have accelerated development; their strategy is to metamorphose and leave the water as soon as possible.

All of these species have pigmented eggs. The melanin in the eggs may promote adsorption of radiant heat energy, thereby allowing the eggs to develop faster; it may also shield the eggs from harmful ultraviolet radiation. Generally, those species that deposit their eggs in areas most exposed to direct sunlight have the most pigment; those species that deposit their eggs in areas sheltered from direct sunlight have the least.

Mode 2 is represented at Santa Cecilia by only one species of tree frog, *Nyctimantis rugiceps*. This species deposits a moderate number of small eggs in a water-filled cavity in a tree or stalk of bamboo. Because the eggs and larvae develop in an isolated site, they are less prone to predation and environmental hazards. However, the tadpoles do have to cope with several problems. Because the cavity is small, they may be subject to mortality due to insufficient oxygen and a limited food supply.

Mode 3 is also represented by only one species of tree frog, the large *Hyla boans*. Males construct basin-like nests in sand, gravel, or mud along the edge of a river. Each male then positions himself beside his nest and calls to attract a female. Males have a protruding prepollex (vestigial digit on the inner side of the first digit on the forefoot) with a long, curved spine. The spine probably aids in grasping the female during amplexus (mating). The female deposits several thousand small, heavily pigmented eggs in the water-filled nest basin. The eggs spread out over the surface of the water, forming a film. The selective advantage of a surface film is that it maximizes an egg’s respiratory area in an oxygen-poor environment.

Although the nest allows for minimal predation by aquatic organisms, the tadpoles in the constrained nest provide an easy target for birds. Another disadvantage is that the nests are subject to flooding or drying if the level of the river changes significantly. Food for the tadpoles is also a limited resource in the nest. And yet, in spite of these hardships, the species is highly successful, as demonstrated by its distribution and abundance in the Amazon Basin. The specializa- tion of the isolated egg deposition site must therefore be advantageous.

Fourteen species of frogs deposit their eggs on leaves above water (mode 4). When the tadpoles hatch, they fall into the water below and complete an aquatic larval development until metamorphosis into young frogs. The clutch size of these species ranges from 18 to more than 1,000 eggs. Because most of the species deposit their eggs hidden among vegetation, and so are not exposed to direct sunlight, mode 4 frogs usually have totally unpigmented or only slightly pigmented eggs.

An advantage of this mode of reproduction is elimination of the problems of early development in an aquatic environment (evaporation of

*Nuptial excrescences on the thumbs of the male Phyllomedusa dacnicolor enable him to cling to the back of his mate, piggyback fashion, while she searches for a suitable site to lay eggs.*

James Harken
mass consist mainly of eggless capsules. These “plugs” at the top and bottom provide protection from the sun and dry air. The one at the bottom also serves to keep the nest intact until hatching occurs. The empty capsules also provide an extra source of fluid for the developing embryos.

The eggs of six species of the family Leptodactylidae are suspended in a frothy mass of mucus, semen, air, and water, produced by kicking of the male during amplexus (mode 5). This frothy mass, with a consistency of whipped egg whites, is called a “foam nest.” Some species produce this foam nest on the surface of a pond; others place the nest in a cavity by the water’s edge. Such a nest provides a moist environment for developing eggs and young larvae. Young tadpoles leave the nest and complete their development in the water. The larvae of most of these species have thin, muscular bodies adapted for migrating from the foam nest to adjacent bodies of water.

The tadpoles probably avoid much competition for food and space in the pond by undergoing early development within the security of the foam nest. The nest also provides a protective covering for the eggs and young larvae, eliminating the problems of desiccation and predation. (Who would want to bite through a frothy mass of foam just to eat tadpoles for dinner?}

Males of two of the species have prepollicial spines for maintaining a secure grip on the female—mated pairs of these species are quite active when kicking up the foam nest. One species has a cluster of horny spines on the chest and greatly enlarged forearms for the same purpose. Clutch sizes for the six species are moderate (235 to 1,740 eggs) and most species have nonpigmented eggs.

Five species of frogs (family Dendrobatidae) deposit large, moderately pigmented eggs in moist, secluded places on the ground in forest or forest-edge habitats. When the larvae hatch, they are carried to water on the back of one of the adults (whether the male or female transports the tadpoles may be species-specific). Three species of these mode 6 frogs carry their larvae to slow-moving streams, where the tadpoles develop in quiet pools. At this point, the larvae are subjected to aquatic predators and no longer have the protection of the adult.

Two species transport their tadpoles to some constrained body of water such as a cavity in a tree or log. These larvae are less exposed to aquatic predators, but food is probably a limited resource due to the small, confined area.

Adults have no apparent modifications for attachment of the larvae.
The larval body form is slightly depressed and the anteroventral half of the tadpole is slightly concave. This shape probably helps the tadpole fit the slightly curved surface of the adult's dorsum. The tadpoles are capable of maintaining their position on the adult in spite of considerable physical disturbance. Release apparently is a combination of larval and adult activity and probably is correlated with larval age. All of these are small frogs (less than 30 mm) and have low fecundity (9 to 23 eggs).

One species of the family Leptodactylidae produces foam nests in depressions under logs or rocks on land (mode 7). The foam nest is similar to that of mode 5, except that in this case there is total independence of standing water. All larval development occurs within the nest. The clutch size is small (fewer than 20 eggs), but the nonpigmented eggs are large. The hatching tadpoles have large yolk sacs, which provide all their nourishment until they metamorphose and leave the foam nest.

This specialized mode of reproduction eliminates the problems related to aquatic development. The outside layer of the nest becomes crusty, thus alleviating the potential problems of desiccation and terrestrial predators.

Fourteen species of frogs (genus Eleutherodactylus) deposit large, nonpigmented eggs in moist, seclusional terrestrial or arboreal sites, usually amidst leaf litter, in and under logs, and in bromeliads (mode 8). Development takes place within the egg capsule, resulting in the hatching of a miniature replica of the adult. The eggs have large quantities of yolk that provide nourishment for the entire development of the embryo. Hatchlings have a horny projection (called an "egg tooth") on the tip of the snout, which they use to rip through the jelly capsule during hatching. The egg tooth is shed soon after hatching.

These species are small (20–45 mm) and deposit few eggs (5 to 43). Because the free-swimming larval stage has been eliminated, these species are entirely independent of standing bodies of water. The eggs are subject to desiccation and terrestrial predators, however.

A totally aquatic species, Pipa pipa, has evolved extreme specializations for parental care. The eggs develop in pits, covered with skin, on the back of the female (mode 9). Incredible acrobatic behavior is used by these frogs in transferring the eggs from the cloaca to the dorsum of the female. The male grasps his mate in front of her hindlegs, and the pair then swim upward in a loop. The female releases the eggs at the top of the loop (when the pair are upside down); the eggs fall on the male's underside and are fertilized. As the pair continue swimming, the fertilized eggs fall onto the female's back. Her skin swells up around the eggs and encloses each one. All development takes place within the egg, and the tiny frogs eventually swim out of their individual pouches. The clutches are relatively small, and the eggs are large.

There is also a terrestrial species at Santa Cecilia, Hemiphractus probos-cideus, that has evolved specializations for parental care (mode 10). Eggs are carried on the back of the female in separate depressions. Again, the clutch size is small and the eggs are large. The eggs contain sufficient yolk to nourish the embryos throughout development. Development is direct; when the young hatch, they are miniature replicas of the adults. Hatchlings are carried about on the female's dorsum for awhile; the young have large, flat gills that adhere to the back of the female. By the provision of extensive parental care, the young of this species are protected from many hazards.

With so many different modes of reproduction, we can see how the available habitat is partitioned in different dimensions. Many species exhibit the generalized mode of depositing eggs directly into water and having aquatic larval development. But slightly more than half of the species in the Santa Cecilia frog community have evolved breeding specializations. These highly evolved reproductive modes are adaptive strategies in response to environmental pressures. No one mode is "perfect" but such a diversity allows for maximal coexistence, resulting in a species-rich fauna.
Hyla punctata of Trinidad lays its eggs in a standing body of water. This strategy results in high mortality due to water evaporation and predation. Consequently, this species lays a large number of eggs.
Brooklyn's Hasidim

by Jerome R. Mintz

Exiled from their homes in Europe, these ultra-Orthodox Jews have reestablished their communities in New York and face their future with optimism.

"The difference between Satmar hasidim and other Jews is this: Once when the time came to put the Torah (the Old Testament) back in the covering, it was too difficult to fit it in, and the man who was putting it in suggested that they cut the Torah to make it fit. Ridiculous? Of course. You have to cut the covering to shape. We will adjust our environment to fit the Torah and not the reverse."

This parable, told by the Satmarer Rebbe (leader) at a Friday night meal, epitomizes the attitudes of the most Pietistic hasidic Jews living in the Williamsburg section of Brooklyn. The hasidim are ultra-Orthodox Jews who until World War II were the easiest residents of the villages and ghettos of central and eastern Europe.

R. Leib (a pseudonym), a Satmar hasid who quoted his Rebbe's parable to me, is a Hungarian Jew who survived the final year of the war in a concentration camp. Today he is one of some 75,000 hasidic Jews who live in Brooklyn, New York.

Leib's religion dominates his life, as it did in prewar Hungary, and his full beard and black caftan are outward signs of a complete allegiance to his faith. Early each morning and again just before nightfall he prays in the besmedresh (house of study), usually with the same quorum of at least ten men; during evenings after prayer, he studies the commentaries on the Torah with another small group.

His wife shares the daily rhythm of religious life, although women's activities are sharply separated from those of the men. Like most hasidic women, she rarely attends public services in the besmedresh, where she must sit in a screened balcony with the other women. The most evident signs of her religiosity are her efforts to maintain the ritual purity of her home, her attendance at the ritual bath after her menstrual cycle, her modestly cut, long-sleeved dresses, and the wig she wears to cover her closely shorn hair. Only the housing project where they live, the brownstone houses on the neighboring streets, and the elevated subway connecting Williamsburg to Manhattan testify that the hasidim have been transported to the New World and that their life has changed.

Most hasidim who immigrated here in earlier decades melted rapidly into the larger American Jewish community. Those who arrived in the postwar years, however, refuse to slip quietly into the surrounding soci-
They almost never intermarry, attend the theater, watch a movie or television, or seek advanced secular education. A large percentage work in the diamond and knit goods industries, while others work at jobs related to the community's religious needs, such as teaching at yeshiva (schools) or handling kosher food products.

The Brooklyn hasidic community's social and economic organization closely replicates that of the prewar eastern European village where hasidic Rebbes and their courts were established. The Rebbes were the descendants of the disciples of the Baal-Shem-Tov and Rabbi Dov Baer, the two figures who initiated the hasidic movement in the mid-eighteenth century. The early hasidim separated themselves from established congregations and initiated a range of religious and social changes: the scholarly rabbi, who decided on questions of law, became subordinate to the inspired Rebbe; a more esoteric liturgy was substituted; prayer and devotion were intensified, and some rituals, such as visiting the ritual bath (a small pool, deep enough for one to completely immerse oneself while standing) were emphasized. As the disciples of the first hasidic leaders gathered their own followings, hasidic dynasties developed, with the Rebbes and their hasidim maintaining mutual loyalty in succeeding generations.

The physical center of each group was the hoyf, or “court,” a term that carried both the physical sense of the courtyard containing the Rebbe's residence, the house of study, the bathhouse, and the shops and storehouses, and the intrinsic dynastic qualities of inherited statuses and loyalties. Each court took its name from the town in which it was settled, for example, Satmar in Hungary, Lubavitch in Russia, Ger in Poland, Bobov in Galicia. Each was largely self-contained, with its own artisans, ritual slaughterers, shopkeepers, and an endless stream of visitors who sought the Rebbe’s blessing, contributed financial support, and carried back to their villages tales of the miracles wrought by the Rebbe.

The various hasidic courts, which were once scattered throughout eastern Europe, are now located in this

An undercover detective dressed as a hasid.
At a demonstration supporting Soviet Jews, hasidic children dress in karate robes to symbolize Jewish power.
country and in Israel. Here, they are concentrated in three Brooklyn neighborhoods—Williamsburg, Crown Heights, and Borough Park. Most hasidim in Williamsburg are of Hungarian origin and have allegiance to Satmar. The Russian hasidim of Lubavitch are settled in Crown Heights; while the growing community in Borough Park, comprising a range of courts of diverse geographic origins, is strongly influenced by its many American-born hasidim. Each court’s size, which varies from fifty to several thousand families (for the Satmar community), is related to the number that survived the war, the percentage that preferred to settle in Israel, and the reputation of its Rebbe.

The strength of the present hasidic community derives in great measure from the intimacy and shared responsibilities within the courts. Each court is attached to a particular Rebbe and bound by special customs and traditions and a common language. Its followers have a shared point of view regarding religious and political matters and an oral literature concerning its Rebbes from the past to the present. Each court maintains its own yeshiva and besmedresh which are supported by tuition and voluntary contributions, generally 10 to 20 percent of every household’s income. The duties and shared obligations develop strong, self-perpetuating bonds, with the sons assuming the loyalties and responsibilities of their fathers.

Like all Orthodox Jews, the hasidim are regulated by the 613 commandments (mitsves) of the Old Testament and by the elaborations of rabbinical interpretation. The mitsves embrace every area of human activity and are the moral and legal guides for daily life. Each Jew’s personal fate, as well as the destiny of the community, is believed to hinge on the fulfillment of the laws. The hasidim, more fervent and punctilious than other Orthodox Jews, are considered to be zealots of the law.

In accordance with the most pervasive commandments, the hasidim honor the Sabbath (Shabbes) and the holy days, pray three times each day, bind phylacteries (tefillin) to the forehead and arm each morning, eat only kosher food, and use separate kitch-
enware for milk products and for meat.

The Sabbath is divinely mandated and its observance is public and communal. From Friday sundown until Saturday night all work comes to a halt and a sense of solemnity and celebration descends over the neighborhoods. On Friday afternoon Joel and his fellow hasidim return home early from work. The shops close on the avenue and cars and trucks are parked, except for those of outsiders who pass through the quiet streets. The men come to the basement of the besmedresh where they step into the ritual bath to purify themselves in honor of the holy Shabbes. They wear silk caftans, and those who are married wear round fur hats with twelve spokes of fur. It is an emulation of the dress of the nobility of two centuries ago, now worn in celebration of the holy day and as a symbol of the hasidim’s exalted state. That night and the following day are times for intense prayer, for periods of study, for visiting, strolling, and for meeting with the Rebbe and the court.

During the Shabbes the men con-
aggregate three times for communal meals. The hasidim are famous for the third meal, which takes place late Saturday afternoon. The Rebbe, dressed in a resplendent robe and fur hat, is seated at a long table; at the table are learned rabbis and illustrious members of the court. A newly married hasid has the seat of honor next to the Rebbe. The rest of the followers crowd before the table, those in the rear standing on benches, to observe the smallest motion of their Rebbe, be it lifting his spoon or stroking his beard. Individual hasidim catch the Rebbe’s eye and toast him with a glass of brandy or beer and, in return, receive his blessing. The Rebbe is customarily served large platters of food—fish, chicken, bread, and soup—but he eats sparingly from the portions. The remains of each dish are then divided into small pieces and passed out to the hasidim, with the Rebbe or his assistant designating the recipient. The tidbits that the hasidim receive are not meant to satisfy their appetite; rather, the morsels enable them to share in the Rebbe’s holiness and power. Most of the food is divided in an orderly way, but there are moments when the desire to partake results in chaotic scrambling. The food is passed among the followers until everyone has tasted it or until the supply is exhausted.

After the meal, in the growing darkness, the Rebbe says toyrekh, his teachings. His talk is often set in mystical terms intertwined with biblical and talmudic allusions. At times, the Rebbe presents his thoughts as if in a semitrance, interweaving examples from the past with problems of the present. He may urge his followers to worship with fervor or insist that they preserve every vestige of the past as a shield—or he may warn his followers against riding the subway during rush hour when contact with women is unavoidable. Often the Rebbe’s toyrekh concludes with the prayer for the coming of the Messiah.

The laws are the primary factor in the development of the hasidic ethos. Fear of contamination through purposeful or accidental failure to carry out the mitzvos helps create a pervasive anxiety that begins early in life. At the age of two, children are taught to make a blessing when they awaken.
and before each meal. When young men reach sufficient maturity to be present at the Rebbe’s table to listen to his teachings, each is certain that he is being directly addressed.

The tensions in fulfilling the laws would be insupportable if they were not introduced gently and balanced by the acceptance of human frailty and by the warmth and affection that are characteristic of hasidic life. Hasidic children play in the heart of the besmedresh, sometimes disturbing prayers and spilling over into the corridors and offices. For children, the house of study is their playground; for adults, it is the center of their lives. Among many of the most dedicated hasidim the religious law is compensated by sympathy and understanding for the problems of young people.

Although every hasid is observant of the laws, the Rebbe’s zeal and insight are considered to be on a different scale from that of other hasidim. As a Lubavitcher hasid described it, the Rebbe “worships God every second of the day with all his heart and soul.” Because of his prayer, his piety, and his family lineage, the Rebbe is thought to be in contact with enormous spiritual power.

Despite his importance in the community, the Rebbe is not lost to the individual hasid. Several times each week the Lubavitcher Rebbe remains in his office throughout the night to receive individual hasidim who come for his blessing or for his counsel. Although the Satmar Rebbe is 89 years old, he still receives his followers individually at his retreat in Belle Harbor, New York. The Lubavitcher Rebbe is celebrated for stimulating Orthodoxy among less religious Jews, and the Satmar Rebbe is known for his fierce determination to maintain every vestige of law and custom and for his opposition to the government of Israel. Notwithstanding their general fame and public responsibilities, the Rebbes’ personal relationships with their hasidim are crucial for the maintenance of their courts.

Hasidim approach their Rebbe with a wide range of motives and needs. Some come for compassion, others require advice or a blessing, and some seek a miracle. They petition their Rebbe to help them overcome an illness in the family, the conflicts in a bad marriage, the curse of poverty and ill-fortune. To fend off potential danger, the Rebbes are also asked to decide on and to bless any family affair or business venture. A hasid will rarely make an important decision or pass through a crisis without visiting the Rebbe to ask for his blessing.

While its Rebbe provides a spiritual center of gravity, a court also requires legal, administrative, and practical organization. These are tasks not usually expected of the Rebbe, whose otherworldliness and spiritual stature generally remove him from the administration of mundane affairs. Orthodox Jewry has always maintained its own legal system to resolve such matters as divorce, contracts, and torts, and it is customary for the Rebbe to designate rabbis who decide such issues. The Rebbe also customarily names a committee of rabbis and learned laymen to administer the besmedresh, the yeshiva, and the ritual bath.

Despite the intense faith and strong traditions of the hasidim, the community would not flourish without new
forms of organization. Survival for each court now depends upon responses to problems involving neighborhood relations, jobs, housing, and government agencies. Today the Rebbe must name men with wide practical experience as court managers to match the needs of the community with the ways of the modern world. With the help of "culture brokers" within the community, the hasidim have used the techniques of contemporary society to perpetuate and strengthen their community.

The Satmar court, for example, now has community services that include a private school system for more than 5,000 children, a weekly newspaper, an interest-free loan service, summer camps, an employment agency, a bus service linking Borough Park and Williamsburg, and community butcher shops whose profits support the yeshivas. The court also operates a medical and dental clinic, a pharmacy, and an emergency first aid and ambulance service. There is a new besmedresh, which holds more than 7,000 people, as well as a new ritual bathhouse for the women. To meet the housing needs of its growing population, the court purchased several hundred acres in Monroe Township, New York, where it will build a satellite community and develop local industry and job opportunities. One such community is already flourishing in nearby Monsey. To meet the loss of jobs in New York City due to the recession in the knitting and diamond industries, the Satmar hasidim have obtained federal aid to initiate programs to retrain unemployed hasidim as mechanics, machine repairmen, computer programmers, bookkeepers, and secretaries—after first assuring the Rebbe that these types of employment would not conflict with Orthodox responsibilities.

Because of the size and unity of their court, the Satmar hasidim have become an important voting bloc in their neighborhood and district. In 1972 they voted to defeat Allard Lowenstein's bid for John Rooney's congressional seat because of their interest in government support for parochial schools. Their voting power, however, was dealt a sharp blow in 1974 when the New York State reapportionment plan redrew state senate and assembly districts, thereby dividing the 35,000 hasidim in Williamsburg into two districts.

The hasidim do not object to their community being the minority in a nonwhite voting district, but they oppose having their community divided. They have brought suit in federal court, contending that the redistricting minimizes their voting strength and denies them their constitutional rights to equal protection and due process as hasidim and as white voters. The Supreme Court has agreed to hear what promises to be a landmark case in the determination of racial and ethnic prerogatives.

The hasidim are threatened by internal as well as external change. The growing hasidic population has resulted in greater geographic spread; as a consequence, social controls within the courts have been weakened. Some hasidim have expressed
distress over the contrast between the appearance of religiosity and true piety. They distinguish between the frum (observant) who obey the basic tenets of Orthodox Judaism, and the ehrlicher (honest) hasid whose piety requires him to do more than the law requires.

With their continued zeal, the hasidim are not likely to discard their Orthodox traditions as did earlier immigrants. Rather, there is the likelihood of dramatic counterreactions. These might take forms already seen in hasidim—revitalized leadership and a more intense perception of Orthodoxy. The most immediate threat to the hasidim, however, is the advanced age of their most distinguished leaders. When a Rebbe dies, his place is usually taken by his son, although leadership can fall to a son-in-law, a grandson, or a devoted disciple.

The process of determining succession often intensifies conflicts between factions and can result in a court’s division or dissolution. In the stress of selecting a Rebbe, differences resulting from geographic distance, size, or ideology may become exacerbated. The fracturing of an overextended court can mean survival for the faction that chooses wisely and dispersion for the one that does not. For this reason, the maintenance of the court is uppermost in the minds of the hasidim when a new Rebbe must be named. They must choose as heir someone who will enable the court to continue. With the death of the Stoliner Rebbe in 1955, his followers in Israel chose to follow an established Rebbe there, while those in this country decided to wait for the Rebbe’s infant grandson to grow up. Since that time, the faction in Israel has dwindled. In Brooklyn, however, the court has grown. The grandson, now the Rebbe, is twenty-two years old and has been married to his first cousin for one year. He keeps an office in his parents’ home in Borough Park. Young and untested, the Rebbe must still prove himself as a leader and teacher, but his presence has enabled the Brooklyn court to remain intact.

The problem of leadership may not be so easy to solve for the Lubavitch and Satmar courts, whose Rebbes are old and without direct heirs. For the hasidim, however, tragedy has supernatural ramifications portending messianic redemption. It signals the culmination of a great design. Expressing his faith, Joel Leib says: “In the darkest hour the Messiah will come.” It is this devotion to their mystical and social heritage, together with their loyalty to the law and to their leaders, that enables the hasidim to flourish in twentieth-century New York.
The Great Stone Faces

by Mark D. Coburn

Trying to carve up Mount Rushmore today would cause a national outcry

If the notion of carving gigantic presidential heads on Mount Rushmore were initiated today instead of during the 1920s, it would not stand a chance. Imagine, if you will, the story of the creation of the Shrine of Democracy moved half a century into the future, and the likelihood of the heads being carved will be immediately apparent.

In December 1923, Doane Robinson, secretary and superintendent of the State Historical Society of South Dakota, began to act on a brainstorm. He approached an old acquaintance, the widely respected United States Senator Peter Norbeck, and proposed to him the staggering idea of hiring a monument sculptor to carve heroic figures somewhere amid the Black Hills. As the months passed, Norbeck was gradually won over by Robinson's reasonable contention that patriotic statuary on a scale larger than that of the Sphinx would draw national attention and tourist dollars to South Dakota. Encouraged by Norbeck, Robinson, in August 1924, broached his scheme to the famous sculptor Gutzon Borglum. The idea promptly aroused Borglum's fervent enthusiasm, and the following month he made his first site-searching trip. By March 3, 1925, Norbeck and Rep. William Williamson had easily pushed through federal legislation permitting a mountain sculpture in Harney National Forest. A corresponding bill in the state legislature faced considerably stiffer opposition (mainly on financial grounds), but by March 5, it too had passed. On August 10, 1927, President Coolidge dedicated the project, and two months later drilling began in earnest.

Transport Robinson's inspiration to our own day and the results are easy to predict. The Sierra Club and Friends of the Earth would be among the best known of the dozen or more conservationist organizations that would immediately launch protests. Such periodicals as Natural History and Audubon would hasten to throw their weight into the battle. Post-Bicentennial enthusiasm notwithstanding, for every thousand letters that would pour into Washington, D.C., or Pierre, South Dakota, voicing patriotic approval of the proposed monument there would likely be ten thousand condemning the plan. The public and its elected representatives would be thunderously reminded that the national forests exist to preserve the natural beauty of our landscape, not to shelter men busily engaged in transforming awesome summits into George Washington's wig or Teddy Roosevelt's mustache.

The objections that would overwhelm the Mount Rushmore Memorial today, then, would likely be primarily a blend of ecological and esthetic concepts. Opponents would argue that the project and the crowds it would draw would mar the environment and that statues are less beautiful than the untouched terrain. During the seventeen years that passed between Doane Robinson's first inspiration and the end of sculpting at Mount Rushmore, in October 1941, these objections were raised, but the protesting voice was merely a whisper in comparison to the national shout we would hear today. Two other kinds of objections to Borglum's endeavors came far closer to stopping the memorial.

The first obstacle, and by far the most important, was economic. In large part, the history of the Mount Rushmore Memorial is a story of the struggle for funding. From Robinson's first battle to induce regional businessmen to pay for Borglum, visit to the Black Hills until the final congressional appropriation for carving the mountain, in August 1940, the dollars were painfully hard to come by. The various Rushmore commissions and other friends of the project did yeoman work to obtain every cent of the $989,992.32 the monument finally cost. Had the general mood of the New Deal years not favored large public projects, the depression would probably have brought Borglum's work to a stop. A $50,000 appropriation for the monument, from grant made to South Dakota by the Reconstruction Finance Corporation in the waning days of the Hoover administration, was the first real turning point for Mount Rushmore. Until then, though, there were always enough congressmen and other opponents who agreed with Rep. T. L. Mortiz of Pennsylvania when he asserted that the statuary was a poor buy because "you cannot eat art." No did the numerous delays in the work particularly endear the undertaking to Congress. It seemed as if each year Borglum needed funds for just one additional year.

Second, the sculptor's personality...
and reputation led many in Washington and South Dakota to question his ability to bring the memorial to completion within a reasonable time and at a reasonable cost. On balance, Gutzon Borglum over the years did more harm to Mount Rushmore than to help it when he directed his considerable energies to raising and administrative problems. On the positive side, Borglum was a superb publicist with a Barnum-like flair for ballyhooing his work. He had many wealthy and influential friends and, for the most part, was deaf at keeping them working for him. Further, his own profound enthusiasm for his labors at Mount Rushmore and his deeply felt belief that he was creating something of enormous patriotic and artistic importance were infectious. Whenever Borglum spoke or wrote about his presidents he made converts. On the other hand, his lack of financial acumen, his desire to be project administrator as well as artist, his belligerence, and his self-righteousness did much to retard the work and to weaken the monument’s cause in Washington. Borglum’s sense of mission too often tended to make him behave autocratically and abruptly at just those times when circumstances called for political finesse, willingness to compromise, and patience for treading calmly through jungles of red tape.

Those disturbed by the havoc that might be wrought by Borglum’s “artistic temperament” found ample justification for their fears in the story of his involvement with the abandoned Confederate Memorial at Stone Mountain, Georgia. In 1925, with a decade of planning and nearly two years of full-time carving behind him, Gutzon Borglum had walked away from his work in response to a stormy disagreement with the Stone Mountain Memorial Association. Further, he destroyed his models (no longer his, but rather their property, claimed the association), and was forced to flee from the Georgia police and to seek sanctuary in North Carolina. Dispassionate examination of the evidence suggests that the sculptor was more sinned against than sinning. His assistant, Jesse Tucker, swore to Borglum that representatives of the association, disturbed by what they deemed Borglum’s extravagance, had approached Tucker in his chief’s absence and tried to get him to consent to finish the monument from Borglum’s models after they fired him.

But such explanations seldom catch up with the headlined stories. No matter that dozens of completed Borglum statues and paintings graced homes, museums, and public buildings in America and Europe (including a fine head of Lincoln in the Capitol rotunda)—by late February 1925, Borglum, inevitably, was best known to the public as the man who had abandoned an elaborate mountain memorial with little more than one head completed. To further diminish confidence in Borglum, when word of the Mount Rushmore project became public, a Georgia group began saturating both South Dakota and Washington with a pamphlet denouncing him.

While economic crises and Borglum-centered problems several times came close to bringing a permanent halt to the blasting and chipping in the Black Hills, a further ground for opposition never became much more than a footnote to the Rushmore saga. Over the years there were sporadic, indignant complaints from groups that seemingly approved of the general concept of a national mountain memorial, but sharply disagreed with the choice of Washington, Jefferson, Lincoln, and Theodore Roosevelt as the sole Americans worthy of immortality through petrifaction. Borglum repeatedly explained the symbolic significance of the men he had chosen. The memorial, he asserted, was less a monument to four particular presidents than a celebration of certain basic themes of American history and culture: Washington stood for independence and the founding of the new nation; Jefferson’s presence recalled government by the people and the first great era of expansion; Lincoln symbolized the preservation of the Union; and Theodore Roosevelt represented the importance of the West in our history and, through his association with the Panama Canal, “the completion of the dream of Columbus.” But such explanations cut little ice with Teddy’s niece Eleanor. Mrs. Roosevelt strongly advocated including the head of Susan B. Anthony, a plea supported in a 1939 resolution by the National Federation of Business and Professional Women. Nor did Borglum’s explanations wholly stifle those Democrats who felt that if modern presidents were to be included, a granite Wilson was needed to balance the rocky Republicanism of T.R.

Although in our day they may seem the most germane possible objections
to the Shrine of Democracy, ecological and aesthetic condemnations of the Mount Rushmore Memorial never came close to threatening the monument's completion. Quite simply, the conservationist view of Borglum's efforts drew relatively little press coverage. Rather, the numerous journalists who commented on the actual carving process were inclined to revel in the statuary's scope and the skill with which the mountain was being devastated. Their prose usually reflected that sense of wonder before the colossal that Borglum himself considered to be so typically American and, hence, one more justification for creating such gargantuan heads in the first place. Most of the newspaper and magazine stories dwelt with awe on the dimensions of the heads, on the engineering problems involved in "carving with dynamite" and in transferring human features from model to mountain, and on geologists' speculations concerning how long the carvings might endure. The journalists' typical slant implied conviction that their readers were more likely to view Borglum's opus as a fine example of American know-how than as aggression against nature. Pictures more often showed how many men could stand in Lincoln's eye or on Jefferson's lip than the rock heap accumulating beneath the presidents or the trees that were chopped down to clear roadways to the peak.

Nor, of course, did the few art critics who spoke out have a chance of convincing the general public that a great engineering feat was not necessarily a great esthetic achievement. And who but the avant-garde cared in the least that Borglum's naturalism was more than slightly passé in the age of Matisse and Picasso?

Usually the ecological and esthetic strands of criticism fused, with the objectors regarding the presidential heads as unlovely because they were unnatural. While such criticisms proved ineffectual, their modern tone makes some of them stimulating reading today.

Cora B. Johnson, editorial writer for the Hot Springs (South Dakota) Star, was prominent among the early critics. She attacked the monument even before Mount Rushmore was selected, when the most likely site for the statuary was reported to be a group of Black Hills spires called the Needles. Said Mrs. Johnson in one of her outspoken attacks: "We view with alarm Doane Robinson's proposal to carve the Needles into statues. Man makes statues but God made the Needles. Let them alone."

Perhaps the most eloquent opponent of the shrine, if a rather tardy one, was a South Carolinian named Ernst Bacon, whose letter to the New York Times appeared in March of 1940, some eighteen months before work on the memorial reached its present state of completion. "I believe there are many people in America," said Mr. Bacon, who do not admire this type of mutilation of the noble outlines of mountains.

There may be some who think that the motive behind such a work is not to make a monument for the Confederacy, as at Stone Mountain, or for the great Presidents of America, as the Rushmore. Stone Mountain is an extraordinary phenomenon. . . .

On its most precipitous slope, where the curvature of the rock is certainly most interesting, Mr. Borglum chose to blast out huge quantities of rock, leaving an enormous pile of detritus underneath and exposing the inner rock, which is white by comparison to a beautiful weathered gray on the natural surface.

In looking over your pictures of Rushmore Mountain before Mr. Borglum went to work there, I have the impression of an extraordinary rock formation being rendered offensive to the eye through this work which is supposed to be art. . . .

We wonder who is served by these gigantic monuments, and the speculation arises as to how far we will yet go toward destroying that which is natural because we must put the trade marks of what we like to think of as our civilization in its place.

In the next few days the Times received two responses to Bacon's letter, both strongly supporting him. One writer brooded on "how long it would take Nature to obliterate the desecration." The other, like Mrs. Johnson fifteen years earlier, asserted that "most people prefer mountains the way God made them."

Some of Borglum's favorite ways of describing his esthetic intentions were tacit responses to criticism of this sort. He enjoyed turning one of his opponents' pet words against them by referring to his work as "natural." The explanation he gave to an interviewer in 1927 is typical of that strain of Borglum's "logic":

Sculptured work on a mountain must belong to the mountains as a natural part of it [sic]; otherwise it becomes a hideous, mechanical application.

A simple inscription upon the broad face of the mountain, for instance, is much nobler and more natural than if that inscription has a line or border around it.

Precisely why the 36-inch-high gilded letters in which Borglum originally intended to carve a brief history of the United States around the corner from the four heads would be "natural," while a border of, say, stars, stripes, and eagles would not be—that the artist never quite made clear.

Another way in which Borglum implicitly justified the naturalness of his work was his dramatic habit of asserting that the essence of the presidential heads had always been a part of Mount Rushmore, and therefore the sculptor's great task was to "free" those heads from the surrounding stone. Such comments as the following are pure Borglum: "Washington still lies behind the granite." The rock must be "relieved.
from the head." "The brow [of Washington] has emerged, amazing mass, vigor and beauty of form, the great face seemed to belong on the mountain; it took on the elemental courage of the rocks surrounding it." "[I must] try and re-

tise the faces of four great Americans within that granite mountain." Caught up in Borglum’s elo-

cence, perhaps his audience never asked themselves why the heads of Hester Keaton and Jack Dempsey could not equally well be "released" on the Black Hills granite. Even

The columnist in The Nation who signed himself "the Drifter" made the point with greater deftness. After opening with some gentle digs at the pretentiousness of carving on a mass scale with dynamite as the chief tool, he reflected on the potential spread of the custom:

In time our financial wizards, seeking new ways of perpetuating their memory, will buy up any remaining available mountains and sit for a sculptor carrying a stick of dynamite in one hand and a match in the other. It is this prospect which fills the Drifter with despair. To come face to face with Washington or Lincoln along some remote mountain range would be at least bearable. But he cannot face the prospect of having to pitch his camp under the nose of Henry Ford.

Ironically, by the time work on the Mount Rushmore Memorial was concluded, some of those charged with the responsibility for it were finding themselves uncomfortably close to agreeing with the project’s opponents. Higher officials of the National Park Service were becoming aware of the problems of land ethic involved in their anomalous position. How could an organization charged with the duty of preserving large portions of the wilderness justify administering a project whose goal necessitated decimating a wilderness peak?

In March 1941 (the same month Gutzon Borglum died and his son Lincoln took over supervision of the final stages of the work), Newton B. Drury, director of the National Park Service, appeared before a congressional subcommittee to plead for a small appropriation for maintaining Mount Rushmore Memorial the following year. When a congressman speculated that there might soon be requests for funds for new mountain statuary, Drury’s reply was both emphatic and suggestive of weariness: "As far as I am concerned, I hope this will remain as it is now, unique, and the only one of its kind."

We could not easily legislate the Mount Rushmore Memorial out of existence, and certainly most Americans have no wish to do so. The Shrine of Democracy remains an engineering wonder, a patriotic treasure, a fact of American life. The conflicts over Borglum’s work are history; the work itself is as immortal as any human creation can hope to be. The memorial, as Borglum often asserted, would seem to have a chance of surviving when virtually all other artifacts of our civilization have vanished. The passing years are making it clear, however, that like any other man-made object, the Mount Rushmore carvings reflect the era of their creation: although Borglum’s presidents may endure half a million years, they are already dated. They reflect a love of the colossal and an assumption about man’s right to overmaster nature more acceptable in the American 1920s and 1930s than in our own day. While future changes in artistic taste and in attitudes toward landscape may again make mountain sculpture seem worth attempting, it is improbable that Borglum’s achievement will be matched in the years immediately ahead. Most of the hundreds of thousands who visit Mount Rushmore annually, however deeply moved they be, would likely share Drury’s hope that the carvings remain unique.
Night Shift for Sloths and Other Sluggards
by G. Causey Whittow

Being slow of foot is not a handicap if you live in the trees and come out after dark

Most mammals move quickly and may cover large areas to obtain the quantities of food they require. High body temperatures and metabolic rates are common features of such active animals. Some species, however, move only very slowly, and they are noted for their extremely sluggish behavior. Slow mammals that immediately come to mind are the sloths. The word sloth itself is derived from the Old English word for slow.

Slowness is not confined to the sloths; it is also characteristic of some prosimians, among the primates. Not all prosimians, however, are sluggish; in fact, some, such as bush babies, are extremely active. But the lorises of Southeast Asia and the pottos of Africa are slow moving by any standards. There are also slow species of marsupials, notably some of the phalangers of New Guinea and Australia.

Sluggishness has not developed as a specialized adaptation in only one order or family. Slow mammals, however, do have some features in common: they are all largely confined to the tropics and they are all both arboreal and nocturnal.

It might be argued that the tropical distribution of slow mammals points to their failure to survive in colder climates. The metabolic response of sloths to cold is defective, but the slow loris and potto are able to regulate their body temperatures at quite low air temperatures. The arboreal habitat of slow mammals might simply reflect the prevalence of rain forests in the tropics or the filling of an arboreal niche for reasons unconnected with being slow. Nevertheless, a slow mammal is probably exposed to fewer predators in the trees than on the ground. Furthermore, although many mammals are able to move rapidly through the trees, an arboreal life—as opposed to life on the ground—makes for relatively slow movement.

From a thermoregulatory point of view, it makes eminent sense for a sluggish mammal to be nocturnal. The animal produces the minimal amount of heat, by metabolism, during the warmer day when it sleeps, and it becomes active and thereby increases its heat production during the cooler night.

What are the advantages of slowness to a mammal? At first sight, a slow-moving animal would seem to be at the mercy of its predators. However, a slow-moving animal is less likely to attract the attention of a predator. By the same token, the prey of a slow mammal may not be aware that they are being preyed upon. I was able to verify this in Malaysia, watching a slow loris capture grasshoppers. First, the loris carefully examined a grasshopper from a distance; then moved forward at an even pace, its outstretched arms spaced wide apart. As it neared the prey, the loris gradually brought its hands together and clutched the grasshopper before the insect suspected its fate.

Another advantage of being slow is a reduced energy requirement. An inactive mammal expends less energy than an active one, and this would give it an advantage in times of food.

Three-toed sloth
Richard B. Peatock, Photo Researchers
shortage. Slowness may also be regarded from the standpoint of niche separation. Some animals are arboreal and some terrestrial (spatial separation); others are diurnal or nocturnal (temporal separation). The spectrum of activity from the very slowest species to the fleetest of foot or wing results in different niches within a habitat, enabling more species to coexist in a given area.

Sluggishness in mammals is associated with an array of structural and functional divergences from the usual mammalian pattern. The most obvious of these is in the limbs. Sloths spend a great deal of their time hanging upside down from the branch of a tree, which, incidentally, virtually removes them from the grasp of many predators. Their digits terminate in huge hooked claws, which are effective structures for suspending the animal from a tree. The slow primates have relatively large hands and feet that are capable of a powerful sustained grip. Not so apparent, but also involving the limbs, are vascular structures called retia mirabilia. The main arteries and veins in the limbs break up into a network of many fine vessels in close apposition to one another. In the potto, the function of these structures may be to insure that blood continues to flow to and from the hands, feet, arms, and legs during the prolonged contraction of the muscles involved in gripping.

Low body temperature is a correlate of slowness in mammals. Rectal temperatures of the two-toed and three-toed sloths were found to be only 34.4° and 33.0°C, respectively, 3° to 4° below the values for most placental mammals. The body temperature of a potto is 2° to 3° below the expected value. I have found that the body temperature of a slow loris is 34.8° during the day and somewhat higher at night. Recent work by T.J. Dawson in Australia has shown that

Searching for a suitable resting spot, a cuscus inches through a network of fine branches in its New Guinea forest habitat. This slow-moving marsupial feeds mainly on fruits and leaves.

Jack Fields; Photo Researchers
The body temperature of the cuscus is 85°C. Low body temperature may be a mechanism for conserving energy. To maintain a high body temperature requires additional food, which would have to be obtained by basking in the sun. Associated with the low body temperature in slow mammals is a very low metabolic rate. The metabolic rate of sloths was found to be only 36 percent of that of other mammals of comparable body size. In the slow lorises, the metabolic rate during the day was 36 percent of the normal rate for placental mammals. The gwtantibo, an African relative of the slow loris and potto, also has a very low metabolic rate. The cuscus is particularly interesting in this regard, because it is a slow marsupial. The metabolic rate of marsupials is generally about 70 percent of that of placental mammals; that of the cuscus is even lower, only 83 percent of the predicted value for marsupials.

The physiological basis of low metabolic rates in slow mammals is not clear. Sloths are deficient in body heat—producing skeletal muscle—a major heat-producing tissue in most mammals. In sloths, the total amount of muscle constitutes only 25 percent of body weight, approximately one-half the proportion of muscle in other mammals. This might contribute to the low metabolic rate. And an animal that spends a great deal of its time motionless does not require as much muscle. Sloths also have a low thyroid gland activity. A Hypothyroid state would be consistent with a low metabolic rate because thyroid hormones are the main hormonal stimulus of an animal’s metabolic activity. A mammal that moves very slowly ed not necessarily have a low metabolic rate while it is at rest. The speed movement during activity will obviously affect the metabolic rate, but it does not follow that there should be a difference between the metabolic rate of a sluggish animal and an animal that moves rapidly, when they are both at rest. Indeed, some very active and quick mammals have low metabolic rates at rest. Nevertheless, all slow mammals studied do have low metabolic rates—conceivably an adaptation to being sluggish. An animal that is inactive for a large part of its time, and then moves slowly when it is active, has a limited capacity to obtain food and energy. A low resting metabolism may reduce the animal’s energy requirements to conform with its diminished feeding capabilities. According to this theory, the low metabolic rate of slow mammals is a consequence of their slowness.

Another possibility is that the low metabolic rate of slow mammals is an adaptation to a hot climate. All slow mammals are tropical animals, and in view of the difficulties of dissipating body heat in a warm, humid environment, it would be to their advantage to produce the minimal amount of heat by metabolism.

The acquisition of a low metabolic rate, and commensurately reduced energy requirements, might then have permitted these mammals to adopt a slow mode of progression and a life of considerable inactivity. In other words, the low metabolic rate might have been the key change that permitted mammals to occupy the niche of slowness. This hypothesis would conform with the finding that all slow mammals that have been investigated are hypometabolic, but not all hypometabolic mammals are slow. Seen in this light, the reduction of muscle tissue in sloths is probably a consequence of slowness rather than the underlying basis of the low metabolic rate. A species that uses its muscles very little will not require the muscle mass of an active animal.

Whatever the origins of a low metabolic rate in mammals, hypometabolism seems to have generated the development of a number of adaptive mechanisms. The reia mirabilia in the limbs may not only insulate an adequate blood flow to the limbs during grasping but may also minimize heat loss to the environment. This is important to an animal that produces little heat, even in a tropical climate. The proximity of arteries and veins in the retia allows the rapid transfer of heat from the warm arterial blood to the cooler venous blood. Heat carried in the arteries, instead of being transported to the skin of the hands, feet, arms, and legs, and then lost to the surrounding air, is “short-circuited” back to the heart via the veins and is thus retained by the body. This is a well-established function of the retia in the flippers, fins, and flukes of marine mammals, which face a formidable problem in the regulation of heat loss because of the enormous cooling power of water. In the sloths, the forelimbs are extremely long, and while this may be an adaptation to their unusual posture, it does increase the potential for heat loss and the need for structures such as the reia mirabilia, which attenuate cooling of the limbs.

In effect, the reia mirabilia serve to increase the thermal insulation of the tissues of slow mammals because they reduce heat transfer from heat-producing tissues to the environment. Another, more obvious way of preserving heat is to acquire a thick coat of hair. The sloths, the slow pri-mates, and the cuscus all have thick fur. The pioneer work of physiologist P. F. Scholander and his colleagues revealed that the thermal insulation of the sloth was greater than that of other tropical mammals. Sloth hair lies in a direction reverse to that of other mammals, presumably to facilitate the runoff of rainwater when they are hanging upside down. This would prevent their fur from becoming sodden and losing its insulative properties. (In some sloths, the growth of algae on the fur imparts a greenerish tinge that may help conceal them from predators.)

Why do slow mammals need a thick coat and reia mirabilia if both serve the same purpose? The answer is that the limbs are usually not as well insulated with hair as the rest of the body. In addition, the limbs have a large surface area relative to their bulk and, in consequence, tend to cool rapidly. In fact, the physics of heat flow from slim, cylindrical structures such as the limbs determines that their hairy integument is ineffective as a thermal insulator.

An animal that starts the day with a low body temperature and meta-
bolic heat production, and which sleeps during the day, is both physiologically and behaviorally well adapted to a hot environment. Studies I have conducted revealed that the slow lorises can also effectively dissipate heat by panting. This would enable the slow loris to tolerate conditions as hot as those it is ever likely to experience in the tree canopy, where solar radiation presents an added heat stress.

In the tropical rain forest, air temperatures in the tree canopy are low at night. In addition, an arboreal animal may lose body heat by radiation to the sky. Under such conditions, the animal's thermoregulatory problem is reversed. We found that the slow loris adjusts to these conditions by increasing its metabolic heat production. Its nocturnal activity produces additional heat, compensating for the increased heat loss to the cooler microclimate.

Slow mammals should show marked changes in their neuromuscular physiology. One investigator found that a sloth's muscles contract much more slowly than those of other mammals. In the potto, the rate of contraction of the limb muscles is intermediate between that of the "fast" muscles, which a cat uses for rapid movements, and that of the "slow" muscles, which are used in maintaining posture. But the speed of muscular contraction may not be the only factor responsible for slowness; the central nervous system may also be involved. A suggestion has been made that sloths have some features of a decerebrate animal—one in which the cerebral hemispheres of the brain have been removed or are not functional. This means that, for part of the time, the higher levels of the brain may not be exerting any influence on the control of breathing, muscle contraction, or other body function.

Passage of food through the gut is exceptionally slow in sloths. The animals defecate and empty their urinary bladder only at infrequent intervals. They often descend to the ground to do this, which may be the basis of their very simple social behavior. Normally solitary and inactive animals, the use by several individuals of the same spot for toilet purposes may be the mechanism by which they meet and breed. Although slowness of movement limits range, the widely circulated story that sloths (and lorises) live their entire lives in one tree is almost certainly untrue.

Slowness invites comparisons with the related phenomena of hibernation and estivation. These are torpid states characteristic of cold climates or periods of drought. Both hibernation and estivation result in a considerable reduction in the energy requirements of the animal and, appropriately, both states may often be induced by a curtailment of the animal's energy supply. However, these are periodic events in response to periodic variations in the environment. Slowness is a less drastic phenomenon and is a continuous state. In the equatorial rain forest, seasonal changes in temperature, rainfall, or food supply are minimal. It is intriguing to consider slowness as a less pronounced, tropical counterpart of true torpidity. In place of a phasic change in the physiology of the animal, correlated with a recurring change in the environment, there is a constant physiological (low metabolism) and behavioral (slowness) adaptive state, induced by exposure to the unchanging heat and humidity of the rain forest. Perhaps slow mammals are the most highly adapted mammals of the tropical rain forest, not only physiologically but also in terms of the energy demands that they make on the rain forest ecosystem.

The slow mammals are an enigma among a group of animals noted for their high body temperature and metabolic rate and for their activity. They deserve more study. Low metabolic states among mammals, particularly in primates, may help us understand how mammalian tissues may adapt to low metabolic levels. Such knowledge could have implications for space travel and for life in any environment where a reduced energy requirement would be an advantage.

Three-toed sloths travel, eat, sleep, mate, and even give birth while hanging upside down. All of these are done very slowly.

Robert C. Homies, National Audubon Society
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NH02
High Torte

For alpine cooks, taking a cake is a supreme achievement.

After a day or so, the body adjusts to high altitude, and we can begin to walk through a normal life without headaches, nausea, and a pounding heart. Cooking, however, remains a problem. Low air pressure compels nearly all the processes of the kitchen. It slows down boiling and reds up deep frying. It throws sugar and propellants out of kilter, and it turns the baking of breads and cakes into a dismally unpredictable affair.

The alpine poltergeists begin to fiddle with our meals as soon as we: 2,500 feet above sea level. Significant trouble settles in at 5,000 feet, approximately the elevation of Denver. And by the time we reach adville, Colorado, the nation’s highest city (elevation 10,190), or adville’s tiny neighbor, Climax, at 11,300 feet probably the loftiest settlement in the country, we have attained a height where it is all but impossible to cook beans in the conventional manner, where bread rises too quickly, and where a poached egg is an achievement.

Of all the pesky changes brought on by thin air, the most unsettling for sea-level natives is the lower boiling point of water. For most of us, 212°F is one of the basic benchmarks of life. It is certainly a crucial factor in cooking because it acts as an upper limit, a foolproof temperature ceiling for anything we might choose to cook in water. You simply can’t heat water higher than 212°F (unless you put it under artificial pressure). Above that limit, it turns to steam, bubbles away.

But, as the air pressure falls at significantly high altitudes, water will turn to vapor more easily. There is less air pushing down on the surface of the water, and so it can bubble up and away with less of a push from beneath, for example, at a lower temperature. This means that boiling will occur sooner, but that the boiling point—that crucial heat ceiling—will be proportionally lower. At 5,000 feet, water boils at 202.6°F. At 10,000, the hottest it will get is 194°F. At 14,000, water boils away in fury, giant bubbles at only 187.3°F.

Consequently, when you put food into this “cool” boiling water, it cooks much more slowly than you might have expected. Bubbles or not, the heat is simply not there.

I tested this proposition last fall on the trail leading up Mount Whitney at the lower right-hand corner of the Sierra Nevada in eastern California. At approximately 12,000 feet, it took slightly more than six minutes to produce a “three-minute” egg. The white took that long to turn opaque. It was delicious, nonetheless. The egg had been purchased the day before when very fresh in Shoshone, California, near Death Valley, where it takes just under three minutes to...
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soft-boil eggs at 280 feet below sea level. But the altitude on the Whitney Trail had turned my stomach and taken away my appetite for eggs or anything else.

Even after fourteen hours of supine acclimatization in a small orange and blue tent bought for $10 at a bankruptcy sale, I was still slightly nauseated. But my body had adjusted enough to the air so that I was able to lace my boots and consider with some confidence the final stage of my assault on the highest peak in the contiguous United States. Whitney rises 14,495 feet. My job: bake a cake at the top.

I will spare you a step-by-step account of my heroic ascent over the last five miles of snow-covered trail, which zigzags skyward in a great, jagged bowl and then rounds a corner to the mountain’s back slope, where, smacked, the previously hidden entirety of the Sierra hits your glare-strained eyes. Stretching hugely away below are trees, peaks, valleys, and flashing monoco lakes.

Getting there is no great feat. Hundreds of Boy Scouts and sedentary marmot-lovers climb Whitney every summer. Baking a cake at fourteen and a half thousand feet, however, is a real accomplishment. Indeed, it may never have been attempted before, because altitude interferes more severely with cakes than it does with anything else in cookery. Even at relatively low elevations, trouble sets in. At a mere 3,000 feet, The Joy of Cooking warns us, cake doughs will begin to suffer “pixie-like variation that often defies general rules.”

If you were to mix up a standard white cake dough and bake it in the usual way in your oven in Denver or Laramie, it would come out flat and dry. The dryness is caused by the low humidity of the mountain atmosphere, while the flatness is a result of the thin air, which defeats the best efforts of baking powder, beaten eggs, shortening, and sugar to hold air in the cake and keep it light.

Baking powder is a chemical raising agent in which an acid and an alkaline substance react, in the presence of moisture, to emit carbon dioxide. This gas forms small bubbles in a normal cake dough. The heat of baking then “sets” the cells formed in the dough by the bubbles. (Modern baking powders are double acting; they begin to act in cold dough, but they do not do most of their work until they are subjected to heat. This permits us to mix up a better, then wait a while before using it.)

High altitude plays havoc with this chemistry. The gas has less air pressure to work against, so it works to well. The batter puffs up and bubbles as if it were boiling. Then the gas escapes before the cells have set and the cake collapses. Other factors also contribute to the density of cakes at high altitude. Sugar, in excess, produces a coarse, crumbly texture. Beaten eggs are a source of unwanted air. Butter and other shortenings also cause problems in air retention.

In other words, if we are to bake a cake at high altitude, we must significantly alter the delicate balance of the batter designed for use at sea level. And, indeed, if you look at modern cookbooks’ baking sections, you will find many recipes that have been modified for the conditions of alpine baking. A typical set of such instructions might direct you to reduce the baking powder in a conventional recipe by ¾ teaspoon per 1,000 feet of rising above sea level. It would also advise decreasing the sugar by ⅛ teaspoon per 1,000 feet, and the shortening by ¼ teaspoon. Conversely, you will sometimes be told to add extra flour and water to the recipe. In the end, this is a sea-level phenomenon, a trick that works in one environment and not in others.

Prospectors and mountaineers, for instance, long ago learned that above 10,000 feet they had to use pressure cookers to cook beans and other foods that require long boiling even at the high temperatures practicable at sea level. Similarly, at alpine altitudes, the standard adjustments for cakes approach practical limit. If you continue to reduce the baking soda by decrement of ⅛ teaspoon per 1,000 feet, you eventually reach a point at which you must, following the rule, eliminate the baking soda altogether from the recipe. For example, the 2 teaspoons of baking soda called for in The Joy of Cooking’s recipe for gold layer cake would have to be omitted in any ve
have verified certain other textbook nostrums about cooking in the upper reaches. As things stand, I am willing to take it on faith that above 2,500 feet, it is a good idea to compensate for dryness by covering prepared foods with aluminum foil and by using slightly less flour or more liquid in bread doughs (and watching carefully so that the more rapid action of yeast does not take you by surprise). I am also ready to believe that pressure cookers require an extra pound of pressure for every 2,000 feet above sea level and an increase of 5 percent in cooking time for every 1,000 feet above the first 2,000. And I will not hesitate, when next in Leadville, to add extra liquid to pancake batter or to consult a table of high-altitude temperature equivalents before attempting to cook sugar for candy or icing. All the usual stages, from soft ball to hard crack, occur sooner (at lower heats) the higher you go.

Finally, I take pleasure in advising the fast-food moguls that when they set up shop atop Pike's Peak, they will have the devil's own time serving crisp French fries. Even at relatively modest altitudes, the recommended frying temperature has to be reduced to about 355°, from the normal 375°, because the boiling point of the internal water in the potatoes is lower. Without lowering the fat temperature, you get external browning well before the inside has cooked. Presumably, at high enough altitudes, correcting for this anomaly will force French-fry vendors to lower their fat temperature to a point so low that it will seep into the potatoes and leave them as limp and greasy as some I once ate in a low dive in Austin, Texas. But that's another story for another time, when we have come down to earth. For the moment, my thoughts are still lofty, and I want to offer you the world's highest cake. The recipe is printed with ingredient quantities suitable for the summit of Mount Whitney.

Whitney White Cake

11½ tablespoons sugar
2 cups sifted cake flour
3/4 teaspoon salt
3/4 teaspoon baking powder
2½ tablespoons shortening, softened
1 cup milk
1 egg, unbeaten
1 teaspoon vanilla

1. Preheat oven to 400° or set up your camp stove.
Discovering underwater treasures

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AN ANCIENT WORLD PRESERVED
by Frederic André Engel


CROWN

2. Mix together the sugar, flour, s and baking powder.
3. Beat the shortening and the n into the mixture from step 2. C
4. Now beat in the egg and the nilla and mix until smooth.
5. Turn into a greased, floured ni-
6. Cool briefly and turn out onto rack or other clean surface.

Yield: one nine-inch cake

Note: The quantities given above are intended for altitudes in the 14,000 to 15,000-foot range. To translate backward for lower altitudes, add teaspoon baking soda per 1,000-foot descent. Also, add ½ tablespoons sugar and ½ teaspoon shortening for each 1,000-foot drop and subtract tablespoon of milk for every 2.5 feet. Reduce oven temperature 4° for 1,000 feet of descent.

Rocky Mountain Icing

1 cup sugar
½ cup water
½ cup light corn syrup
1 egg white
2 marshmallows, cut in eighths
½ teaspoon vanilla extract
½ teaspoon almond extract

1. Stir together sugar, water, a corn syrup in a saucepan.
2. Bring to a boil and continue cooking over high heat until it reaches the soft-ball stage (202°- 14,000 feet. For lower elevation add 2° for each descent of 1,000 feet. For example, at sea level, the soft-ball stage is reached at 234°; at 7,500 feet above sea level, the equivalent temperature is 219°).
3. Beat egg white until stiff. Scat marshmallow bits over it. The pour on the hot syrup and beat vigorously until the icing holds shape and has almost completely cooled.
4. Beat in vanilla and almond extracts and apply icing to cake.

Raymond Sokolov's most recent cookbook is The Saucier's Apprentice, a guide to French sauces.
THE AMERICAN MUSEUM OF NATURAL HISTORY ANNOUNCES EVENING LECTURE SERIES FOR ADULTS STARTING FEBRUARY, 1977

THE GRAND DELUSION—6 Tuesdays starting February 8, 7:30-9:00 p.m. Fee: $25.
Human curiosity has discovered the Americas, photographed Mars, isolated antibiotics and concocted mayonaise. However, a mocking and attractive delusion walks beside each scientific field of knowledge. In this illustrated series, four noted scholars in the history of ideas explore the grandest and most persistent human delusions that still haunt 20th century science—Atlantis, Astrology, Dream Interpretation, Underworlds, Alchemy and Decipherment. Professors Claireve Grandjouan, Jean R. Bram, Robert J. White and Tamara M. Green, all from Hunter College, The City University of New York.

UNDERWATER ARCHAEOLOGY IN THE MEDITERRANEAN: Ancient Ports, Ships and Travelers—6 Wednesdays starting February 23, 7:30-9:00 p.m. Fee: $25.
Dr. Anna Marguerite McCann, one of the major archaeologists working under the sea in the Mediterranean, will explore the importance of ancient harbors, concentrating on recent underwater excavation which she has directed. The historical setting, the significance of the sites and the artifacts found will be included with a background on the people and travelers of the times.

AN ANTHROPOLOGIST AND A VILLAGE—6 Wednesdays starting February 9, 7:00-8:30 p.m. Fee: $25.
Drawing on a line collection of colored slides, Dr. Malcolm Arth, Curator at the Museum, shares his experiences in a West African village and in a Native American community as a basis for discussing the many facets of living with other peoples; and recreates the frustrations and joys of the cultural anthropologist engaged in field work.

AN AWAKENING IN ANTHROPOLOGY—7 Thursdays starting February 10, 7:00-8:30 p.m. Fee: $30.
Social "trivia," from naming dogs to patterns in swearing, even the choice of paints for a home are now considered significant social data with complex symbolic meanings. Paul J. Sanfalcon, Lecturer in Anthropology at the Museum, brings to light some present-day thinking of anthropologists about both modern and tribal societies.

EXPLORE WEAVING—10 Tuesdays starting February 8, 7:00-8:30 p.m. Fee: $60. Limited Enrollment.
In this introductory workshop, Kate Bennett-Mendez of the Museum's staff will explore the evolution and history of weaving from an anthropological point of view. Lecture/demonstrations focus on techniques, materials and looms used by North American Indian, Guatemalan, Peruvian, West African and Pacific Island weavers.

MEDICAL ENTOMOLOGY—8 Thursdays starting February 10, 7:00-8:30 p.m. Fee: $30.
Some insects look quite harmless but have helped to wipe out entire populations in some parts of the world and are a constant threat almost anywhere. In these slide-illustrated lectures, Dr. Mohammad Shadab of the Museum's Department of Entomology describes the insect vectors, their biology and the life cycles of the parasites they carry.

MUSHROOMS, MOSSES, FERNS AND OTHER NON-FLOWERING PLANTS—5 Thursdays starting February 10, 7:00-8:30 p.m. Fee: $20.
The non-flowering plants range from microscopic bacteria to gigantic kelps and conifers. In this series of slide-illustrated talks, Helmut Schiller, Lecturer in Botany at the Museum, introduces diverse plants: mushrooms, mosses and ferns of forest floors and meadows; lichens of rocky and sandy places; algae at the edge of the sea; and conifers.

THE WORLD OF MAMMALS—8 Wednesdays starting February 9, 7:00-8:30 p.m. Fee: $30.
A survey of some of the world's more interesting and unusual mammals. In addition to slide-illustrated lectures, visits will be made to three of the Museum's exhibition halls, where a variety of North American mammals will be seen in their natural habitats. Kenneth A. Chambers is Lecturer in Zoology at the Museum.

Special Tour of the new SECTION OF METEORITES, MINERALS AND GEMS—2 Tuesdays, Feb. 22 and March 1; and repeated 2 Thursdays, March 31 and April 7, 7:00-8:30 p.m. Fee: $10. (Indicate preferred dates.) Limited enrollment.
Dr. Martin Prinz, Chairman and Curator of the Department of Mineral Sciences, and Dr. George Harlow, Assistant Curator of the same Department, will personally interpret this spectacular exhibition of some of the world's largest gem stones, finest mineral and crystal specimens and the dramatic beauty of earth materials and meteorites.

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Celestial Events

by Thomas D. Nicholson

Sun and Moon  The sun is in the constellation Sagittarius in early January, moves into Capricornus about January 19, and into Aquarius about mid-February. Its motion through Sagittarius, almost parallel to the equator, keeps it well south and low in our sky, bringing short days. But in Capricornus it moves rapidly north, almost halving its distance from the equator before leaving that constellation. Sunset occurs perceptibly later by the end of January, although sunrise has not advanced much since winter began.

The morning moon of the second and third week of January (last-quarter on the 12th) becomes new on January 19 and should show up as an evening object (near Venus) by the 22nd. First-quarter is on January 23, full moon on February 3, and last-quarter again on February 10. After being a bright evening object in late January and early February, the moon returns to the morning sky.

Stars and Planets  Evening skies this month and in February bring Venus and Jupiter into greater prominence as evening stars, although Venus sets too early to appear on our evening Star Map. You should find it without trouble, however, quite brilliant in the southwest from dusk until it sets after dark. Jupiter is on the map in Aries, near the border with Taurus, where it appears well up in the east in the early evening, setting before dawn. Saturn is on the evening map, too, although it is a morning star until February 2. It rises shortly after dusk, in Cancer, moves up into the south past midnight, and still shines in the west at dawn. Mercury and Mars are too close to the sun for easy viewing. Among the telescopic planets, Uranus is in Libra, Neptune in Ophiuchus, and Pluto in Virgo; all are morning stars.

January 3: Earth is at perihelion, nearest the sun.
January 4: Latest sunrise of the year.
January 5: Mercury, in inferior conjunction, becomes a morning star.
January 15: Jupiter resumes its direct (eastward) motion through the stars. Watch it move toward the Pleiades and the Hyades (in Taurus) over the next several weeks.
January 16: Moon at perigee, nearest earth.
January 17: Mercury ends its retrograde motion.
January 22–23: The moon is near Venus, moving from right to left above the planet, nearest (conjunction) at 6:00 A.M., EST, on the 23rd.
January 24: Venus is at greatest eastern elongation, most favorably placed for viewing to the left of the sun in the evening sky.
January 27–28: The moon, moving from right to left below Jupiter, is close to the planet on both evenings. On the 28th, moon is at apogee, farthest from earth, and Mercury is at greatest elongation in the morning sky, but not well placed for viewing.
February 2–3: Saturn is at opposition from the sun, rising at sundown, setting at sunrise. It now becomes an evening star. On the night of February 3, the full moon passes close by below the planet.
February 10: The moon covers Uranus (an occultation) over parts of Europe and Africa. The moon is at perigee late in the day.
February 12: Mercury and Mars are in conjunction and quite close to one another, but too poorly placed to be seen.

★ Hold the Star Map so the compass direction you face is at the bottom; then match the stars in the lower half of the map with those in the sky near the horizon. The map is for 10:15 P.M. on January 15; 9:15 P.M. on January 31; 8:15 P.M. on February 15; and 7:25 P.M. on February 28; but it can be used for an hour before and after those times.
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nstein’s theory of relativity makes these singular objects viable, but the concept is nonetheless unsettling to many astrophysicists.

"The greatest crisis in physics of time," is the way physicist John Aheer of Princeton University described the entrance of black holes to respectable quarters in the scientific community. Defying all sense of mischief created by the theory of relativity in its continued support, the bastions of intuitive perception and everyday experience, The story of black holes begins innocuously in the swirling clouds of drogen that surge and eddy about as space. These clouds, when, under their random motions, numbers of atoms occasionally meet by accident to form ball pockets of gas. Once formed, pocket of gas is held in the grip of its own gravity. As time passes, the atoms in the pocket "fall" towards its center, picking up speed as they fall. They meet at the center and pile up into a dense mass, the temperature rises, and when it reaches roughly a million degrees Fahrenheit, nuclear reactions flare up and a star is born.

The stars live out their life in the balance between the outward pressure generated by the continued release of nuclear energy at its center and the inward pressure created by the pull of gravity. When a star's reserves of nuclear fuel are exhausted, the balance is destroyed and the star collapses under its own weight. If the star is modest in size, like our sun, it collapses relatively gentle and the star fades out slowly in the lingering death of a white dwarf. When the star is massive, it does not fade away; instead, it collapses rapidly and violently, and rebounds from the collapse in a cataclysmic explosion known as a supernova. A glowing cloud of debris expands from the site of the explosion at a speed of thousands of miles per second. Buried in the cloud is the compressed remnant of the star's core—either a neutron star or a black hole in space.

A neutron star is a lump of matter with a mass comparable to that of the sun, but squeezed so severely that the separate electrons and electron nuclei within it have combined to form neutrons—subatomic particles having no charge. This ball of pure neutrons, about ten miles in radius, is so dense that a matchbox filled with matter from it would weigh several billion tons. The ball of neutrons, spinning rapidly on its axis several times a second, emits flashes of radiation that move through space like the light from a rotating lighthouse beacon. These flashes periodically sweep across the earth and are observed by astronomers here as regularly repeated pulses of radiation. They are responsible for the neutron star's other name—the pulsar.

Neutron stars, or pulsars, are relatively well-understood objects. Their general properties can be explained without difficulty, and their existence creates no strains in the body of science. Black holes are another matter. According to experts in relativity theory, their existence is certain; it is an inexorable consequence of the laws of relativity, combined with all known facts on the birth and death of stars. When a star's nuclear fuel is burned up, the star must collapse under the force of its own weight. If the star is fairly massive, its core will be squeezed down to a radius of approximately ten miles and a ball of pure neutrons will form there; if it is extremely massive, the force of the collapse will squeeze the core down to an even smaller radius. If the core is squeezed down to a radius of about two miles, the theory of relativity predicts the sudden occurrence of an extraordinary phenomenon.

According to Einstein's theory, a ray of light should possess mass. If Einstein is right, a ray of light emitted from a star will be pulled back by the star's gravity, as a ball thrown up from the surface of the earth is pulled back by the earth's gravity. When a star is normal in size—about one million miles in diameter—the force of gravity on its surface is not strong enough to keep the light rays from escaping and they leave the star, although with their energy somewhat diminished.

But if the matter of the star is squeezed into a very small volume, the force of gravity on its surface is very great. This can happen to the core of a star as a result of a supernova explosion. Suppose the core—which may be several times as massive as the sun—is squeezed down to a radius of a few miles. At that point, the force of gravity at the surface of this compact mass is billions of times stronger than the force of gravity at the surface of the sun. The tug of that enormous force prevents any rays of light from leaving the surface of the star; like the ball thrown upward from the earth, they are pulled back and cannot escape to space. All the light within the star is then trapped by gravity; no radiation can emerge. From that moment on, the star is invisible. It is a black hole in space.

If the mass of a star is exceptionally great—for example, twenty or thirty times the mass of the sun—calculations indicate that the entire star, and not merely the core, will become a
black hole when the star's matter inside shrinks to a point infinitely dense. The gravitational pull of a black hole is so strong that nothing, not even light, can escape from it. This property is known as the 'event horizon' or 'black hole horizon'.

The force of gravity within a black hole not only prevents light from escaping; it also prevents all physical objects from getting out of the hole. This property of black holes is a prediction of Einstein's theory of general relativity, which asserts that no object can travel faster than light. If the black hole were to disappear, it would take everything with it into its singularity at the center.

If the black hole were to reappear, it would continue to draw everything in its vicinity toward its center. According to current knowledge in theoretical physics, the atoms of the star pile up in the center of a dense lump that contracts steadily. First the materials of the star shrink to the size of a pinhead, then to the size of a microscope; and finally, still shrinking, they pass into the realm of distances smaller than any ever probed by man. All the while, a mass of ten thousand trillion trillion tons remains packed into the contracting volume.

But while the materials of the star shrink to microscopic size at the center, the radius of the black hole remains unchanged because no mass has disappeared. It is all still there at the center of the hole; exerting the same powerful force of gravity on objects and rays of light in its neighborhood.

In fact, since black holes capture any material they encounter, the mass and therefore the radius of a black hole will always tend to increase in time. A black hole is, in a sense, insatiable. As more matter enters it, its gravitational pull increases, and therefore its boundary expands.

This property does not imply that black holes act as gravitational vacuum cleaners, drawing in matter from the space around them. A ray of light, a star, or a spaceship can pass by a black hole safely as long as it does not come too close. However, if the object is on a collision course with a black hole, it will enter the hole and vanish. Even if its course carries it within a mile or two of the hole's boundary, the gravitational pull of the
black hole will curve the path of the
object, deflecting it away. Should the
object enter the black hole, it would
be ripped apart by the extreme gravita-
tional forces. The relativists argue that
the object would be stretched to
incredible lengths before disinte-
grating. To the physicist, it is a
paradox that defies the laws of
physics.

It is difficult to assess the truth of
these statements without the aid of
mathematics. For many of the pro-
ducts described, the reader must
rely on word of mouth, hearsay, or
imagination.

At the end of the two-page article,
there is a section called "Paradise
is in Asia".

Paradise is in Asia
and PIA flies you there.

21 days in the unspoiled
world of Pakistan, Afghanistan,
India and Sri Lanka

By the world’s highest mountains
there’s a story book land of mosques
and lotus pools, where people com-
monly live to be a hundred. The
bazaars are a happy hubbub of
exotic little treasures. Beaches
are warm and gold while the
ski slopes are still snow
white. It’s the place where
Shalimar’s gardens still
in
toxicate the air, and the
Khyber Pass looks down the
centuries to remember
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Paradise-In-Asia has
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and usually share your own
language.

The cities are music to pronounce:
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both. In stereo, of course.

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silent, or any of our other fine movie products. Write for information.

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2. The Amazonas River—Downstream. Again 2300 miles from Iquitos down to the open sea and to Trinidad. The abounding bird life on the river will be of special interest.

3. The Gulf of Darien and West Coast of Central America. We sail west from Trinidad to remote and seldom seen islands, then through the Panama Canal to Costa Rica and Guatamala.

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hole’s gravitational force. The rapidly moving particles, converging on the black hole, will collide with one another and produce an intense stream of X-rays, making the black hole an X-ray source of the kind observed by the X-ray satellites.

Furthermore, as the two stars revolve around one another, the X-rays emanating from the vicinity of the black hole will be periodically blocked by its companion. Cygnus X-1 fits this description precisely, because the intensity of the X-rays coming from it vary regularly every 1.8 days.

What about other explanations for Cygnus X-1? According to one theory, the invisible member of the binary could be a neutron star instead of a black hole, since neutron stars also emit X-rays. However, this is turned out to be unlikely. The properties of the binary in which Cygnus X-1 is located indicate that its estimated mass is at least six times the mass of the sun. But calculations show that the mass of a neutron star cannot be greater than two or three solar masses. Thus the neutron star explanation seems to be excluded. A black hole is consequently the most acceptable explanation remaining.

There is a general reluctance to accept the existence of black holes because they are such peculiar objects, but Cygnus X-1 appears difficult to interpret in any other way.

Black holes remind physicists of the time at the beginning of this century when, although physics seemed triumphant, the laws of the atom prophesied the imminent collapse of the universe. There was no way then to make sense out of the atom, just as there is no way today to make sense out of the black hole. The revolutionary concepts of quantum mechanics saved the universe from annihilation in that earlier crisis, at the tremendous cost of removing fundamental physics forever from the domain of ordinary experience. Revolutions are exciting but painful, and a aura of discomfort pervades the scientific community today as it awaits the next revolution in physics thought, which, we now suspect, cannot be too many years off.

An astrophysicist, Robert Jastrow is the founder and director of the Goddard Institute for Space Studies in New York City. He also teaches geology and astronomy at Columbia University and Dartmouth College.
COME SHARE OUR DISCOVERY

American Museum of Natural History Announces an Extraordinary Adriatic-Aegean Cruise

On September 19, 1977, 255 fortunate (and foresighted) friends of the American Museum will embark on a voyage to the splendid past...the glories of ancient Greece and Byzantium...interspersed with quiet days on unspoiled islands, in the favorite haunts of rare and beautiful birds.

DISCOVERY offers you 19 days in a region blessed with natural beauty and towering human achievement. It starts in Venice, ends in Athens, stops at Dubrovnik, Istanbul, Troy, Delphi, Rhodes, Crete, Corfu, to name only a few. It's an area rich in history, art, the imprint of many cultures - and DISCOVERY makes it yours in a way that few travelers can expect.

More than a holiday, more than a rest, even more than a chance to see and explore other places, peoples, customs, DISCOVERY is also a unique adventure in learning.

The superb itinerary, planned in consultation with Museum scholars and scientists, overlooks no opportunity to reveal and illuminate, to veer off the traveled paths for special, extra insights.

The expert arrangements will be supervised by W.F. and R.K. Swan, Ltd. of London. Every detail has been scrutinized to contribute to your comfort. We'll use only the best accommodations on a spacious, gracious ship (70% of the cabins, but 100% of the crew and service staff). We've booked rooms at the two best hotels in Venice for the two nights before m.t.s. Orpheus becomes your home.

The company you'll keep includes a group of distinguished lecturers who will lead discussions, travel with you, share their own enthusiasms. There are six in all, including the American Museum's director, Dr. Thomas D. Nicholson. Two Museum ornithologists will concentrate on the bird life (they plan to take you to Scutari in Turkey, at the best of all possible places to watch the spectacular Fall migration of thousands of birds). An Oxford don, a Brown University archeologist, the former director of the British Museum will share the honors when you're visiting archeological digs or admiring works of art.

The flexible, comprehensive program features a dazzling array of side trips- all of them included in the price of the trip, none of them required, if you prefer to swim, stroll, shop or visit sidewalk tavernas on your own.

Optional, too (but not included in the price) is an extra four day extension in Athens for those who have the time.

Prices for DISCOVERY range from $1475 to $1925 for each of two persons sharing a cabin (single prices and airfare estimates on request). And all participants are asked to contribute $350 to the American Museum.

If DISCOVERY sounds right for you, please send for further information now. Announcements like this bring immediate and enthusiastic response from those who have already traveled with the Museum and their relatives and friends. It's as simple as filling out and mailing the card bound in over this page. Or, if someone has already removed the card, simply write today to this address:

American Museum of Natural History Central Park West at 79th Street New York, New York 10024 c/o Ms. Ellen Stancs.
Wildlife Recaptured


Ernest Thompson Seton was born at the right time and with the right talents to become celebrated as a sympathetic and popular interpreter of the back to nature sentiment that flourished about the turn of the century. The frontier was officially closed. A predominantly urban and suburban America was shaping up. Seton was a transitional figure of extraordinary versatility—a recognized field naturalist, a copious writer of wide influence, a frequent lecturer on wildlife, and an animal artist who knew, as Mr. Samson says in his introduction to the present volume, "where each muscle, bone, and tendon belonged."

If Seton's art has occasionally seemed to be ancillary to his immensely popular writings, the balance is handsomely redressed in the present collection, which reproduces—in 10¼- by 11½-inch pages—a careful selection of the outdoorsman's full-color paintings and a generous gathering-up of the quick studies, done in pencil, ink, or watercolor, that appeared as data in his field notebooks and were later worked up as illustrations for his books and articles.

Mr. Samson, the compiler, who is also editor of Field and Stream magazine, divides his book into discrete sections devoted to the fauna of the far north, the east, and the west, with a closing section on Indians and woodcraft, and a selective bibliography of Seton's books. Biographical material and commentary by the editor introduce each of the sections, followed by brief excerpts from several of Seton's forty-odd books, among them Trail of an Artist-Naturalist (1940), Lives of Game Animals (1925–27), Life Histories of Northern Animals (1909), Arctic Prairies (1911), Wild Animals I Have Known (1898), Lives of the Hunted (1901), and Animal Heroes (1905).

Originally named Ernest Seton Thompson, the artist-naturalist was born in England in 1860 and grew up in the wilds of Canada. He came early to his vocation, building a woodsy shack of his own when he was fourteen years old. Later he studied at the Royal Academy of Art in London and under French artists, sketching from life in the menagerie of the Jardin des Plantes in Paris where, a generation later, the grand animalier, François Pompon, found the models for his renowned sculptures of the stag and polar bear. Something of a prodigy, Seton was first published when he was barely in his twenties. In 1883, while still living in Canada, he changed his name legally from
Thompson to Seton, a change confirmed in the Supreme Court of New York in 1901 because many of his copyrights had been taken out in the name "Seton-Thompson."

Apart from lecture tours and periodical visits to the wilderness to refresh his vision, Seton spent his most productive years in New York and its vicinity. There he wrote and illustrated his books and received a flow of commissions to illustrate the works of other authors: one editor, for example, ordered a thousand drawings. Friendships developed with curators and department heads of The American Museum of Natural History, with scientists at the U.S. Biological Survey and the New York Zoological Park, and with a highly visible personality concerned with the preservation of America's native fauna, a president of the United States, Theodore Roosevelt.

Along with honors, awards, and prosperity, came sharp controversies.
The new, improved 1977 Natural History Photographic Competition is open for entries

The greatest photographic competition in the history of Natural History is on. The Grand Prize is a round trip for two to Peru, a country that will challenge any photographer with vistas of ancient royalities, Andean peaks, Amazonian jungles, deserts, fog-shrouded coasts, and a colorful mixture of peoples. The cash prizes this year total more than $3,000. And the winning entries will be published in a special double issue of Natural History in August and will be shown at The American Museum of Natural History.

The four categories for entries are broad enough to fit the interests of any photographer because Natural History is concerned primarily with receiving and publishing great photographs. The categories are: (1) The Natural World; (2) A Sequence of an Event in Nature; (3) Microphotography, including pictures with a scanning electron microscope; and (4) The Human Family. First prize in each category is $500. In addition, these awards will be selected from all the entries: Humor in Nature, $200; Urban Wildlife, $200; and ten Honorable Mentions at $100 each.

The deadline is April 15, 1977. Please put your name and address on every entry, and include a stamped, self-addressed envelope—since we do want to return your pictures to you.

And, the best of luck!

The Rules

1. The competition is open to everyone except employees of The American Museum of Natural History and their kin.
2. Competitors may submit up to three previously unpublished entries in each of the four categories. Decision of the judges is final.
3. The Museum acquires the right to publish, exhibit, and use for promotion the winning photographs. The Museum assumes no responsibility for other entries.
4. Entries may be transparencies or prints up to 8 by 10 inches, and each must bear the photographer's name and address.
5. Enclose a self-addressed, stamped envelope for the return of entries.

Pack them carefully and mail to:
Natural History Photographic Competition
11 West 77th Street
New York, N.Y. 10024
Seton’s interest in young people led to his organization of the Woodland Indians. Subsequently an abrupt dispute arose among Lord Baden Powell, the hero of Mafeking; Daniel Carter Beard, like Seton a nature writer and illustrator; and Seton over the proper distribution of credit for the founding and shaping of the international Boy Scout movement. The disagreements ruptured old friendships and left a residue of alienation.

A romantic in temperament, Seton was able as an artist to discipline himself to observe the natural world accurately and catch the essence of each creature in his sketchbooks—timber wolf, the varying hare, various members of the hawk family, the caribou, badger, lynx, or whatever. He once counted the feathers of a Brewer’s grackle. The total: 4,964. But when he wrote for a general audience, especially young people, Seton was unabashedly anthropomorphizing his subject animals, giving his subject animals individual names and personalities, such as Lobo the wolf, Johnny Bear, and Redruff the grouse. Criticism followed from the scientific community. John Burroughs, for instance, criticized Seton for introducing human motivation into what purported to be true accounts of animal behavior and insisted that Seton’s widely read Animals I Have Known should more properly have been entitled Wild Animals I Alone Have Known. And President Roosevelt, generally a friend and critic, while praising the author...
interesting observations of fact, I commended that he be more circumspect about introducing his vast wisdom of juveniles to animals that I think symbolically, transmit a nature, and perform acts of heroic orifice reflecting human moral values. Some years later, after the publication of his four-volume monograph American game animals, Seton received the John Burroughs Medal for contributions to natural history. Perhaps the greatest impact of The Worlds of Ernest Thompson Seton upon today's animal appreciator, living in the culture of the 1970s with urban sprawl and shrinking habitats, comes from a fresh awareness of an abundance of wilderness species available for field study during Seton's productive years. The ecosystem was still relatively stable, although Seton lived to see the extinction of the passenger pigeon and the reduction of the wild buffalo herds. One wonders how this gifted man, essentially a poet as well as artist, would react if he could know that the 1976 Christmas catalog of Nieman-Marcus, the Texas department store chain, offered—as a gift to the couple who had everything—his and her bison. Price, complete with shipping charges, $11,750 each.

Carson's most recent book is Beasts and Gods, an account of men's attitudes toward animals through historic times.

"A superbly illustrated introduction to the subject of animal courtship and mating."
—DR. DESMOND MORRIS, author of The Naked Ape

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The Brontosaurus

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Now, the amiable spirit of this popular dinosaur has been captured in a solid sculpture of genuine, clear Swedish crystal.

Make Room in Your Home
For A Brontosaurus

Whatever the decor, wherever you place it, the Brontosaurus sculpture will capture attention with its lucid brilliance, its fluid lines. This is neither a laboratory model nor a gimcrack souvenir.

It is a work of fine art!

The Brontosaurus sculpture was created for the American Museum of Natural History exclusively by Svenskt Glass and is being produced in a limited edition by Kosta Glassworks of Sweden.

Connoisseurs of crystal collectibles will readily acknowledge the reputation of Kosta among the world's great crystal makers. Their name assures the quality of the full-lead crystal and the excellence of the hand craftsmanship.

The Sculptor: Paul Hoff

The Brontosaurus sculpture was created by Paul Hoff whose works are represented in museums and galleries on three continents. He has combined scientific evidence with the artist's prerogatives to form pure crystal into a sculpture of fascinating beauty.

A Strictly Limited Edition

This one time edition of the Brontosaurus sculpture will be limited to 10,000 perfect pieces. Once this number has been realized, the patterns will be destroyed.

A Certificate of Authenticity will accompany each sculpture. It will bear the serial number of that particular sculpture in the edition.

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The beauty of the sculpture, the quality of the crystal, the limited nature of the edition and the hallmarks on the base combine to make the Brontosaurus sculpture a most prudent investment. Historically, sculptures of this quality show satisfying appreciation over the years.

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The Brontosaurus crystal sculpture is available only from Natural History Sculptures. The price is $77.50. However, if you are an Associate Member of The American Museum of Natural History, you are entitled to a discount of ten percent; your price-$69.75. Shipping, insurance and all customs duties are included. Satisfaction is, of course, assured. Prompt action will be well advised.

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THE AMERICAN MUSEUM OF NATURAL HISTORY

NATURAL HISTORY SCULPTURES
Dept. O-250, Box 5123 Des Moines, Iowa 50340
Letters

Backyard Beauty
On my way to work this morning I noticed a large white-tailed kite sitting on a telephone pole. So, upon
reaching home this evening and finding an article about the bird in your November issue, I discovered some-
thing truly relevant to my daily existence. A day seldom passes that I don't see these magnificent birds.
Having observed these birds for

The final picture of the sullen young man was positively offensive in its representation of the American
flag being degraded and insulted by this arrogant individual wearing it pinned inverted to the leg of his cor-
duroys.
I think if any of the Indian veterans of the Forty-fifth Division, to
which I had the honor of being attached for a time in Italy in 1943-44,
this display of contempt for the
flag would waste few words or little time in correcting
able gesture.
appointed by your poor
n selecting that photo-
represent the Northeast
ey have dignity and tra-
the Western Indians do.
Naragansets, the Pen-
Mohawks, the residual
ions, and the few Shinne-
our calendar.

Paul Van Gieson
Hillsdale, New Jersey

Note:
(a) A photograph of the Indian flag was selected for the
cause it strongly revealed the American Indian life.
the fact that this act is con-
major public gathering of
others is a revealing com-
our society today. This
means that we approve of
in the picture nor that we
of the flag.
fully aware that, as edi-
tors, we are particularly fortunate to
be working in the country of that
flag, where the freedom of the press
to publish both good and bad information is a fundamental right.

A Correction
In Edward Abbey's book review
(November 1976), his assumption
that an orchid is a parasite is simply
wrong. In this largest family of the
plant kingdom, the nontererestrial
members are epiphytes. Although
several nongreen species have sym-
biotic relationships with fungi, no
orchids are parasitic.

Laura B. Sindlinger
Elmira, New York

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Louise Magaw Ackerman
Lincoln, Nebraska

Thank you for the beautiful cal-
dar I received a few days ago. The
ustrations are beautiful and en-
lightening to me. The center-fold pic-
ture of the young boy is especially
pering. I fear I have used too
any superlatives, but the calendar
worthy of them.

Laura B. Sindlinger
Elmira, New York

Ken Frieling
Steward, Ohio

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In Sparkling Clear, Genuine Swedish Crystal

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Backyard Beauty
On my way to work this morning noticed a large white-tailed kite sitting on a telephone pole. So, upon returning home this evening and finding an article about the bird in your November issue, I discovered something truly relevant to my daily experience. A day seldom passes that I fail to see these magnificent birds.

Having observed these birds for several years since moving to southern California, I was thrilled to read about their unique beauty and hunting skills.

One does not need to travel the old over to find a “rare” creature of great beauty. Thank you for publishing Lee Waian’s article on a bird any person fails to notice in the area here I live.

JANET ROYSTER
Irvine, California

The Turbulent Sun
I’ve just finished looking at your November issue. The sun has never seemed so near. I appreciate your thoughtful arrangement of articles and photos.

MICHAEL ROBINSON
Battle Ground, Washington

The Turbulent Calendar
In your 1977 calendar, which features pictures of Indians in the Northeast, some of the pictures are of interest and are historical. Some are even beautiful. However, the picture on the last two pages of the calendar, entitled Powwow in New York, made me angry. The flag code of the United States definitely prohibits displaying a flag as this Indian was doing.

LOUISE MAGAW ACKERMAN
Lincoln, Nebraska

Thank you for the beautiful calendar I received a few days ago. The illustrations are beautiful and enlightening to me. The center-fold picture of the young boy is especially appealing. I fear I have used too many superlatives, but the calendar was worthy of them.

LAURA B. SINDLINGER
Elmira, New York

The final picture of the sullen young man was positively offensive in its representation of the American flag being degraded and insulted by this arrogant individual wearing it pinned inverted to the leg of his corduroys.

I think if any of the Indian veterans of the Forty-fifth Division, to which I had the honor of being attached for a time in Italy in 1943-44, saw this display of contempt for the country, they would waste few words and take very little time in correcting this contemptible gesture.

I am disappointed by your poor judgement in selecting that photograph to represent the Northeast Indians. They have dignity and tradition, as the Western Indians do. Look to the Narragansets, the Penobscots, the Mohawks, the residual Seven Nations, and the few Shinnecocks for your calendar.

PAUL VAN GIESON
Hillsdale, New Jersey

EDITOR’S NOTE:
The photograph of the Indian wearing a flag was selected for the calendar because it strongly revealed one element of American Indian life today. The fact that this act is condemned at a major public gathering of Indians and others is a revealing comment about our society today. This does not mean that we approve of the action in the picture nor that we meant to defile the flag.

We are fully aware that, as editors, we are particularly fortunate to be working in the country of that flag, where the freedom of the press to publish both good and bad information is a fundamental right.

A Correction
In Edward Abbey’s book review (November 1976), his assumption that an orchid is a parasite is simply wrong. In this largest family of the plant kingdom, the nonterrestrial members are epiphytes. Although several nongreen species have symbiotic relationships with fungi, no orchids are parasitic.

KEN FRIELING
Stewart, Ohio

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Announcements

The American Museum-Hayden Planetarium is now offering a Saturday Morning Sky Show for Children at 11:00 A.M. A planetarium lecturer will explain why the moon changes shape, why the seasons change, what shooting stars are, and how the nighttime sky would look without the city’s lights and pollution. The lecturer will also discuss the status of such current space research as the Viking Project to Mars, Pioneer’s journey to Jupiter and Saturn, and Mariner’s flight to Venus and Mercury. The show is designed for children in grades six through eight. Special rates are available for groups of ten or more. For further information call 873-1300, extension 206.

A small exhibit of nineteenth-century Mongolian Jewelry and Ornaments will open in the Museum’s Roosevelt Rotunda on January 20 and run through March 1. The display includes women’s necklaces, rings, earrings, and headbands, as well as various ornaments used by men. All handcrafted, the pieces are made from locally mined silver, inlaid with coral, turquoise, and jade. One of the attractions of Mongolian silver-smithing of the last century is the contrast between the delicately crafted silver and the usually rough-hewn inset minerals.

Places are still available on the Museum’s Anthropology Tour to Morocco, April 2 to April 16, 1977. The trip is especially designed for persons interested in discovering the diversity of Moroccan culture. Led by Paul J. Sanfalcon, Museum lecturer in anthropology, participants will visit mosques and the King’s palace in Rabat and the medieval Muslim city of Fes. The tour will continue through the Atlas Mountains to Rissani, crossroads of the caravan trade between the Sudan and North Africa, and will include the city of Marrakech. Throughout the journey, visits will be made to archeological sites, museums, ancient towns, and markets. For further information call 873-1300, extension 341.

Note: The Museum’s geology tour of Iceland and Greenland, scheduled for August 10 to August 30, 1977, has been cancelled.
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Additional Reading

canoes and Climate (p. 8)


og Reproduction (p. 38)

originally published in 1931, G. agsley Noble’s The Biology of the Ambia, nearly 600 pages and with 320 strations, is still considered the defini-reference work on this group; an nensive paperback edition is now avail-e (New York: Dover Publications, 50). David L. Jameson surveys repro in the frog families in “Evolve-ary Trends in the Courtship and Mat-

American Hasidim (p. 46)

In Legends of the Hasidim (Chicago: University of Chicago Press, 1974, $5.95), Jerome R. Mintz describes the mores and history of present-day communities, analyzes the cultural content of more than 370 folk legends, and explores the intimate relationships between hasidic legend and law, rituals and values, roles and social structure. Sensitive photographs enhance this work. For socio-logical insights into the New York communities see Solomon Poll’s The Hasidic Community in Williamsburg: A Study in the Sociology of Religion (New York: Schocken Books, 1969, $3.45) and Israel Rubin’s Satanar: An Island in the City (New York: Quadrangle, 1972, $8.95). In Major Trends in Jewish Mysticism

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Mount Rushmore (p. 60)

Gilbert C. Fite's Mount Rushmore (Norman: University of Oklahoma Press, 1964, $2.95) explores many aspects of this monumental project—from funerary and engineering to the sociology of the project and of the time period its construction encompassed. Although written for younger readers, Willadene Preisler's Gutzon Borglum: Artist and Patriot (Chicago: Rand McNally, 1961) is a carefully researched biography of the Mount Rushmore sculptor, providing a perspective on his other artistic endeavors, such as the carvings at Stone Mountain, Georgia, and the somewhat less objective account of Borglum's life, Give the Man Room, was written by Robert J. Casey and Mary Borglum (Indianapolis: Bobbs-Merrill, 1962). Frederick G. Vosburgh's "Shriners, Each Patriot's Devotion" (National Geographic, January 1949, pp. 51-82) illustrates scores of national historic shrines, including Mount Rushmore. For readers wishing to do their own historical research on contemporary attitudes toward some past project such as Rushmore, the New York Times Index gives references to news articles, and even parts of articles, that deal with specific subjects.

Slow Mammals (p. 66)


Gordon Beckhorn

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4 Authors

12 This View of Life Stephen Jay Gould
   The Continental Drift Affair

22 A Matter of Taste Raymond Sokolov
   How to Treat the Common Cole

34 A Naturalist at Large Richard Dawkins
   The Remarkable Replicators

42 Rock Art and the Power of Shamans Dean R. Snow
   These enigmatic symbols may be messages from a world of spirits.

50 Shotgun Houses John Vlach
   Some tar-paper shacks have ancient, exotic roots.

58 A Coarrangement of Kingfishers Photographs by Milo Olano and J. Echevarri
   A remarkable photographic series shows just how well these birds can fly.

64 Endangered Fish of Kentucky Streams Branley Allon Branson
   Let's not forget the paddlefish, the popeye shiner, and other creatures of streams.

70 How It Really Was Dorothy Harley Eber
   An Eskimo's rare view of his own world.

76 The Fly That Would Be King Robert S. Desowitz
   A tiny parasite is one of Africa's most effective game wardens.

85 Sky Reporter Stephen P. Maran
   EUV Makes the Grade

90 Celestial Events Thomas D. Nicholson

92 The Market

93 Announcements

94 Book Review Alvin M. Josephy, Jr.
   A Sojourn Among the Indians

100 Additional Reading

Cover This watercolor by Karl Bodmer was done in September when herds of buffalo and elk gathered along the banks of the river. Artist Bodmer accompanied the naturalist Prince Maximilian on an expedition up the Missouri River in 1833. Review on page 94.
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Authors

As a teen-ager in rural Minnesota where he grew up, Dean R. Snow frequently examined the petroglyphs on a nearby rock outcropping. Even during those years, Snow knew that he wanted to be an archeologist. Since then he has conducted archeological research on American Indians from Mexico to Alaska to Maine and now teaches the subject at the State University of New York at Albany. Snow’s article, “The Changing Prey of Maine’s Early Hunters,” appeared in the November 1974 issue of Natural History and his book, The Archaeology of North America, was published last year. For the past three years, he has studied the archeology of New York’s Lake George region; later this year, he will return to Mexico to continue the research he began more than ten years ago.

Among the least-known aspects of folklore in this country is the contribution that blacks have made to architectural concepts. With this in mind, John Vlach traveled to west Africa, Haiti, and Louisiana to trace the history of the building design on which the “shotgun” house is based. A professor of folklore at the University of Maryland, Vlach is involved in examining the continuity of such African traditions in this country as work, pottery, basketmaking, grave decoration. Enthusiastic about preserving old buildings, he is now in the midst of “piecing together” late-nineteenth-century row houses in Washington, D.C.
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For the past eleven years, Allan Branson has explored the threat of damage to freshwater aqua-life of the southeastern United States due to highway and dam construction and strip mining (see “Stripping Appalachians,” Natural History, November 1974). A professor of zoology at Eastern Kentucky University, Branson is looking into the factory system of minnows, as well as the distribution of terrestrial slugs on Washington’s Olympic Peninsula. He plans to expand this search to include all such mollusks throughout the western United States and Canada. When not investigating freshwater fauna, Branson does wood carving and writes poetry.

After receiving her BA from the University of Toronto, Dorothy Harley Eber became a journalist. In 1968, a magazine assignment sent her to Baffin Island in the Canadian Arctic. There, in Cape Dorset, she met a highly articulate Eskimo woman artist, who, although not related to Peter Pitseolak, the subject of Eber’s current article, had the same last name. Eber’s admiration for this elderly woman’s beautiful drawings led to the publication in 1972 of Pitseolak: Pictures Out of My Life. When the book came out, Peter Pitseolak remarked that there was certainly more to tell about Eskimo life and showed Eber the photographs he had taken over twenty years. Using interpreters and a tape recorder, Eber produced an oral biography in book form, People from Our Side, to accompany Peter Pitseolak’s photographs. The article in this issue is adapted from that book.

Robert S. Desowitz began studying trypanosome in 1951 at the African Institute for Trypanosomiasis Research in Nigeria while on an eighteen-month tour for the British government. “I became so captivated by Africa,” he writes, “that I did not emerge until nine years later. At that time, my colleagues and I had grown to believe that the disease would be eradicated or controlled. Today when I visit, there is a consensus of despair that little progress has been made and that the situation may even have worsened.” Desowitz now teaches tropical medicine at the University of Hawaii and is concentrating his search on malaria. His article, “The Wise Men Brought Malaria to Africa,” appeared in the October 1976 issue of Natural History.

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Scientists had a hard time solving this mystery, even though many clues pointed to the solution

As the new Darwinian orthodoxy swept through Europe, its most brilliant opponent, the aging embryologist Karl Ernst von Baer, remarked with bitter irony that every triumphant theory passes through three stages: first it is dismissed as untrue; then it is rejected as contrary to religion; finally, it is accepted as dogma and each scientist claims that he had long appreciated its truth.

I first met the theory of continental drift when it labored under the inquisition of stage two. Kenneth Caster, the only major American paleontologist who dared to support it openly, came to lecture at my alma mater, Antioch College. We were scarcely known as a bastion of entrenched conservatism, but most of us dismissed his thoughts as just this side of sane. (Since I am now in von Baer’s third stage, I have the distinct memory that Caster sowed substantial seeds of doubt in my own mind.)

A few years later, as a graduate student at Columbia University, I remember the a priori derision of my distinguished stratigraphy professor toward a visiting Australian drifter. He nearly orchestrated the chorus of Bronx cheers from a sycophantic crowd of loyal students. (Again, from my vantage point in the third stage, I recall this episode as amusing, but distasteful.) As a tribute to my professor, I must record that he experienced a rapid conversion just two years later and spent his remaining years joyously redoing his life’s work.

Today, just ten years later, my own students would dismiss with even more derision anyone who denied the evident truth of continental drift — a prophetic madman is at least amusing; a superannuated fuddy-duddy is merely pitiful. Why has such a found change occurred in the space of a decade?

Most scientists maintain — or at least argue for public consumption — that their profession marches toward truth by accumulating more and better data, under the guidance of an infallible, objective procedure called the scientific method. If this were my question would have an easy answer. The facts, as known ten years ago, spoke against continental drift; since then, we have learned more and revised our opinions accordingly, and will argue, however, that this nario is both generally applicable and utterly inaccurate in this case.

During the period of nearly universal rejection, direct evidence for continental drift — that is, the data gathered from rocks exposed on our continents — was every bit as good as today. It was dismissed because one had devised a physical mechanism that would permit continents to plow through an apparently solid oceanic floor. In the absence of a plausible mechanism, the idea of continental drift was rejected as absolute.

The data that seemed to support could always be explained away, these explanations sounded contrived or forced they were not half so probable as the alternative — accepting continental drift. During our ten years, we have collected a new of data, this time from the ocean basins. With these data, a heavy of creative imagination, and a basic understanding of the earth’s interior, we have fashioned a new theory of planetary dynamics. Under this theory of plate tectonics, continental drift is an inescapable consequence. The old data from continental rocks were soundly rejected, have been humed and exalted as conclusive proof of drift. In short, we now accept continental drift because it is the pectation of a new orthodoxy.
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I regard this tale as typical of scientific progress. New facts, collected in old ways under the guidance of old theories, rarely lead to any substantial revision of thought. Facts do not "speak for themselves"; they are read in the light of theory. Creative thought, in science as much as in the arts, is the motor of changing opinion. Science is a quintessentially human activity, not a mechanized, robotlike accumulation of objective information, leading by laws of logic to inescapable interpretation. I will try to illustrate this thesis with two examples drawn from the "classical" data for continental drift. Both are old tales that had to be undermined while drift remained unpopular.

1. The late Paleozoic glaciation. About 240 million years ago, glaciers covered parts of what is now South America, Antarctica, India, Africa, and Australia. If continents are stable, this distribution presents some apparently insuperable difficulties:

A. The orientation of striae in eastern South America indicates that the glacier moved onto the continent from what is now the Atlantic Ocean (striae are scratches on bedrock made by rocks frozen into glacier bottoms as they pass over a surface). The world's oceans form a single system, and transport of heat from tropical areas guarantees that no major part of the open ocean can freeze.

B. African glaciers covered what are now tropical areas.

C. Indian glaciers must have grown in semitropical regions of the Northern hemisphere; moreover, their striae indicate a source in tropical waters of the Indian Ocean.

D. There were no glaciers on any of the northern continents. If the earth got cold enough to freeze tropical Africa, why were there no glaciers in northern Canada or Siberia?

All these difficulties evaporate if the southern continents (including India) were joined together during this glacial period, and located farther south, covering the South Pole: the South American glaciers moved from Africa, not an open ocean; "tropical" Africa and "semitropical" India were near the South Pole; the North Pole lay in the middle of a major ocean, and glaciers could not develop in the Northern Hemisphere. Sounds good for drift; indeed, no one doubts it today.

II. The distribution of Cambrian trilobites (fossil arthropods living 500 to 600 million years ago). The Cambrian trilobites of Europe and North America divided themselves into two rather different faunas with the following peculiar distribution on modern maps. "Atlantic" province trilobites lived all over Europe and in a few very local areas on the far eastern border of North America—eastern (but not western) Newfoundland and southeastern Massachusetts, for example. "Pacific" province trilobites lived all over America and in a few local areas on the extreme western coast of Europe—northern Scotland and northwestern Norway, for example. It is devilishly difficult to make any sense of this distribution if the two continents always stood 3,000 miles apart.

But continental drift suggests a striking resolution. In Cambrian times, Europe and North America were separated: Atlantic trilobites lived in waters around Europe; Pacific trilobites in waters around America. The continents (now including sediments with entombed trilobites) then drifted toward each other and finally joined together. Later, they split again, but not precisely along the line of their previous junction. Scattered bits of ancient Europe, carrying Atlantic trilobites, remained at the easternmost border of North America, while a few pieces of old North America stuck to the westernmost edge of Europe.

Both examples are widely cited as "proof" of drift today, but they were soundly rejected in previous years, not because their data were any less complete but only because no one had devised an adequate mechanism to move continents. All the original drifters imagined that continents plow their way through a static ocean floor. Alfred Wegener, the father of continental drift, argued early in our century that gravity alone could put continents in motion. Continents drift slowly westward, for example, because attractive forces of the sun and moon hold them up as the earth rotates underneath them. Physicists responded with derision and showed mathematically that gravitational forces are far too weak to power such a monumental peregrination. So Alexis du Toit, Wegener's South African champion, tried a different tack. He argued for a local, radioactive melting of oceanic floor at continent borders, permitting the continent to glide through. This ad hoc hypothesis added no increment of plausibility to Wegener's speculation.

Since drift seemed absurd in absence of a mechanism, ortho-geologists set out to render the press evidence for it as a series of unconnected coincidences.

In 1932, the famous American geologist Bailey Willis strove to refute the evidence of glaciation by comparing the climates of eastern and western continents. He invoked "deus ex machina"—a northern land bridge flung with its abandons across 3,000 miles of ocean. He placed one between eastern Brazil and western Africa, other from Africa all the way to India via the Malagasy Republic, an island from Vietnam through Bolivia and New Guinea to Australia. Willis' colleague, Yale professor Chauncey Schuchert, added one from Asia to Antarctica and another from arctic to South America, thus explaining the isolation of a southern continent from the rest of the world. Such an isolated ocean might freeze along its southern margin, melting glaciers to flow across eastern South America. Its waters would also nourish the glaciers of southern Africa. The Inglis glaciers, located above the equator 3,000 miles north of any southern continent, suggested a separate explanation. But Willis wrote: "No direct connection between the occurrences can reasonably be assumed. The case must be considered on the basis of a general cause and the local geographic conditions." Willis' inventive mind was equal to the task he simply postulated a topography elevated that warm, wet south waters precipitated their product: snow. For the absence of ice in temperate and arctic zones of the Northern Hemisphere, Willis reconstructed a system of ocean currents that permitted him to postulate "a warm subsurface current flowing north of the equator, which flows beneath cooler surface waters and, reaching the Arctic, as a warm-water heating system." Schuchert was lighted with the resolution proved by isthmian links:

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exists today), still another the this polar land to Australia from the latter across the Ara Sea to Borneo and Sumatra an on to Asia, plus the ace means of dispersal along shelf and by wind and water currents migratory birds, and he has all possibilities needed to explain life dispersion and the land ocean realms throughout geologi cal time on the basis of the pre arrangement of the continents.

The only common property sh by all these land bridges was their hypothetical status; not an of direct evidence supported any of them. Yet, lest the saga of isthmus links be read as a warped fairy invented by dogmatists to support untenable orthodoxy, I point out to Willis, Schuchert, and any right thinking geologist of the 1930s, thing legitimately seemed ten the as absurd as imaginary land br technology of the 1930s, thousand miles long—continen

self by the light of such highly few imaginations, the Cambrian trilob could present no ininsurmountable problem. The Atlantic and Pacific plates were interpreted as different environments, rather than differ places—shallow water for the cific, deeper for the Atlantic. We freedom to invent nearly any hypo thetical geometry for Cambrian oceans, geologists drew their maps and hewed to their orthodoxy.

When continental drift came fashon during the late 1960s, classical data from continental re played no role at all: drift rode if the coat tails of a new theory, sup ported by new types of evidence, physical absurdities of Wegener theory rested in his conviction that continents cut their way through ocean floor. But how else could it occur? The ocean floor, the crust the earth, must be stable. After all where could it go, if it moved pieces, without leaving gaping hole in the earth? Nothing could clearer. Or could it?

"Impossible" is usually defined our theories, not given by native Revolutionary theories trade in the unexpected. If continents must p through oceans, then drift will occur; suppose, however, that con tients are frozen into the oceanic c and move passively as pieces of cr shift about. But we just stated that crust cannot move without lea
We reach an impasse that must
be avoided by creative imagination,
just as another field season in the
Appalachians—we must
the earth in a fundamentally
tent way.

We can avoid the problem of holes
in a daring postulate that seems to
laid. If two pieces of ocean lloor
away from each other, they will
no hole if material rises from
earth’s interior to fill the gap. We
do further by reversing the casual
ations of this statement: the
of new material from the earth’s
or may be the driving force that
sea floor away. But since
earth is not expanding, we must
ave regions where old sea floor
ers into the earth’s interior, thus
ving a balance between cre-
and destruction.

Indeed, the earth’s surface seems
broken into fewer than ten major
es, “bounded on all sides by
zones of creation (oceanic
s) and destruction (trenches).
ments are frozen into these
s, moving with them as the sea
spreads away from zones of cre-
at oceanic ridges. Continental
no longer a proud theory in its
right; it has become a passive
quence of our new orthodoxy—
tectonics. Most geologists, my-
cluded, have been over-
ed by the breadth of evidence
late tectonics gathered from the
s during the past ten years—but
at defer this tale for another time.
we now have a new, mobilist or-
, as definite and uncompro-
ing as the staticism it replaced. In
ight, the classical data for drift
been exhumed and proclaimed
roof positive. Yet these data
e a role in validating the notion
andering continents; drift
ephed only when it became the
assary consequence of a new
ity.

The new orthodoxy colors our vi-
of all data; there are no “pure
” in our complex world. About
years ago, paleontologists found
ntarctica a fossil reptile named
ossaurus. It also lived on South
rica. If anyone had floated such
argument for drift in the presence
Villis and Schuchert, he would
been howled down—and quite
ctly. For Antarctica and South
rica are almost joined today by
ring of islands, and they were cer-
ly connected by a land bridge at
ous times in the past (a minor

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Quest 77 LIFE NEVER CEASES TO AMAZE.
How to Treat the Common Cole

The cabbage and its kin are versatile vegetables

Mark Twain wrote: "Training is everything. The peach was once a bitter almond; cauliflower is nothing but cabbage with a college education." I used to think that was just a wisecrack about a vegetable the old wag didn’t like, but Twain was, it turns out, literally correct about cauliflower. It is a descendant of the common cabbage.

In fact, it is a cultivated variant of the very same species, Brassica oleracea.

More remarkable still, the same Protean plant is just as intimately related to Brussels sprouts, kale, broccoli, and kohlrabi. They are all cultivars (varieties known only in cultivated form) of B. oleracea. Each plant does have its own varietal name. Cabbage is capitata (a surname that includes green, red, and Savoy cabbage). Kale is acephala. Both cauliflower and broccoli are lumped together as B. oleracea botrytis. And so on, in a series of seemingly well-ordered appellations, but even they do not begin to nail down the surprising diversity produced by human attention to one wild, leafy weed very long ago.

What is genuinely hard to see at first is how so many apparently dissimilar vegetables could be so closely connected. It turns out that each is a highly specialized distortion of the original wild type, which was a proto-kale native to the seacoasts of Europe’s North Temperate Zone. The genus Brassica includes many other useful plants: rutabaga, turnip, various mustard greens, and bok choy. But none of them lent itself to human hybridization so brilliantly as B. oleracea. The most useful of these artificial freaks, the cabbage, was coaxed to grow a very short stem and lots of leaves that overlap and appear to form a huge bud. Real buds of B. oleracea (axillary buds grown on an erect stem) have been trained to develop into heads—what we know as Brussels sprouts—instead of sprouting normally into branches. Kohlrabi is a headless stem swollen into a mass of edible tissue. Cauliflower and broccoli are both examples of a stunted inflorescence, heads of abortive flowers on thick, hypertrophied branches.

It is as if a mad agronomist had set out to magnify and bloat the various organs of an inoffensive weed and then had found that each mutation was more attractive than the last. Of course, cultivation of the cabbage kin must have stretched over a long period and seems to have occurred primarily in prehistoric times. True cabbage, as well as cauliflower and broccoli, was known to the Greeks and Romans. The poet Propertius, in the persona of Vertumnus, god of vegetation and the changing seasons, wrote: "I am famous for the green cucumber, and the swelling belly of the gourd and for the cabbage fed with light rushes."

Germans, Saxons, and Celts brought the oleracea cultigens to Great Britain, where the original native variety, a stout perennial called colewort, still grows wild. The word cole also survives, as all-purpose name for members of Brassica genus. It is obviously connected, linguistically, with kale and cauliflower and with the German word for cabbage, Kohl. Kohlrabi, Austrian dialect for cabbage-turnip (standard German for turnip is Rüeb), is, for once, popular nomenclature reflects botanic reality; reflects it, fact, more accurately than the confounding, if official, binomial moniker Cole, at any rate, is the oldest to have in English for cabbage, appears in an Anglo-Saxon soult dated about 1000. And it is in common usage in the phrase "cole slaw" cabbage salad. Nevertheless, under all other circumstances, we call oleracea v. capitata just plain cabbage. The earliest written source for the word is a cookbook printed 1440, which directs us to "take baches and cut ham on foure..." hit boyle." This is good advice and it also shows the French origin of the word cabbage. Cabocher is French slang for a "big head," a nog cabbage is big heads, and the journey from cabocher to cabocher to cabbage is a short and direct one.

Today, cabbage and its specimens grow almost everywhere in the world except the tropics. They are easy to cultivate, do well in weather, and yes, they are good for you. Nutritionally, cabbage is m
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than 90 percent water, but it is low in calories (only 24 per grams, or 3½ ounces, of raw bag) and high in vitamin A and C. Kale is phenomenally high vitamin C, with 186 milligrams 100 grams. An orange averages 50 milligrams per 100 grams peeled fruit.

More enticing, perhaps, to the sumer than all this nutritional boning is the welcome news, cabbage et al. can be prepared dozens of brilliantly delicious with starting with the moderately Szechwan recipe for broccoli bell. The stir-fry method keeps the vegetables from izing as doves the addition of dried red peppers and fresh ginger to the sa. You may also use cauliflower for the recipe. Not only do the Chinese themselves practice this taxonomic plausible substitution, but they use the same name to both cauliflower and broccoli, huacai.

If you were brought up thinking cabbage as a malodorous penalty gave you gas, you will be pleased perhaps jealous to learn that a simple French households got around the dreadful sight of gray massed steamed leaves by pureeing cabbages and adding equal weight of boiled potatoes, dehydrating excess moisture from the puree in a hot oven, and serving it with butter. Almost every culture but ours has a cabbage combining meat, cabbage and other vegetables. My grandmother can this soup borscht and made it to beef. In the Pyrenees, they the recipe and call it garbure.

For real cabbage versatility, however, we face east, toward Budapest George Lang’s The Cuisine of Hungary lists a score of dishes, from basic stuffed cabbage to a learn concoction of pâte and crinkly Sá cabbage. Hungary is also a place does not snub the kohlrabi, but fully scoops out the centers, and them together with the leaves uses the mixture as a sauce (after it has been cooked and seasoned) to cover the kohlrabi shells, which are stuffed with a mixture ground veal and pork. For some reason, kohlrabi seems tend to be complicated. But I discovered recently, having returned from farm stand with four small and ten ones, that they can be peeled, sliced thinly, and sautéed in no time. the result is very appealing. They done when they turn an opaque whi
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The deadline is April 15, 1977. Please put your name and address on every entry, and include a stamped, self-addressed envelope—since we do want to return your pictures to you.

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Pack them carefully and mail to:
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Cabbage and company (Brussels sprouts and kohlrabi excepted) can also be eaten raw, ideally with aial a garlic-laden mayonnaise, to accompany the shredded leaves or curd flowerets. Red cabbage, shredded and mixed with plain yogurt, makes a Lucullan, filling dish for a dietary lunch or for anyone in search of unappalling source of roughage.

For more exotic moments, try cauliflower pakorisa, a sort of Indian tedi pura with a chickpea-flour batter. Cut the flowerets into 1-inch segments. Then mix together—as Madhur Jaffe suggests in An Invitation to Indian Cuisine—1 cup sifted chickpea flour, 1 teaspoon each of salt, ground turmeric, ground cumin, and baki soda with 1/2 teaspoon each of bla and cayenne pepper. Dip 1 flowerets in the batter and fry a few at a time, slowly, in oil, until golden brown.

Thus surfeited, you will permit to close with a few random and delicious tidbits about Cabbage and Sons:

The white part of the cauliflower is known as its "curd."

Sauerkraut is shredded cabbage fermented by the action of lactic acid on the natural sugars in the cabbage juice. This produces lactic acid, with its characteristically sour taste, that preserves the cabbage, turning it in what one authority calls "humanage." This mash is, to my mind, palatable only as a stuffing for turkey—the Serbian dish, podvarak (see Natural History, November 1975).

English slang expressions that refer to cabbage are almost always pejorative: cabbagehead for foolishness, for cabbage-leaves for a cheap cigar. French, on the other hand, chou ("cabbage") is a term of endearment. "To have something in your cabbage" (en avoir dans le cho) means to be intelligent. And it is hard to think of pâte à chou ("cream puff dough"); but, literally, "cabbage dough") as anything but pleasant.

American farmers produce roughly 2 billion pounds of cabbage in a normal year. They also grow 350 million pounds of broccoli, 73 million pounds of Brussels sprouts, and 31 million pounds of cauliflower. You have your work cut out for you.

Chao Jieluciai

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1 large bunch broccoli
2 dried red peppers
½-inch piece fresh ginger
1 tablespoon cornstarch
½ cup peanut oil
1 teaspoon salt

1. Wash the broccoli. Cut the flowerets off the main stems fairly good-size pieces. Cut the tough bottom part of the stems, then slice the stems in half lengthwise and then into pieces about 2 inches long.
2. Cut each pepper into 4 pieces.
3. Peel the ginger, then cut it into shreds about ½ inch wide, and width of a wooden matchstick.
4. Combine the cornstarch with cup water in a bowl and set aside.
5. Heat your wok or pan over a high flame for 15 seconds, then add the oil. It will be ready to co with when the first tiny bubble form and a few small wisps smoke appear.
6. When the oil is ready, throw the ginger and the red pepper into the pan. Use your cooking shovel spoon to stir them around in the middle of the pan for 5 seconds.
7. Now add the broccoli and stir for 1½ minutes, scooping it up and down from the sides of the pan and stirring it around in the middle so eve piece is exposed to the hot oil.
8. Add the salt and stir-fry the broccoli for 1 minute longer.
9. Pour ½ cup water into the pan and let it come to a boil, then cover the pan and let the broccoli cook over a moderately high flame for 8 minutes.
10. Stir the cornstarch and water mixture into the pan. Stir the broccoli for a few seconds over a high flame until the sauce turns thick and clear, then serve.

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It is difficult enough explaining how even a simple universe began. I take it as agreed that it would be even harder to explain the sudden springing up, fully armed, of complex order—life. Darwin’s theory of evolution by natural selection is satisfying because it shows us a way in which simplicity could change into complexity, how unordered atoms could group themselves into ever more complex patterns until they ended up manufacturing people. Darwin provides a solution, the only feasible one so far suggested, to the deep problem of our existence.

Darwin’s “survival of the fittest” is really a special case of a more general law of survival of the stable. The universe is populated by stable things. A stable thing is a collection of atoms which is permanent enough or common enough to deserve a name. It may be a unique collection of atoms, such as the Matterhorn, which lasts long enough to be worth naming. Or it may be a class of entities, such as raindrops, which come into existence at a sufficiently high rate to deserve a collective name, even if any one of them is short-lived.

The things which we see around us, and which we think of as needing explanation—rocks, galaxies, ocean waves—are all, to a greater or lesser extent, stable patterns of atoms. Soap bubbles tend to be spherical because this is a stable configuration for thin films filled with gas. In a spacecraft, water is also stable in spherical globules, but on earth, where there is gravity, the stable surface for standing water is flat and horizontal. Salt crystals tend to be cubes because this is a stable way of packing sodium and chloride ions together. In the sun the simplest atoms of all, hydrogen atoms, fuse to form helium atoms because in the conditions which prevail there the helium configuration is more stable. Other even more complex atoms are formed in stars all over the universe, and were formed in the “big bang,” which according to the prevailing theory, initiated the universe. This is originally where the elements on our world came from.

Sometimes when atoms meet they link up together in chemical reactions to form molecules that may be more or less stable. Such molecules can be very large. A crystal such as a diamond can be regarded as a single molecule, a proverbially stable one in this case, but also a very simple one since its internal atomic structure is endlessly repeated. In modern living organisms there are other large molecules which are highly complex, and their complexity shows itself on several levels. The hemoglobin of our blood is a typical protein molecule. It is built up from chains of smaller molecules, amino acids, each containing a few dozen atoms arranged in a precise pattern. In the hemoglobin molecule there are 574 amino acid molecules. These are arranged in four chains, which twist around each other to form a globular three-dimensional structure of bewildering complexity. A model of a hemoglobin molecule looks rather like a dense thornbush. But unlike a real thornbush it is not a haphazard approximate pattern but a definite invariant structure, identically repeated, with not a twig or a twist out of place, over six thousand million million times in an average human body. The precise thornbush shape of a protein molecule such as hemoglobin is stable in the sense that two chains consisting of the same sequences of amino acids will tend, like two springs, to come to rest in exactly the same three-dimensional coiled pattern. Hemoglobin thornbushes are springing in their “preferred” shape in your body at a rate of about four hundred million million per second, and others are being destroyed at the same rate.

Hemoglobin, a modern molecule illustrates the principle that atoms tend to fall into stable patterns. Before the coming of life on earth, rudimentary evolution of molecules may have occurred by ordinary processes of physics and chemist. There is no need to think of design or purpose or directedness. If a group of atoms in the presence of energy falls into a stable pattern, it will tend to stay that way. The earliest form of natural selection was simply a selection of stable forms and a rejection of unstable ones. There is no mystery about this. It had to happen by definition.

From this, of course, it does follow that you can explain the existence of entities as complex as man exactly the same principles on the own. It is no good taking the rig number of atoms and shaking the together with some external energy till they happen to fall into the right pattern and out drops Adam! You may make a molecule consisting of a few dozen atoms like that, but a man consists of over a thousand million million million atoms. To try to make a man, you would have to work at your biochemical cocktail shaker for a period so long that the entire age of the universe would see
COME SHARE OUR DISCOVERY

American Museum of Natural History Announces an Extraordinary Adriatic-Aegean Cruise

On September 19, 1977, 255 fortunate (and foresighted) friends of the American Museum will embark on a voyage to the splendid past...the glories of ancient Greece and Byzantium...interspersed with quiet days on unspoiled islands, in the favorite haunts of rare and beautiful birds.

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More than a holiday, more than a rest, even more than a chance to see and explore other places, peoples, customs. DISCOVERY is also a unique adventure in learning.

The superb itinerary, planned in consultation with Museum scholars and scientists, overlooks no opportunity to reveal and illuminate, to veer off the traveled paths for special, extra insights.

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The M.S. ORPHEUS is registered in Greece.
like an eye blink, and even then you
would not succeed. This is where
Darwin’s theory, in its most general
form, comes to the rescue. Darwin’s
takes over from where the
story of the slow building up of mole-
cules leaves off.

The account of the origin of life I
shall give is necessarily speculative;
by definition, nobody was around to
see what happened. There are a
number of rival theories, but they all have
certain features in common. The sim-
plified account I shall give is probably
not too far from the truth.

We do not know what chemical
raw materials were abundant on earth
before the coming of life, but among
the plausible possibilities are water,
carbon dioxide, methane, and ammo-
nia—all simple compounds known to
be present on at least some of the
other planets in our solar system.
Chemists have tried to imitate the
chemical conditions of the young
earth. They have put these simple
substances in a flask and supplied
a source of energy such as ultraviolet
light or electric sparks—artificial
simulation of primordial lightning.

After a few weeks of this, some-
thing interesting is usually found in-
side the flask: a weak brown soup
containing a large number of mole-
cules more complex than the ones
originally put in. In particular, amino
acids—the building blocks of pro-
teins, one of the two great classes of
biological molecules—have been
found. Before these experiments
were done, naturally occurring amino
acids would have been thought of as
diagnostic of the presence of life. If
they had been detected on, say, Mars,
life on that planet would have seemed
a near certainty. Now, however, their
existence need imply only the pres-
ence of a few simple gases in the at-
mosphere and some volcanoes, sun-
light, or thundery weather. More re-
cently, laboratory simulations of the
chemical conditions of earth before
the coming of life have yielded or-
ganic substances called purines and
pyrimidines. These are building
blocks of the genetic molecule, DNA
itself.

Processes analogous to these must
given rise to the “primeval soup” that biologists and chemists
believe constituted the seas some
three to four thousand million years
ago. The organic substances became
generally concentrated, perhaps in dry-
ing scum round the shores or in tiny
suspended droplets. Under the further
influence of energy, such as ultra-
violet light from the sun, they com-
bined into larger molecules. Nowa-
days, large organic molecules would
not last long enough to be noticed;
they would be quickly absorbed and
destroyed by bacteria or other liv-
ing creatures. But bacteria and
the rest of us are latecomers, and in those
days, large organic molecules could
drift unmolested through the thicken-
ing broth.

At some point a particularly re-
markable molecule was formed by
accident. We will call it the replica-
tor. It may not necessarily have been
the biggest or the most complex mole-
cule around, but it had the extraor-
dinary property of being able to create
copies of itself. This may seem a very
unlikely sort of accident to happen.
So it was. It was exceedingly improb-
able. In the lifetime of a man, occu-
rences that improbable are practically
impossible. That is why you will
never win a big prize on the football
pools. But in our human estimates of
what is probable and what is not, we
are not used to dealing in hundreds
of millions of years. If you filled in pool
coupons every week for a hundred
million years you would likely win
several jackpots.

Actually, a molecule which makes
copies of itself is not as difficult to
imagine as it seems at first, and it only
had to arise once. Think of the repli-
cator as a mold or template. Imagine
it as a large molecule consisting of a
complex chain of various sorts of
building block molecules. The small
building blocks were abundantly
available in the soup surrounding the
replicator. Now suppose that each
building block has an affinity for its
own kind. Then whenever a building
block from out in the soup lands up
next to a part of the replicator for
which it has an affinity, it will tend
to stick there. The building blocks
that attach themselves in this way will
automatically be arranged in a se-
quence that mimics that of the rep-
licator itself. It is easy then to think
of them joining up to form a stable
chain just as in the formation of the
original replicator. This process
should continue as a progressive stack-
ing up, layer upon layer. This is how
crystals are formed. On the other
hand, the two chains might split
apart, in which case we have two
replicators, each of which can go
on to make further copies.

A more complex possibility is that
each building block has affinity, not
for its own kind, but reciprocally
for one particular other kind. Then
replicator would act as a template,
for an identical copy, but for a kine
of “negative,” which would in
turn remake an exact copy of the or-
iginal positive. For our purposes it
does not matter whether the original
replication process was positive—negat-
or positive—positive, although it
worth remarking that the mod-
equivalents of the first replicator,
DNA molecules, use positive—ne-
tive replication.

What does matter is that sud-
ne a new kind of “stability” came
in the world. Probably no particu-
kind of complex molecule was pre-
viously very abundant in the sea
because each was dependent
building blocks happening to fall
luck into a particular stable config-
ratio. As soon as the replicator was
born it must have spread its cop-
rapidly throughout the seas, until
smaller building block molecules be-
came a scarce resource, and all
larger molecules were formed mo-
arely.

So we seem to arrive at a large pop-
ulation of identical replicas. But we
must mention an important pro-
erty of any copying process: it is not
perfect. Mistakes will happen. I ho-
there are no misprints in this mag-
zine, but if you look carefully you
may find one or two. They will prob-
bly not seriously distort the mean-
ing of the sentences because they will
“first generation” errors. But ima-
gine the days before printing, when
books such as the Gospels were
copted by hand. All scribes, howev-
careful, are bound to make a few
errors, and some are not above a lit-
willful “improvement.” If they
their copy from a single master origin-
meaning would not be greatly per-
eted. But let copies be made from
other copies, which in their turn were
made from other copies, and errors
will start to become cumulative and
serious.

We tend to regard erratic copy-
as a bad thing, and in the case
human documents, it is hard to thin-
examples where errors can be de-
scribed as improvements. I sup-
the scholars of the Septuagint cou-
at least be said to have started some-
thing big when they mistranslated
Hebrew word for “young woman
into the Greek word for “virgin,”
coming up with the prophecy: “B
hold a virgin shall conceive and be
a son . . . .” Anyway, as we shi
erratic copying in biological replicators can in a real sense give rise to improvement, and it was essential for the progressive evolution of life some errors were made.

We do not know how accurately original replicator molecules make their copies. Their modern descendants, the DNA molecules, are amazingly faithful compared with most high-fidelity human copying processes; but even they occasionally make mistakes, and it is ultimately the mistakes which make evolution possible. Probably the original replicators were far more erratic, but in case we may be sure that mistakes were made and these mistakes were cumulative.

As miscalculations were made and propagated, the primeval soup became filled by a population, not of identical replicas, but of several species of replicating molecules, all descended from the same ancestor. Would some varieties have been numerous than others? Almost certainly yes. Some varieties would have been inherently more stable than others. Certain molecules, once made, would be less likely than others to break up again. These types would become relatively numerous in the soup, not only as a direct logical sequence of their “longevity,” but also because they would have a longer time available for making copies of themselves. Replicators of high longevity would therefore tend to become more numerous and, other things being equal, there would have been an evolutionary trend toward higher longevity in the population of molecules.

But other things were probably not equal, and another property of a replicator variety, which must have had more importance in spreading it through the population, was speed of duplication, or “fecundity.” If replicator molecules of type A make copies of themselves, on average, once a week while those of type B make copies of themselves once an hour, pretty soon type A molecules going to be far outnumbered, even though they “live” much longer than B molecules. There would therefore have been an evolutionary trend toward higher fecundity of molecules in the soup.

A third characteristic of replicator molecules that would have been positively selected is accuracy of replication. If molecules of type X and type Y last the same length of time and

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replicate at the same rate, but makes a mistake, on average, every tenth replication while Y makes mistakes only every hundredth replication, Y will obviously be more numerous. The X contingent of the population loses not only the rank "children," but also all their descendants, actual or potential.

The primeval soup must have come populated by stable variety molecules: stable in that either the individual molecules lasted a long time or they replicated rapidly or they replicated accurately. Evolution trends toward these three kinds of stability took place in the following sense: if you had sampled the soup two different times, the later sample would have contained a higher proportion of varieties with longevity/fecundity/copying fidelity. This is essentially what a biolo means by evolution when he is speaking of living creatures, and the mechanism is the same—natural selection.

Should we then call the origin replicator molecules "living"? Why cares? Whether we call the early replicators living or not, they were the ancestors of life, they were founding fathers.

The next important link in the argument, one which Darwin himself stress on (although he was talking about animals and plants, not molecules) is competition. The prime soup was not capable of supporting an infinite number of replicator molecules. For one thing, the earth's surface is finite, but other limiting factors must also have been important. In the picture of the replicator acting as a template or mold, we supposed it to be bathed in a soup rich in the building block molecules necessary to make copies. But when the replicators became numerous, building blocks must have been used up such a rate that they became a scarce and precious resource. Different varieties or strains of replicator molecule have competed for them. Le favored varieties must actually have become less numerous because of competition, and ultimately many of their lines must have gone extinct. There was a struggle for existence among replicator varieties. They not know they were struggling; we worry about it; the struggle was conducted without any hard feelings, indeed, without feelings of envy. But they were struggling, in the sense that any miscopying that resulted a new, higher level of stability or
my way of reducing the stability of thals was automatically preserved and multiplied.

The process of improvement was cumulative. Ways of increasing stability and of decreasing rivals' stab-
ility became more elaborate and more efficient. Some of them may even have been "discovered" how to break up molecules of rival varieties chemically and to use the building blocks released for making their own.

These protocarnivores simultaneously obtained food and removed competing rivals. Other replicators perhaps discovered how to protect themselves, either chemically or by folding a physical wall of protein around themselves. This may have been how the first living cells appeared.

Replicators began not merely to test but to construct for themselves new containers, vehicles for their continued existence. The replicators that survived were the ones that built "survival machines" for themselves that lived in the first survival machines probably consisted of nothing more than a protective coat. But making a living got steadily harder as new and more complex machines arose with better and more effective survival machines. Survival mechanisms became bigger and more elaborate, and the process was cumulative and progressive.

Was there to be any end to the gradual improvement in the techniques of artifices used by the replicators to ensure their own continuance in the world? There would be plenty of time for improvement. What weird engines of self-preservation would the millennia bring forth? Four thousand million years on, what was to be the fate of the ancient replicators? They did not die out, for they are masters of the survival arts. But not for them floating loose in the sea; they gave up that cavalier rodomontage long ago. Now they swarm in huge colonies, safe inside gigantic mothering robots, sealed off from the outside world, communicating with it by tortuous indirect routes, manipulating it by remote control. They are you and me; they created us, and we are minds, and their preservation is the ultimate rationale for our existence. They have come a long way, those replicators. Now they go by the name of genes, and we are their survival machines.

Richard Dawkins is a lecturer in animal behavior at Oxford University.
THE FRANKLIN MINT PROUDLY PRESENTS

Baltimore Orioles
by Gilroy Roberts
An original sculpture in fine pewter, by one of the finest artists of our time.
To be issued only once, in strictly limited edition.
Ordering deadline: February 25, 1977

THE SCULPTOR. Gilroy Roberts is recognized throughout the world as one of America's greatest living sculptors.

For the past twelve years, Mr. Roberts has been Chief Sculptor of The Franklin Mint. Before that, Mr. Roberts was Chief Sculptor-Engraver of the United States Mint—the ninth man in history to have held that post.

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To Gilroy Roberts, birds are the most delightful of God's creatures . . . the very essence of all that is beautiful in nature. And for many years, birds have been the subject of many of his most important works. His sculpture of the American Eagle, for example, was personally presented by President Ford to the King of Belgium, Pope Paul VI and the Heads of State.

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Each sculpture will be produced to order, and will bear Gilroy Roberts' medallion mark (R).

THE LIMITS OF EDITION. Baltimore Orioles will be produced only once, in single, strictly limited edition. There is a firm limit of one per person, and an absolute ordering deadline of February 5, 1977.

The sculpture will not be available rough even the finest art dealers or galleries. It is available only from The Franklin Mint. The total edition will be equal to the exact number of valid orders postmarked by the February 25 deadline. And, when these orders have been filled, the master sculpture will be destroyed so that this limited edition pewter sculpture can never be produced again. Thus, the rarity of this beautiful work of art will be assured forever.

The price of this important new work of art by Gilroy Roberts is $150. There is no need to send any payment now. You will be notified when your sculpture is ready, and you will be billed at that time for the required deposit of $37.50, with the balance to be billed in three equal monthly installments after shipment.

AN ADDED OPPORTUNITY. Baltimore Orioles is the first in a series of four pewter bird sculptures being created by Gilroy Roberts.

As the owner of Baltimore Orioles, you will also have the guaranteed option to acquire the three remaining sculptures in this series at the same original issue price. The other sculptures will portray Peregrine Falcons, Pelicans and Blackbirds.

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Rock Art and the Power of Shamans
by Dean R. Snow

Intricate designs, symbols, and imaginary animals attest to the importance many American Indian societies placed on the supernatural.

Here and there across North America, rock art, carved or painted by Indians many years ago, proliferates on smooth cliffs, outcroppings, boulders, and caves. Petroglyphs are more common than paintings, many of which have eroded away. Both, however, consist of human and animal representations and symbols of varying degrees of complexity.

The increasing publicity given in recent years to the location of these intriguing signs of native American culture has resulted in the illicit quarrying and sale of this art. But it has also spurred a desire for preservation and protection and has given anthropologists an opportunity to consider the more subtle characteristics of long since vanished Indian cultures.

This is not to say that anthropologists have been notably successful in interpreting rock art. Until recently, most studies usually compared superficial inventories of motifs found on figures at one site with lists of those from other sites. Such lists included birds, bird tracks, horned humans, fish, and various other human, animal, or abstract figures.

Although painted or carved in a simple style, many of these figures and shapes defy precise identification. Animal representations may symbolize a dog, a bear, or any one of several other quadrupeds. Even more frustrating is the frequent juxtaposition of animal figures, some unfinished, with abstract symbols. There are exceptions to the general simplicity, such as the lavish Chumash paintings in southern California, near Santa Barbara, but clean lines characterize the contents of most rock art sites.

Anthropologists have often interpreted rock art as examples of picture writing (pictographs), assuming that the artist consciously intended to enliven and clarify oral literature. But efforts to read the figures at petroglyph and pictograph sites as if they were narrative statements have consistently failed.

Only a few people studying Indian rock art have suggested that each figure was an entity in itself, bearing no relationship to other nearby figures. Also, there has rarely been an attempt to consider rock art figures in the light of our historical knowledge of various American Indian cultures. To suggest, for example, that rock art was the result of a belief in hunting magic would be futile if historical literature did not mention some form of a belief in such magic.

I was first attracted to the study of petroglyphs as a teen-ager growing up in a small town in southern Minnesota. The land there was once prairie, flattened by a succession of Ice Age glacial advances and now creased by the tributary streams of the Mississippi River. Over most of the area, bedrock lies buried deep under the sand and gravel drift left behind by the glaciers, but occasionally a dome of red Sioux quartzite pokes through the surface. One such outcrop lies like the back of a great red whale in a sea of prairie grass in rural Cottonwood County. The surface of the nearly horizontal rock face bears ripple marks left by the waves of the Precambrian sea as well as a multitude of north-south scratches cut by the glaciers that passed over it millions of years later. The rock face also bears an array of petroglyphs, which are far more difficult to explain than the ripple marks and glacial scratches.

The bedrock surfaces again at Pipestone about sixty miles to the west near the Minnesota–South Dakota border. For centuries, prehistoric Indians came to this area to quarry pipestone, the fine-grained red rock we call catlinite, for the bowls of their long smoking pipes. Even though this attractive raw material occurs in only a few places, finish pipes have been discovered in many Indian sites in eastern North America.

The quarry near the border was of the largest, and its importance was underscored by the dozens of petroglyphs that once adorned the rock surface. The existence of the quarry, however, provides us with only the most general reason for the petroglyphs. For a more specific explanation, we must look to the historic record of the Siouan-speaking Dakota Indians and their ancestors who monopolized the resource for centuries.

An important part of Dakota culture, particularly for men, was the vision quest. This typically involved periods of isolation, fasting, and even self-torture by young men in search of hallucinations that they regarded as guideposts for their future lives. Their chances of having such experiences were increased if they attached themselves to shamans—older men whose supernatural powers we now known. In their search they oft smoked pipes of the strong native tobacco, a potent inducer of hallucinations. There was thus a strong connection linking the pipestone quarries to the supernatural activities of Dakota shamans and their apprentices.

Historical records indicate that Dakota Indians believed the Pipestone petroglyphs to be of supernatural origin. One story has it that a huge thunderbird carved the petroglyphs with lightning bolts. Such explanations

Representations of bighorn sheep such as these in Monument Valley, Arizona, occur by the thousands in the western United States. They were probably painted by Indian hunters practicing shamanism.
may seem quaint to us, for contemporary Western culture draws a clear line between the natural and the supernatural. But in the traditional Dakota culture, concepts of natural and supernatural were elaborately intertwined. The petroglyphs were probably made by a shaman or his apprentice responding to a vision of a thunderbird. But in a culture in which shamanistic power was assumed to exist as a natural component of life, the connection between the vision as an impetus and the petroglyphs as a result is entirely logical.

Shamans were usually men, occasionally women, and always strong personalities. By virtue of this trait and their ability to conjure up visions for themselves and others, they served to integrate the natural and supernatural in Dakota society. The Dakota believed that birds, turtles, deer, fish, humans, and other petroglyph motifs had an inherent magical power of their own because they often saw them in visions.

The notion of art possessing inherent power is also evident in the sand paintings of the Navajo, who believed that the curing power they transmitted into their sand paintings flowed out to sick patients during shamanistic ceremonies. Explanations of such art as simply being picture writing, idle doodling, or evidence of hunting magic often miss the crucial point and thus much of the richness of American Indian cultures.

In some regions of the country, investigators have related certain art techniques and motifs to specific Indian cultures and their shamanistic beliefs. The link between the Dakota vision quest and petroglyphs at remote rock outcrops is only one example. The polychrome rock paintings of the Chumash, which have been so extensively analyzed and copied by Campbell Grant, are another.

The Chumash were one of several cultures of southern California and the interior southwest that practiced the tolguacha, or toloache, cult. Toloache, which comes to us via Spanish from the Aztec toloachtin, refers to plants of the genus Datura, which when eaten produce colorful hallucinations. The plants are also called Jimsonweed, a result of the accidental discovery of their narcotic effects by English soldiers at Jamestown, Virginia. The Chumash thought that the visions produced by the drug foretold the future and made supernatural beings visible. Shamans under its influence thought themselves transported through space and time. It is likely that the colorful and bizarre pictographs were painted during after such experiences.

My own interest in the connection between rock art and historically documented shamanism led me to a study of petroglyphs on the banks of Kennebec River in Maine. I stayed for three years at the University
Maine and during that time became familiar with Abenaki Indian shamanism and the few examples of rock art in the state. The Kennebec is one of two primary river courses formerly led by the Indians of Maine, the other being the Penobscot. The drainage basins of these two rivers comprised most of the territory of the historic Eastern Abenaki, of which the only remaining resident branch is the modern Penobscot tribe. At one place along the course of the Kennebec through southern Somerset County, a ledge of metamorphosed shale juts out into the current, forming a natural dock for canoes and, as it happens, a smooth surface where the Indians carved petroglyphs. The site is one of only a handful of petroglyph sites in Maine. About ninety distinct figures are visible in a band more than eight yards long and two yards wide. Other figures are too faint to be accurately traced, but the original number may have approached two hundred.

The most striking characteristic of the petroglyphs is their heavy sexual content. The only similar phenomenon occurs at a site near Peterborough, Ontario. Joan and Romas Vastokas of Trent University have studied this site carefully and have come to many of the same conclusions that I reached in my study of the Kennebec petroglyphs. Both sites lie within the general distribution of Algonquian-speaking Indians.

Like the Vastokases, I plunged into the literature of Algonquian shamanism. They found their most solid leads in the writing of Henry Schoolcraft, a nineteenth-century ethnologist. My own search led me to a re-examined examination of the writings of Fannie Hardy Eckstorm, a well-known Maine historian, and Frank Speck, an anthropologist who wrote extensively on Algonquian speakers in general and Penobscot shamanism in particular.

I was especially drawn to Eckstorm's biography of John Neptune, an Abenaki shaman who lived from 1764 to 1865. Neptune served as second sagamore (vice-chief) with head sagamore John Attean; together they were the last traditional leaders to enjoy life appointments. Because of Neptune's long life and strong personal charisma, he was remembered by other members of the community long after his death. Both Eckstorm and Speck saw through Neptune's

The complex polychrome paintings of the Chumash Indians of southern California defy precise interpretation. That many of them were hidden in mountain clefts suggests that they were part of a ritual. No longer so isolated, the colorful paintings have inspired modern graffiti.
reputation as a rogue, and realized that he was an excellent example of a charismatic leader who was both a shaman and political figure.

The Abenaki called their shaman *medeolintum*, "supernatural man." Such a person was by definition the possessor of a potent magical power whose vagueness heightened its threat, for persons lacking it were never sure who had it or how it might be used against them. Even the shaman himself might not at first be sure that he possessed magical power since its acquisition was involuntary. Unlike the Dakota, the Abenaki usually did not seek out shamanism, but rather accepted it as a fact of life much as one would accept any other idiosyncratic characteristic of personality.

A shaman could cause illness by simply willing it. And he could supposedly cure the illness by ceasing to impose his magical will on the victim. This is not to say that the Abenaki shaman was a curer. Herbal remedies and other practical, non-magical techniques were normally the province of curers, who did not possess magical powers. A curer had talent, but a shaman had personal charisma, which translated into prestige as well as both real and magical power. The result was that shamans usually rose to positions of leadership in this egalitarian society. In this way, secular power and magical power reinforced and validated each other.

A shaman's sexual prowess was another way in which he expressed his power. Shamans normally had two or more wives and sexual reputations to match. Women occasionally became shamans and acquired the same sort of reputation for magical and sexual power. Because the Abenaki society was normally male dominated, female shamans were generally regarded as even more threatening than their male counterparts. John Neptune had three wives and a reputation as a libertine, the real significance of which we can now readily appreciate, but which escaped most nineteenth-century observers.

Abenaki shamans were quite independent, never coming together into organized societies like Ojibwa shamans. When he wished, a shaman could transform himself into, and travel about in, at least one animal form. To an observer, the shaman's body remained unconscious and inert while this happened. The Abenaki believed that if the animal were killed, the shaman's body died in the same instant. Indeed, this was the logical explanation when a known or suspected shaman died while either sleeping or unconscious.

John Neptune is supposed to have had seven animal forms, the largest number known for any Abenaki shaman. Although his principal form was the eel, he probably treated all seven species with considerable respect. Otters, beavers, porcupines, bears, dogs, and birds served as other typical animals into which shamans could transform themselves. Many legends reinforced this belief; a typical example tells of the hunter who wounded an animal and later encountered a man with an analogous wound. The logical conclusion was that the injured man was actually a shaman in animal form.

A short excursion into Abenaki folklore also supports an interpretation of the Maine petroglyphs. An Abenaki storyteller could shift each of the culture's folk heroes in and out of a cycle of tales in a way confusing to modern readers seeking a clear and permanent structure. Similarly, the Abenaki traditionally believed that a supernatural creature or creatures lived in or on Mount Katahdin, a peak that dominates the interior of Maine. One of the most frequently mentioned creatures was Pamola, often described as a bird with a huge head and wings but without a body. Sometimes this creature was portrayed as being covered with hair or as having a body but no anus; at other times, it was a handsome young man.

In most tales, the characteristics of
the heroes always changed, a frustration to folklorists but not to the Abenaki. The point is that when dealing with the supernatural there was no need for either precision or permanence because the entities described were capable of endless transformation. This characteristic of traditional Abenaki belief makes shambles of modern efforts to impose a rigid structure upon it. Such constant change must be kept in mind in any analysis of petroglyph motifs.

Among the most easily identified Abenaki figures are four human male representations with pronounced phalli. They are also the most obvious evidence of the connections between shamanism, sexuality, and petroglyphs at the site. All four are shown in profile, moving left to right, and three do so with the left arm raised. One figure has an enlarged left hand with fingers splayed, a specific symbol of shamans in Algonquian cultures. The same gesture was common on some historic Ojibwa birchbark scrolls.

Female figures are more difficult to identify because anatomical clues are generally absent. Instead, women appear to be identifiable by posture. Three figures are shown with legs spread and knees drawn up, a gesture of sexual receptivity. Female forms are more often represented as disembodied genitals, possibly an indication that the petroglyphs were made by a man. These occur in two basic forms—one an oval with a short interior line; the other a set of three lines each joined to the others at one end. The latter are common in many North American petroglyph sites, but their frequent identification as bird tracks has tended to obscure their real meaning. Most birds, particularly the birds of prey that most interested North American Indian shamans, have rear toes that leave tracks quite different from the figures here.

Disembodied male genitals are less frequent. There are only two such figures that can be positively identified. Of two phallic representations, one is equipped with wings and resembles bird forms found elsewhere at the site. The connection between birds and sexuality is close. There are at least fifteen birds among the petroglyphs; some of them are almost human in form and at least three are
phallic. The bird forms could represent the supernatural Pamola of Mount Katahdin, interchangeably a man or flying creature, a supernatural being or transformed shaman. Whether a phallic bird, a winged phallus, or a transformed human, the representations are a single amorphous concept.

At least thirteen petroglyphs represent canoes, each usually containing two stick figures of humans. Occasionally, one or both are provided with long paddles. One canoe is part of a larger abstract form, another is upside down, and three others are linked together. Still another carries a complex superstructure with what may represent an animal perched on top. Most of the canoes seem to be moving from left to right.

At first glance, the meaning of the petroglyphs appears to be straightforward, even mundane, perhaps the equivalent of Ojibwa water-route markers. But there is no portage or stream fork at this location, nothing that would have required an aboriginal traffic sign. Instead, the canoe motif could represent a deliberate use of canoe transportation as a metaphor for magical transformation. The canoes with their passengers were probably neither less mystical nor less powerful than the other figures.

Of the remaining petroglyphs, some are too abstract or eroded to allow identification; others are too simple to interpret. The simple H form, for example, occurs at least twice here and is also found at sites in Pennsylvania and Ontario, but its meaning remains obscure. Three house forms, whose shapes are consistent with known aboriginal house types, also defy interpretation. There are also animals of unknown species, some of which resemble the "signatures" of Abenaki sagamores on early treaties, possibly the primary forms assumed by these men in their roles as shamans. Despite the remaining difficulties in interpretation, however, the fundamental connection between shamanism and rock art at this site and at many others is strong.

We can only guess at why shamans sometimes chose to express themselves in rock art. The Maine site suggests that unless destruction of rock art sites has been far more severe than we suspect, this sort of artistic expression of shamanism was much more widespread than shamanism itself. Perhaps only a few shamans felt the need to fix their power in time and space by giving it concrete expression in rock art. If so, we can be grateful that these few chose to do so, without rock art, the varying roles of shamans in the broad range of American Indian cultures might have been neglected forever.

Early nineteenth-century Navajo painted these Spanish horsemen below, in Canyon de Chelly, Arizona. The naturalistic figures suggest they are not directly linked to shamanism. Clear and visible only from air, the 1 foot-long effigy, right, scratched into desert gravel near Blythe, California, was probably made by Yuman-speaking shamans.
Shotgun Houses

by John Vlach

It is obvious in its architecture to often go unnoticed, its building's evolution reveals much about those who dwelled in it.

Old buildings can tell us a great deal. In many cases, they are the only records left of the aspirations and experiences of those who lived before us. If we care at all about the day-to-day life of the past in which our present society began to take shape, we should examine those unpretentious, often derelict structures that sit aside seldom-traveled roads. Should we be sensitive enough to regard these castoffs as the products of effort and hope, we might discover a new pathway to an understanding of ourselves.

The rich insights that may reward further searching are illustrated by the story of a humdrum little house often called a "shotgun shack." An architectural saga that began centuries ago in Africa lies enfolded in its shingles and far paper. Shotgun houses are other common in the United States, and for this reason, do not usually attract the attention of the passerby. In their most basic form, they are small, usually rectangular buildings, one room wide (no more than 12 feet across); three rooms deep, all connected to each other; and with doors at each end. One supposed reason for the name is that pellets from a shotgun fired through one of the outside doorways could allegedly pass through the entire building without doing any damage.

Today, shotgun houses, common in both rural and urban areas, are most often seen in mill towns, cotton and sugar plantations, lumber camps, railroad construction sites, and around oil fields. Traditionally built in this country to house large numbers of workers, they are found from Chicago to the gulf coast and from North Carolina to California.

Their wide distribution during this century makes their history difficult to unravel. Several clues in the American cultural pattern, however, point to Louisiana as the place of origin, in this country, for the shotgun house. Along some stretches of the Mississippi River in Louisiana and in the state's bayou country, no other house form exists. Large numbers of these buildings, many dating back to the last century, are also found in New Orleans, Vicksburg, Memphis, Saint Louis, and Louisville, all river towns first established by settlers as they penetrated the country's interior along its larger waterways.

Architectural historians have thought that the long, narrow form of the New Orleans shotgun house was a reflection of nineteenth-century land pressures, which shaped city lots into narrow, rectangular sections. While it is true that the shotgun plan fit well into the city's urban context, houses of other shapes were also built on these lots. Indeed, the shotgun was not as wide as the usual city lot and was therefore not so restricted by lot size as were some of the large French Creole dwellings. Thus the boundaries set by the city surveyor cannot entirely account for the form of shotgun houses. The proliferation of shotguns in New Orleans suggests an earlier origin based on motivations other than functional ones.

The basic shotgun form is very adaptable. A number of alternate designs in New Orleans suggest that the shotgun house had a long formative period. Such variations were probably a response to conditions not anticipated when the basic shape was first used.

One variant, the double shotgun, developed as early as 1854 and was composed of two single shotgun houses built side-by-side under one roof. Builders also expanded shotgun houses vertically to create "camelback" or "humpback" houses. In these buildings the last rooms were two stories high, thus producing a hump. The double shotgun was also modified by the creation of a second-story rear addition. The development of porches produced yet another variation. Dwellings known as "north shore" houses had wide verandas on three sides. Most of these were built in the piney woods region along the north shore of Lake Pontchartrain, where many wealthy white residents of New Orleans spent the summer months.

Shotguns of this latter type were built in New Orleans as early as 1832. In addition to early dates of construction, variations on the basic shotgun design also suggest antiquity by the very fact of their existence. The long history of the double shotgun, the single and double camelbacks, and the north shore houses provides strong evidence for assum-
ing that the basic single shotgun originated in the first quarter of the nineteenth century. Sporadic documents provide evidence that shotgun houses were sold in the 1830s. These houses were probably built at least fifteen or twenty years earlier.

The origin of the shotgun house lies in the history of New Orleans’s black community. In 1803 there were 1,355 free blacks in the city, many of whom were active and successful in a variety of trades. The size of the community was greatly increased in 1809 by the immigration of approximately 2,100 Haitian mulattoes, who first emigrated to Cuba but were later forced off the island by anti-French sentiment. At the same time, a like number of slaves arrived from Haiti, including many who were relatives of free blacks. By 1810, blacks outnumbered whites in New Orleans, 10,500 to 4,500. Such a population expansion necessitated new housing. As many of the carpenters, masons, and inhabitants were Haitian, it was only natural that they modeled their new homes on those they had left behind.

Even today, many Haitian dwellings closely resemble the single shotgun houses of New Orleans; in some cases, they are identical. More importantly, they share the same set of secondary characteristics. Room sizes are comparable: dimensions average 12 by 14 feet in New Orleans and 12 by 12 feet in Port-au-Prince, the capital of Haiti. Ceiling heights are about 12 feet in both cities. Patterns of internal partitioning are also shared. The first two rooms may be converted into, or treated as, one large room. House façades in Port-au-Prince and New Orleans frequently have two tall frontal openings that serve as either doors or windows. Furthermore, shotgun houses in both
es carry a large amount of decoration on their fronts, while the sides are a neglected.

In Port-au-Prince, shotgun houses are an alternative to Creole houses. Its latter type of building was based on Norman houses and was used primarily by French colonials. Although there are some similarities in plan to Creole house type, the shotgun appears to have developed independently, occurring in those areas that were formerly under the exclusive control of the free blacks. Consequently, the shotgun house is most frequent in southern Haiti near Port-au-

Prince and rarely appears in the north, the area dominated by the former colonial capital, Cap-Français (now Cap-Haïtien).

The long association of free Haitian blacks with the shotgun house type is suggested by the way in which they clung to the design in the late nineteenth century. Even when the Neo-Gothic style—with its spires and lacy trim—was brought to Port-au-Prince from Europe, the narrow shotgun house design was retained as the core of the new architecture, with the new elements draped over the outside of the older form. This tenacious conservatism indicates that Haitian blacks had become accustomed to the shotgun form, retaining internal familiarity while bowing to the stylish fashion.

The shotgun houses of Port-au-Prince, however, have as a local antecedent the dwellings constructed by slaves brought from Africa to Haiti in the early eighteenth century when a strong plantation economy began to develop.

The architectural style of plantation housing in Haiti developed from the interaction of the indigenous Arawak Indians, the French colonials, and the slaves. The Arawaks lived in both round and rectangular houses. The rectangular type, called a bohio, was very much like the shotgun in form, but was significantly different in that it had only one room. In the seventeenth century, French settlers copied this building for their own dwellings. The first Frenchmen in Haiti were groups of vagabonds who for almost a century lived a hunting-and-gathering existence while plundering and raiding the sea lanes of the Caribbean. They had no need for a more substantial house form than the bohio; thus it remained a familiar dwelling long after the settlers had killed off the Arawaks.

When the slaves built their plantation dwellings, they used the form of the bohio, but made it a two-room structure. These houses, constructed of wattle and daub with thatched roofs, were one story high, one room wide, and two rooms deep, had a frontward-facing gable, and usually measured 10 by 20 feet. Today, parts of the southern Haitian countryside are dotted with similar buildings. The stable size of these rural dwellings represents more than two centuries of building custom. Urban shotguns and their rural prototypes can thus be linked in a continuum since they are of the same type. But for the origins of this house form, which evolved after the eighteenth-century influx of slaves, we must look to west Africa.

During the entire slave period, many of the Africans who were taken to Haiti came from southwestern Nigeria, an area dominated by the Yoruba. The houses of the Yoruba, like those in most of western and central Africa, are extremely similar, in spatial terms, to rural shotguns in Haiti. The basic Yoruba house is a two-room module measuring 10 by 20 feet. This unit is variable in its orientation; either the long side or the gable may face the front. With the doorway on the gable end, the house is a true shotgun. The Yoruba slaves probably continued to use their customary buildings after they arrived in Haiti; they had only to make a minor

The south Haitian countryside is dotted with these wattle-and-daub shotgun houses almost identical to the slave quarters of mid-eighteenth-century plantations. Occupied by a single family, the rear room is usually used for sleeping; the front room for storage and cooking. Construction materials—crushed sugarcane stalks for the roofing, split laths or small saplings for the wattle, and mud and clay for the daub—are salvaged from any available sources. Other materials, such as nails, screening, and whitewash for the walls, cost about $50, a high price for many peasants.
Shotgun houses first appeared in this country in the early nineteenth century. Probably brought here by Haitian immigrants, shotguns were inexpensive to build and could quickly provide housing for large numbers of people. Now of several types, the basic structure for all shotguns is exemplified by this single shotgun. The size of each building is similar—three or four rooms deep, each room measuring twelve by fourteen feet. Most shotguns in this country have some adornment under the overhanging eaves; the front of the house being the only part visible from the street. Formerly, shotguns may have had two front doors. Now, virtually all of them have one door at the front and one at the back, leading to a yard that once served as an outdoor kitchen.
adjustment to preserve their preferred house form and simultaneously satisfy the demands of plantation owners. Furthermore, the similarity between Yoruba houses and other houses in western Africa allowed other African peoples to accept the Haitian shotgun as their own.

The two-room dwelling is the core of many Yoruba houses, and the continuous use of the 10- by 20-foot unit suggests that it is a basic premise of design in Yoruba architectural traditions. Entire compounds are fashioned by grouping two-room units together. The compound, the domain of the extended family, is a large rambling structure with many rooms arranged around an open courtyard or a small impluvium.

Compounds are called agbo ile in Yoruba, literally "a flock of houses." This term suggests something of the process by which these houses evolved. Compounds, some of which are said to be more than 300 years old, are the conglomerate result of individual family segments building all their dwellings in one place, using the same kinds of housing units they would have built separately, but in this case, constructing the units in accordance with a communal living pattern.

The odyssey of the shotgun house from Africa to the United States is long and complex. African architectural concepts provided the central, formative influence for plantation houses in Haiti. These concepts, together with features borrowed from house forms used by Indians and Europeans, were incorporated into the rural Haitian shotgun. The long association of blacks with the house form was not severed when slaves were granted their freedom. The mulatto class took the mud-and-thatch house and, by changing the techniques of construction, transformed it into a stylish city dwelling. But their changes did not alter the plan of the building. The internal pattern remained familiar. The shotgun form became for the free Haitian black a physical symbol of independence. And when Haitian blacks were forced to migrate to New Orleans, they retained the basic form.

The importance of the odyssey from the Caribbean and western Africa lies in the African influence that the shotgun house displays in this country. Here, the shotgun is common in black areas and hence is Afro-American by virtue of its users. But in some regions, like Bayou Lafourche in Louisiana, it is the dominant house type used by whites. Although there may be two shotgun traditions—one black and one white (in the latter, the buildings are wider)—both are clearly derived from a single house form.

Although the term shotgun may be related to the door arrangement of the houses and the idea that shotgun pellets fired through the house will meet no obstruction, the name may have also originated from western African languages. Several words commonly used in New Orleans came from western Africa. Voodoo, derived from the Fon word for the god Vodun, is a prominent one. In southern Dahomey, the Fon area, the term used to describe houses is to-gun, "place of assembly." The description, possibly used in New Orleans by Afro-Haitian slaves, was misunderstood and then reinterpreted as shotgun.

But what significance could this house type have for the black community? We are only now beginning to understand that humankind possesses an internal architecture of ideas, that we have architecture without buildings. With space as our only medium, we are constantly constructing invincible barriers, walls, and fences behind which we conduct our daily rituals of conversation, greeting, intimacy, and personal encounter. In black neighborhoods there is often...
great degree of tactility in the way people interact. Touching—hands on shoulders, slapping of knees, extensive ritualized handshakes—is common. There is a type of physical intimacy that is measurably absent in the face-to-face encounters in many white communities.

A tradition for this physical closeness is implicit in the shotgun house plan. The series of small rooms, usually joined without hallways, forces family members into contact with each other or it to the porch and street. When any shotguns are put side by side, as in a plantation arrangement or a city block, interaction with neighbors is as frequent as involvement with one’s family. I once asked a group of black women in New Orleans to define a shotgun house. Their collective reply was, “A shotgun house is a house without privacy.” But in positive terms, it is a house in which there is a focus on communal activity; it is an architecture of intimacy.

This attitude has its counterpart in western Africa where the communal compound is generally dominant. The many rooms of this building type provide a spatial realm in which a hundred or more family members can interact communally or where small segments of the family can be together. In this way priorities for public and private intimacy are satisfied. While the shotgun house differs greatly in form from a Yoruba compound, in philosophy, a neighborhood of shotgun houses is identical to a compound. The shotgun house thus serves today as a vessel in which an alternative black tradition, an etiquette of involvement, has been maintained. The shotgun house is a physical expression of an Afro-American state of mind.

A.D. Iselin
A Coarrangement of Kingfishers

Photographs by Mila Olano and Javier Echevarri

Playing the mating game on the banks of a Spanish river

Along the shores of the world’s fresh waters, there is an ecological niche for an avian predator of small fish and other aquatic organisms. A small bird, with a strong, compact body, short neck, large head, and long, pointed beak, the European kingfisher (Alcedo atthis), fills this niche among many of the slow-flowing streams and rivers, canals, ponds, lakes, and marshes of northwest Africa and the greater part of Eurasia—from northern Europe to central Russia, south to India and southeastern Asia, and eastward through Indonesia to New Guinea and the Solomon Islands.

The bird is an excellent fisher, capturing its aquatic prey by making quick plunges into the water from observation perches, such as branches and roots, overhanging a stream. At times, a European kingfisher will hover over the water almost vertically and plunge from that position.

Fish make up approximately two-thirds of the kingfisher’s diet: aquatic insects another sixth. Favoring prey species are minnows, sticklebacks, and gudgeon; small trout, stone loach, and roaches are other fish often taken. Other prey items include water beetles, Odonata larvae, hemipterons, small mollusks, frogs, tadpoles, and worms. Most of the fish taken are of populous, smaller species. A culling effect results from kingfisher predation because aged, diseased, and weaker fish are more easily captured.

The European kingfisher is not a sociable species, but during the breeding season from March to August, prospective mates seek each other out, form a pair bond, build a nest, and raise young. The male delivers a courting song, often while in a butterfly-like flight. When a female responds, an aerial chase ensues, the pair often rising to considerable heights. As part of his courtship flight, the male zooms about in circles and figures of eight. The female responds to the courting, and as the bond between them becomes firmer, there is much bowing and bobbing by both sexes. Sometimes the male will stroke his mate with his bill; usually he will feed her a fish. Copulation often follows such ritual feeding.

A spot in the earthen bank of a stream or river is selected, and the mated pair begin nest construction. Both birds vigorously hammer at the embankment that will house their nest burrow, knocking out small clumps of dirt with their beaks. After about a day, the female is able to cling to the edge of the hole she and her mate have made. Tunneling begins as she pecks away at the earth, enlarging the hole and deepening it to a length of one and a half to three feet. The male participates in the construction effort by using his feet to shovel out the dirt loosened by the female. The three front toes in this species are fused for more than a third of their length, enlarging the sole of the foot. This is an important adaptation for such burrow nesters, enabling the birds to scoop soil from their excavations by pushing it backward with their feet.

An area roughly 130 meters (426 feet) upstream and downstream from the burrow is claimed by the pair as a nesting territory. During this period of nest-site defense, the female seldom ventures farther than nine meters (thirty feet) from the burrow entrance. By keeping other kingfishers out of the immediate area, the mated pair reduce the predation pressure on the local fish population upon which they depend heavily during the periods of egg laying, incubation, and rearing of their young.

Copulation is frequent from the time the burrow is completed to when the first eggs are laid—a period of about ten days. Up to four matings a day, usually between four in the afternoon and half-past eight in the evening, have been observed. Typically six to eight white eggs are laid during the middle of April and hatch at the end of the first week in May in the southern part of the species’ range.

After she has incubated the eggs, the female assumes the greater responsibility for feeding the young. The male helps with some of the feeding but usually drops out at an early stage. When either adult enters the passage to the nest, located at the terminus of the slightly upsloping burrow, most of the light is blocked out. This darkening of the burrow triggers a behavior in the young nearest the passage entrance: it opens its bill to be fed. After receiving a morsel of food, this nestling moves so that the next in line has a position near the passage opening. The procedure is repeated until all the young are fed.

The young disperse from the near area only a few days after fledging and soon become as intolerant of one another as the adults are outside of the breeding period. The parents separate soon thereafter as well. Since kingfishers periodically suffer heavy mortality during severe winters, a dispersal mechanism based on social intolerance aids in the recolonization of depleted areas. Kingfishers often breed twice in a season; this, together with their large clutch size, help them recoup population losses. The fecundity and their adaptations to feeding on fish have enabled kingfishers to occupy the niche of avian predator along the shores of so many bodies of fresh water.

Frederick Hartman

Singing from a perch along side the Rio Trabancos in Spain a European kingfisher advertises for a mate. Both sexes sing during the premating season.
As a prelude to copulation, a male kingfisher, carrying a small fish he has just caught, joins his mate on a favored perch. He presents the fish, head first, to the female, and as soon as she has swallowed it, he mounts her.
Scanning the water below, a kingfisher spots its prey. With a rapid plunge, the bird smacks into the water and catches a fish. Meal in beak, right, the successful fisher rises to begin the flight back to the nest burrow.
Endangered Fish of Kentucky Streams

by Branley Allan Branson

While some highly visible endangered species are receiving the support of conservation efforts, many smaller ones are on the verge of extinction. The last two decades of American history have witnessed the emergence of an environmental awareness whose momentum has at times been retarded by its development of a blind side. While environmentalists focus on highly visible animal species such as the timber wolf and sandhill crane, the habitats of three-inch minnows and perches are being progressively fractionated. A concern with the ecological requirements of many of the small aquatic organisms under siege may be only academic unless we develop a comprehensive environmental ethic to protect the present habitats.

Aquatic ecologists and ichthyologists generally agree that the recent economic recession and energy cri
ouaged the relaxation or virtual ruination of environmental stand-
that were achieved only with ex-
the difficulty in the first place.
ly, water-quality standards are
en ignored to permit coal mining
oil drilling, and laws stipulating
clamation of land stripped for its
are not always enforced. The lat-
form of environmental degra-
dation that goes far beyond the obvi-
ous.
Nowhere has the impact of coal re-
moval been more apparent than in the
Appalachians. Yet there are segments
of Appalachian forests that have
escaped such human molestation.
One of these is Kentucky’s Daniel
Boone National Forest.
At first glance, this forest appears

Restricted to the larger
streams of Daniel Boone National
Forest because of its size,
the paddlefish’s future is
threatened by the construction
of dams that prevent upstream
migration for spawning.
One of several ancient species, the bowfin, right, inhabits sluggish, but clear, streams. This narrow ecological niche makes the species especially vulnerable to man's alterations. Another relict species, the rosaside dace, below, develops brilliant hues in April just before mating. During the rest of the year, it is a silvery gray color.
The Licking River, encompassing 3,700 square miles of drainage, is the smallest of the three rivers. Some of the highest-quality streams in the state, however, drain into this river from the northern portions of the forest.

Although the forest sometimes grow to the goggle of wild turkeys and the gnash of beaver teeth, most of the large game and fur-bearing animals quickly vanished following the arrival of white settlers. Until recent years, however, the native fish fauna of the forest remained nearly intact, principally because of the wealth of hard-water habitats and sparse man activity.

Now, populations of these fish species are being threatened. One, the elip sucker, is thought to be extinct. Others, ranging from the large 1 primordial paddlefish (Polyodon spathula) to the minnow-sized eye shiner (Notropis arionmus), are becoming increasingly rare as man's encroachments outside the forest steadily wear away the stability of the forest itself.

Three major rivers traverse the forest and their tributaries extensively interface the uplands, running through corridors of nearly impervious growth of rhododendron. The forest is the most beautiful of the three forests. Together with its main tributaries, the Big South Fork and the Dogcastle River, the Cumberland forms the entire southern portion of the forest—more than 5,000 square miles.

Almost 7,000 square miles are drain by the Kentucky River. Since much of the eastern coal fields, the Kentucky has been severely affected by strip mining. In addition, the river's lower portions were modified by a series of navigation locks and dams constructed from the mid-1800s to 1917.

During the last ten years, the construction of Interstate 75 and two turnpikes has severely damaged Daniel Boone Forest's waters. Highway construction disturbance along the upper Cumberland, several large creeks in the Licking River drainage, and three major tributaries of the Kentucky River is delivering serious amounts of silt to those bodies of water. One fork of the Cumberland is virtually blocked by great piles of mud and debris. Little effort is being made to curtail this type of pollution anywhere in the United States.

Acid-water pollution is another effect of highway construction. Sulfide-rich rocks are a common feature throughout this country's mountainous regions. When construction disturbances uncover these rocks (they are also used as fill materials), pyrites are leached into streams where they increase the acidity of the water. As a result, fish growth is retarded, mortality increased, and reproductive ability curtailed by as much as 50 percent. This type of disturbance also often increases concentrations of metal ions in the water—particularly zinc and aluminum—which may kill fish by inducing gill hyperplasia.

But highway construction is just one, underpublicized threat to stream fishes in Appalachia and other parts of the country. Bank clearing, to hasten runoff and as a preliminary step in channel straightening, causes serious erosion and associated siltation in some 25 percent of the Cumberland River system and perhaps as much as 30 percent of the Kentucky system. Channel straightening, particularly in the Kentucky River basin, aggravates bank erosion, and clear-cutting of timber above streams adds still more silt.

The causes of stream degradation are not always so obvious, however. A very innocuous type of influence, one that we have allowed to creep across the nation's waterways practically unchallenged from the 1940s until recent years, is the construction of large dams. Seven dams block the
drainage system in Daniel Boone National Forest—two on the Licking, three on the Kentucky, and two on Cumberland streams. A dam can completely eliminate a shallow-water species; the recent, nationally publicized plight of the rare snail darter in Tennessee is but one example. Its influence, however, stretches far beyond its immediate construction site. During dam construction, a stream must be diverted until the dam is completed. This usually results in heavy downstream silting. Further downstream changes, often involving displacement of 50 percent or more of the fish species in the stream, occur after completion of a dam. As a reservoir builds up behind a dam, cold water from its depths enters the stream, lowering the temperature to such an extent that warm-water fish cannot survive or reproduce.

Many dams completely block passage of seasonally migratory fish, such as suckers, native lampreys, and white bass, to their spawning grounds. According to a Kentucky Fish and Wildlife Resources Commission report, the future of muskelunge in the Middle Fork of the Kentucky River is precarious because the Buckhorn Reservoir dam prevents spawning.

Not only do dams prevent passage of the primitive paddlefish (Polyodon spathula) to upstream spawning grounds but their presence often disrupts the essential spawning stimuli. The paddlefish, so named because of its elongated, flattened snout, often attains a length of five feet or more, spends most of the year in deep, downstream pools of water, and makes spawning runs upstream only when heavy spring rains cause a rapid rise in stream levels. Dams tend to prevent flood stages and hence spawning.

Siltation of spawning beds also eliminates paddlefish. These factors have, at the same time, been instrumental in exterminating the lake sturgeon and the shovelnose sturgeon, neither of which have been seen in Daniel Boone National Forest waters for many years. The harelip sucker has also suffered the same fate.

The effects of surface mining far exceed the combined damage of all other stream-degrading factors in the Appalachians. Like highway construction, strip mining results in acidification and siltation of streams and rivers. In the process of stripping overburden from coal seams, sulfide-bearing rocks exposed to air and water produce hydrosulfuric acid, which flows into streams and increases their acidity. The effect on the gills and blood of fish often results in the complete eradication of faunas. Such has been the case in the Beaver, Stinking, and Straight creeks of the Cumberland River system and in Goose Creek, a tributary of the Kentucky. In addition, acidic drainage enters practically every stream in Bell and Harlan counties, and more than half of those in five additional counties drained by the Cumberland River, as well as 1,000 miles of streams in the upper Kentucky River drainage.

The real culprit of surface mining, however, is the silt from eroding spoil banks, haul roads, active mining sites, and coal washers. Silt load in streams sometimes increases thirty times the normal amount. Its effect upon fishes is just as drastic as acid mine wastes, although the process takes longer. According to our research, more than 200 miles of streams in the Licking River drainage system, 850 miles in the Kentucky River system, and almost as many in the Cumberland River system are affected by mine-derived silt.

There are approximately ten million acres of unmined coal in eastern Kentucky. And in all of Appalachia more than thirty million acres of coal fields have not yet been stripped. When we project the known devastation to these as yet unmined areas, the magnitude of the problem facing small-stream fishes begins to emerge more clearly. Few people are aware of the problem; fewer still seem to care. I was particularly chagrined to receive a letter from the pro-coal editor of a magazine who wrote, "Since these fishes have no commercial value, 95 percent of the public couldn't care less what happens to them." Most Americans are unfamiliar with the presumed extinction of the harelip sucker but even small schoolchildren recall the sorry fate of the passenger pigeon.

The twenty-three rare, threatened, and endangered fish species in the forest's drainages system can be divided into three categories: relict species from the past, species with specialized habitats, and species with specialized feeding and breeding habits. The first category includes paddlefish, sturgeons, and the bowfin (Amia calva). All of them have extremely long genealogies and required millions of years to adapt to their present environment. These apparently have been able to compete with more modern fish, but their tolerance for man's activities is low. The bowfin is not endangered throughout its entire range, but a proriate habitats for this large precocious species in the forest are scarce and only minimal damage could diminish its populations.

North America is rich in fish that live in widely separated relict populations where the habitat has remain unchanged for many hundreds of years. These fish have narrow habitat requirements, such as small spring and cold, sandy bottoms. Daniel Boone Forest has some of the niches. The rosside dace (Clinostomus funduloides), silvery minnow (Hybognathus nuchalis), and speckled chub (Hybopsis aestivalis) are relicts in forest streams, but all of them are threatened by increasing silt and acid mine drainage. The popeye shiner (Notropis arionnus) is a rare species throughout much of its range, including segments of the upper Kentucky and Cumberland drainages in the forest, where mining operation threaten the fish in all of its known population sites. This handsome minnow has completely disappeared from two large Kentucky River tributaries—Red Bird River and South Fork—and its populations are seriously depleted elsewhere.

Twelve perch species in the forest are endangered. More than a hundred species of these highly colorful three- to six-inch-long fish—called darters—exist in this country but most Americans are not even aware of them. Such little-known animal need the greatest safeguards, for the can become extinct without anyone even noticing.

Darters are a very specialize group of fishes requiring particular habitats. They do not have air bladders, so they are restricted to living on, and feeding from, the bottom of relatively shallow, well-aerated
trums. Silt may extinguish entire communities by suffocating the small bottom-dwelling invertebrates they feed by smothering their eggs and larvae and under extreme conditions, smothering the adult fishes as well.

The blotched darter (Percina burro), formerly abundant in the upper Cumberland, has been forced downstream into Tennessee segments of the stream, and even there it is now rare. In the same waters, the Cumberland snubnose darter (Etheostoma pinnine) and redline darter (E. alineatum) have been completely extirpated from Daniel Boone National Forest waters, although they exist elsewhere. And in the upper Kentucky and Licking rivers, the gilt darter (E. evides) and redline darter (E. alineatum) have been completely extirpated from Daniel Boone National Forest waters, although they exist elsewhere. And in the upper Kentucky and Licking rivers, the gilt arrow darter (E. evides) and redline darter (E. alineatum) have been completely extirpated from Daniel Boone National Forest waters, although they exist elsewhere.

The minute tippecanoe darter (Etheostoma tippecanoe) has an extremely fractionated distribution in Pennsylvania, Ohio, Indiana, Kentucky, Tennessee, and Virginia. Such localized populations are easily destroyed by massive siltation and stream acidification. And, finally, the ashy darter (E. cinereum) had long been considered extinct in Kentucky until 1974 when a small population was rediscovered in the Rockcastle River, a principal tributary of the Cumberland. Strip mining has since crept onto the slopes above the river and whether this little fish will survive there much longer is doubtful.

What is happening to the fish fauna in Daniel Boone National Forest should not be taken out of context and scrutinized only as a case study. Fish species in other parts of the Appalachians and the Ozarks, in the Colorado Rockies where oil-bearing shales are beckoning, in the coastal forests of the Pacific Northwest, and in the marginal habitats of the arid Southwest where coal miners are gearing up for a massive assault on newly discovered deposits are subject to the same fate.

The precarious condition of myriads of small fishes should be telling us something about our oft-heralded capacity to understand and order the universe about us. We have learned much about ecological adaptation, about the unique fit of species in the interstices of nature, about the bright fluid streamers we call water.

Yet, oddly, we seem to have forgotten that our probing brains and other organs are but slightly different constellations of the same elemental particles that make up fish.

The ashy darter was thought to be extinct in Kentucky until, in 1974, a small number were discovered in a Cumberland River tributary. The fish's markedly different morphology has attracted the interest of researchers.
A demonstration for the camera on how to set a fox trap.
How It Really Was

Dorothy Harley Eber

A Eskimo photographer has recorded a lost moment in his people’s history.

Peter Pitseolak took his first picture in the 1930s for a white man who was red to approach a polar bear. Peter Pitseolak wasn’t too sure it was such a good idea either and he told a fellow interpreter, “If he starts to move, you shoot him.” But he got the picture, and some years later—either in 1942 or 1943—he acquired his own camera. His photographs, taken over a twenty-year period of friends and relations and how they lived in the last days of Baffin Island Eskimo life are regarded today as part of Canada’s national heritage. The Dominion secretary of state recently made funds available to purchase the negatives and place them on permanent deposit in the Notman Photographic Archives of McGill University’s McCord Museum.

Unfortunately, Peter Pitseolak didn’t live to see this recognition. He died in 1973 at the age of 71, just four months after completion of People from Our Side, the book we wrote together. During the time I spent with him, taping interviews with the help of young Eskimo interpreters, and in conversations with his remarkable wife, Aggeok, I learned many tales of how he taught himself photography and of how he and Aggeok developed the negatives in igloos, tents, and huts.

For me, these pictures, taken literally just prior to the time Eskimo moved from the camps to the settlements, are a marvellous testament to his will to try, to his creativity and determination. For instance, to cut one’s hair on arctic sunlight, Peter Pitseolak made a filter by filing a pair of dark glasses and fitting the amber-colored lenses into the head of a flashlight, which he hung over his lens. Before he had had to wait until the sun was low to take pictures. And what pictures! Peter Pitseolak and Aggeok used a three-battery flashlight and covered it with a piece of red kadluna [white man] material.” Aggeok explained.

“My first camera was a box,” Peter Pitseolak told me shortly before his death. “It was simple to use; you didn’t have to set it. Then I got a camera from the Catholic missionary. It was a 122 camera and very heavy. It was a big one. It had settings that could focus on the subject so you could be sure the picture would not be lopsided. When the pictures were taken properly, they turned out very well. Another camera I got from the Bay [Hudson’s Bay Company] manager. It was able to expand. It wore out so I took the good parts and used them with the 122. Later my daughter Uduriak got a 620 and I used that sometimes, too.”

Peter Pitseolak always referred to his cameras, not by the manufacturer’s name or the lens opening, but by the film he used. The various cameras have not yet been properly identified, but five negative sizes have been discovered. Unfortunately, at the time Peter Pitseolak and I were working together, he no longer had any of the cameras he talked about, although his favorite—the 122 camera that took big postcard-sized negatives—is still in Cape Dorset, the settlement where the hunters of the camps of the southwest coast of Baffin Island now live. Peter Pitseolak had lost it in a gambling game to Iyola Kingwatsiak, son of old Kingwatsiak, whose picture he had taken many times and from whom he heard some of the stories he told in People from Our Side.

Aggeok recalls that the very first picture Peter Pitseolak took was of her. “He was always practicing on me,” she remembers. “He would say, ‘Comb your hair and smile!’” Developing the first pictures in an igloo, tent, or hut was “the hard part,” Peter Pitseolak admitted. “I watched a man doing it, but I knew he wasn’t doing it well. He was a white man but he couldn’t develop pictures. I thought to myself, this man is not washing the pictures

Peter Pitseolak and his 122 camera.
enough. So I washed the picture longer than he did."

Eventually, both Peter Pitseolak and his wife became expert developers and printers, and he recalls "People often came to me to develop—especially the Catholic missionary. He thought he knew how but he was using boiling water! Or someone gave me a thermometer to test the water but my finger was always best. I used to order the hy from the Bay. Today I have a Polaroid but lately I have been thinking of ordering again. I developed a picture just recently in the X-ray fluid up the nursing station where my nephew Elee Parr is working. It came out was visible."

Particularly interesting descriptions of the techniques they used and the circumstances in which they developed and printed their pictures came from Aggeok. When Peter Pitseolak got his first camera (he thought the year was 1942; Aggeok believes it was 1943), he was living in Cape Dorset and working for the Bathurst Company, and a number of photographs he took at this time were developed on camping trips to igloos. "When Peter Pitseolak wasn't working we would go camping for a while," Aggeok says "When he was out hunting he would put the camera on top of the igloo until the film was all used up [in order not to subject it to temperature changes]. It was in a case and he used caribou skins to wrap it up. He would put it on top of the igloo with the dark traces over it so it wouldn't blow away. Only after he finished the film would he take the camera inside and take out the film. The igloo didn't appear to be an igloo because he had a canvas tent inside it, which made a difference in the temperature. We would develop on top of the sleeping platform with the three-battery flash light and after we did the washing we would keep the negatives overnight in a warm place on top of the box [the box, which was used to store possessions, would be on the woman's side of the igloo near the kudluk, the seat of the oil lamp]. We would use two kudluk and plenty of oil, which made a good temperature. An igloo with a linen was good enough even though it was made out of snow."

Aggeok says that they used "three
of water, two chemical ones," developing. They used plates that are not quite the right size (later they acquired regular developing), and to make a measuring cup stuck a piece of paper just below halfway on a mug. Printing photographs, Aggeok explains, had to be "where there was light," so the first negatives were printed back in the Dorset in their small wooden igloo (Peter Pitseolak was one of the Cape Dorset Eskimos to live in a igloo). "When the pictures were to be transferred onto paper we did them where we got home. The negatives were washed in the igloo and the printing was done when we got home. We used oil lamps. To make the prints we placed the negatives with the negative facing up in this tagatujik [literally, a mirror], but in this instance, in frame, which had locks that closed and a part would open where you put the negative and the mirror making sure the paper was in the way. Then you would lock it and that was done you would place the front of the lamp, which hung on the ceiling, counting 'One, two, three.' You would make sure you put it long enough because ending on the time, the lightness and darkness of the prints would vary. How did they feel when they took their first photographs, I asked Aggeok. She replied, "We were very happy; we were laughing and we were proud."

In 1946 Peter Pitseolak ceased being the traders in Cape Dorset and moved a few miles away to Keatuk, where ten families lived under his ownership. Keatuk was to be his last home; he left it for settlement life in 1949. "I left the camp because my children had to go to school, I afraid they might try to walk home and on the way they could very easily freeze. And I thought if a mother or anybody else gave a child this time, he would be unhappy and to come home. I think the other people thought the same thing."

At the Keatuk camp, most developing and printing was done in the quarry, a double tent lined with bushes set over a wooden frame, then covered with snow blocks. Many of the photographs from the Keatuk period portraits taken prior to Peter Pitseolak's evacuation for TB. "Because he wasn't feeling well, he would only take pictures when he didn't have to move around too much," Aggeok says. They were taken indoors with lighting from the window or from the oil lamps—he had no flash—and were considered by some admirers to be his finest work.

The most frequent subjects are members of the family: Udluriak and Kooyoo, Peter Pitseolak's daughters by his first wife, Annie; his natural daughter, Mary, by Nyla of Lake Harbour; Ashevak, Aggeok's son from her first marriage, and his wife, Mary; and the adopted children and the grandchildren. There are also many pictures of the Keatuk campers and other relatives and friends. "When Peter Pitseolak got his camera," his half-sister Elleshushee remarked, "the skin clothing was just beginning to disappear—many people borrowed my clothing to dress up for his camera." Aggeok says, "He would explain to people that he had learned to take pictures and that he was interested in taking pictures of them. He would know if a person wanted his picture taken or not simply by looking at the expression on his face. Some were simply shy. He didn't want to take pictures of those who didn't want it. He used only to take pictures of people who were happy to be taken. He could tell from the picture afterward if the person had been willing."

One often-asked question is whether Peter Pitseolak knew he was photographing a disappearing life style. The answer is that he was well aware he was documenting vanishing Eskimo life, although he probably considered his work was for the benefit of his grandchildren. He told me, "When I was in the hospital with the kidney in the south [his first hospitalization in 1945], I heard people say that many more white men would come to this land. They said, 'The Eskimo will be changed; he will talk like a white man in years to come.' I've always expected this and now it's happening. I'm not surprised."

Many pictures were set up specifically for the camera. A good example, probably taken by Aggeok, is a series that shows Peter Pitseolak setting a fox trap and then claiming his quarry. "That is Peter Pitseolak showing how for the future," Ag-
With the help of his niece, Peter Pitseolak prepares a sled’s runners for a trip.

A seal feast in Keatuk.

gerok explained. Peter Pitseolak also liked to plan pictures purely for the esthetic effect, as is the case with one of his loveliest photographs, the joyous shot of passengers at the back of a sled, raising their arms in the air, almost dancing with delight as they set off on the land. Aggeok remembers that Peter Pitseolak said, “When you start to move, please...”

An important reason for many of the posed photographs was to help Peter Pitseolak with his drawings. In the 1950s, as the traditional Eskimo life style foundered under the impact of the white technological society’s northward push, art projects were introduced in the North and supported with Canadian government backing. Particularly spectacular work has come from Cape Dorset and its West Baffin Eskimo Co-operative, owned and operated by the Eskimo. It is said that today there is hardly a gallery in the Western world without a Cape Dorset print. As soon as experiments in printmaking got under way in Cape Dorset, Peter Pitseolak began to contribute skillful and vivid drawings that, like his photographs, document Eskimo life.

One series of photographs Peter Pitseolak took to assist him was particularly ambitious. He had campers at Keatuk act out a well-known adventure of Taktillitak, a man who lived in the lifetime of Peter Pitseolak’s father and whose exploits were legendary. While hunting for seabirds, Taktillitak was carried away on an ice floe to a very small island where he ran out of food. He built his own grave and lay down to die, but after dreaming of seals he got up and killed a seal with a club. He made a sealskin float, paddled to shore, and walked to a camp, where his friends were so happy to see him they burst into tears. Photographs, which include an old-style Eskimo grave and the weeping friends, recount the whole story. Sometimes Peter Pitseolak would use the photographs as a guide in drawing; other times, particularly when etching a picture on ivory walrus tusks, he would place carbon under a photograph and trace. “He had less than ten photographs of this kind,” Aggeok says, but a number of drawings in the West Baffin Eskimo Co-operative bear witness to the remarkable skill and ingenuity with which he used these photographs.

There are approximately 1, negatives in the Peter Pitseolak collection, but he certainly took more. However, many of the negatives were ruined. “Sometimes it got very cold and then it would get very hot so some of the negatives got mildewed. I had to burn them,” he explained. Nevertheless, a great collection remains. Stanley Triquet, curator of the Notman Photographe Archives, says, “The photographs are extremely valuable because they document the life of a community—a certain point in time and were taken by a member of the community themselves—and extremely rare in any society.

To celebrate its acquisition of negatives, the Notman Archives year hung an exhibition of new prints made from the earliest of the negatives. Aggeok, accompanied by Rosie Kelly, a young Eskimo interpreter, came south for the opening. Rosie was enthusiastic about the project. She herself couldn’t really remember a time when she did not live in a prefab house. “Sometimes I think I remember something about life in an igloo and I ask my mother if I am dreaming or is it true?” Lig years away from her parents’ generations, she looked at their beautiful tailored skin clothes in Peter Pitseolak’s pictures and said with wonder, “They had everything we have, even panties, but it was all in caribou skin! Her favorite pictures, however, were those in which Peter Pitseolak set the situations to “show how the future...” “It blows the mind,” she said.

Aggeok also knows the pictures are “useful.” She puts it this way: “Speaking only for myself the usefulness of the pictures is that one can look into the past and see people who are no longer alive—who have been dead for a long time. They can be seen through the pictures and that makes me happy. Also, they are useful for remembering what it was like in the past. You can look at the pictures and start talking about how it was used to be. Those are the things I feel are important.” And then, as an afterthought, “The schoolchildren Cape Dorset have the pictures on the walls. They tell me they see from the pictures how it really was.”
Enthusiastic passengers setting off on a sled trip.
The results of conquering trypanosomiasis might be more devastating for Africa than the disease itself.

This African tyrant does not attend political councils, is not a member of the Organization of African Unity, and has not palavered with roving diplomats, but it does have a personal air transport system—the tsetse. Holding Africa in thralldom since ancient times, this parasite, known as a trypanosome, is only six ten-thousandths of an inch long, but it has affected the economy, social institutions, and even the religious complexion of the continent.

During the mid-nineteenth century, Muslim Fulani cavalry swept from their near-desert west African Sahel kingdom into the savanna to the south and east, conquering and converting the animist tribes with whom they came into contact. But in their progression through woodlands and forests they encountered a formidable adversary, the tsetse. Swarms of these flies attacked and bit the horses, transmitting the parasite to them, which resulted in a lethal form of animal trypanosomiasis. In rapid order the cavalry became a disarrayed infantry. On foot, the Fulani were actually powerless; their invasion halted before it could reach the great population centers of the Benue and Niger river valleys. Thus was Islam with its sociopolitical consequences prevented from infiltrating this densely peopled region of Africa more than half a century.

The popular notion of trypanosomiasis is depicted by the lethal human suffering from the "sleeping distemper," as an English observer described it some 200 years ago.

A tsetse feeding on a small animal
rm of distemper at all, the infection in man is caused by one of two closely related parasitic organisms, *Trypanosoma gambiense* and *T. rhodesiense*, and in animals by *T. brucei*, *T. congolense*, and *T. vivax*. (*T. brucei* was thought to be a parasite restricted to man but researchers recently implicated the pig as a reservoir host.) Both animal and man trypanosomes are transmitted by tsetse, a bloodsucking fly of the genus *Glossina*. Tsetse inhabit Africa south of the Sahara, from approximately 15 degrees north to 20 degrees south latitude, although they once had a wider distribution, as evidenced by the discovery of a fossilized tsetse in the Oligocene shales of Colorado. While human trypanosomiasis continues to be a public health problem, responsible for some 7,000 deaths each year, it is the infection in domestic animals that has had the greatest impact on African development.

The tsetse belt encompasses more than six million square miles of land denied to livestock production, mixed farming, and in some regions, human settlement. It is an area that could potentially provide 125 million head of cattle to the protein-starved continent. The disease has forced herdsmen to concentrate their stock on the limited amount of fly-free pasturage, which has led to overgrazing and attendant soil erosion. When cattle are trekked to distant markets through fly-infested country, some 25 percent of the herd may die before reaching their destination. And yet, a less anthropocentric view might hold that by preventing overexploitation of this enormous area, the tsetse and the trypanosome are the most stalwart guardians of the African ecosystem and its magnificent wild fauna.
A like many antelopes in sub-Saharan Africa act as reservoirs for trypanosomiasis, have evolved an immune response to the parasite.

The manner and degree of transmission of trypanosomes involves complex interactions of parasite, host, and fly vector. With this in mind, let us consider the scenario and persona of The Fly That Would Be King, an African spectacle with a cast of millions. A single tsetse is set in a forest in Africa. Stage the host, either a man, or antelope. A closer, microscopic examination reveals the second character, the trypanosome, mingling about in the blood of the host, means of an undulating membrane and lashing flagellum. A sound fly buzzes coming from offstage. A tsetse, a brown insect not larger than a housefly. The insect smells and sights the host, then becomes excited, sinking in the nosose-containing blood. The tsetse takes place inside the host's gut, where the trypanosome multiplies by simple division. About after four days, it migrates to the fly's salivary glands, where, over the next fifteen days, further transformation takes place until it assumes a short, stumpy appearance. This is the metacyclic stage, the terminal developmental stage capable of infecting a new host. At three opens in the forest twenty later. The original host lies oblivious to the stage floor. Enter his host. The infected tsetse fly delivers the metacyclics to the bloodstream of the new host and the tsetse cycle begins. Curtain. While this plot is essentially the same for all African trypanosomes, the details for each species differ in important respects. In man, the disease caused by Trypanosoma gambiense is of a chronic, malignant nature and gives rise to the torpor and eventual coma and death classically associated with sleeping sickness.

The pathology of the disease is largely unknown. Over the course of time, the trypanosomes tend to leave the blood and enter first, the lymphatics, and later, the spinal fluid and the tissues of the central nervous system. During this latter phase, the patient becomes comatose and dies after several years if he has not received chemotherapeutic treatment.

Whereas Gambian sleeping sickness results in a slow death, that caused by Trypanosoma rhodesiense kills its victim within weeks or months. Besides a difference in the degree of virulence, the two infections differ in other respects. Gambian trypanosomiasis is essentially a human disease cyclic from man to man, while Rhodesian trypanosomiasis has a third host in the transmissive cycle—the wild antelope—which acts as a reservoir of infection. By all biological criteria, T. rhodesiense is a parasite of the wild ungulates, rather than man. It has evolved to a state of equilibrium in the animal host and produces no overt disease. Man, for the most part an accidental host, has not attained this accommodation, as reflected by the intense virulence of the human disease. The manner by which the antelope modulates the infection remains a mystery, but its elucidation might aid in devising a means of similarly stimulating a protective state in man.

The ecological setting—the landscape epidemiology—of the two disease varieties are different. Gambian sleeping sickness is generally restricted to the humid forests bordering the lakes and rivers of west and central Africa, the obligate habitat of the Glossina palpalis vector, the tsetse species that transmits this form of the disease.

Because rural African populations rarely have the means to obtain water from distant sources, communities tend to form along the banks of rivers and lakes, and village activities—bathing, washing, drawing water, and fishing—take place at the water's edge, making for intense man-fly contact. Epidemics flare from time to time but generally the disease level is low because the tsetse is, biologically, a relatively inefficient vector. Trypanosomes can readily multiply in Glossina palpalis only shortly after the fly emerges from the pupal stage. Therefore, very few older flies are able to act as successful vectors after feeding upon infected humans.

Sleeping sickness caused by Trypanosoma rhodesiense is endemic to the dry savanna woodlands of east and central Africa, the mutual habitat of the Glossina morsitans vector and the great herds of antelope that serve as reservoir hosts. Human infections occur when man settles or intrudes into the savanna to hunt, gather wood, or graze cattle. The species of vector that transmits this form of the disease is not an equal opportunity biter and prefers to take a blood meal from mammals other than humans. When game becomes scarce, however, the fly will feed on man. Apparently attracted to large, slow-moving objects, the fly's instincts become confused when these sometimes turn out to be vehicles, and it will feed on the passengers. In this curious way, a package tour of east African game parks occasionally includes trypanosomiasis.

There is, then, an intimate relationship between the nature of the ecosystem and the epidemiology of trypanosomiasis. The history of Africa, however, is characterized by continuous ecological change—felled rain forests succeeded by grasslands and savanna woodlands, an advancing or retreating desert, and shifting distribution or concentration of man and the wild fauna. These environmental changes have played a crucial role in the epidemiological patterns of the Gambian and Rhodesian forms of trypanosomiasis, particularly where their ranges overlap in east-central Africa.

The activities of both Africans and colonial expatriates and their diseases have also contributed to the epidemiological status of trypanosomiasis. Before the nineteenth-century colonial period, trypanosomiasis was confined to a relatively few, smoldering foci. Intermingling warfare and lack of roads restricted communication and prevented the spread of the infection. The rapid dissemination of
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*Sleeping sickness can be traced to opening up of Africa by the colonizers. It was the Pax Britannica that made it possible, and once experienced, the disease spread rapidly. How this complex of changing environmental and human factors has influenced epidemicity of the two trypanosomes is illustrated, par excellence, by the events that have occurred along the Kagera and Uganda shores of Lake Victoria.*

Prior to human settlement, the area was surrounded by a tropical forest. Primitive agriculturists settled on the lake's shores and forest tracts for their shifting farm. Forest-inhabiting tsetse were present but human trypanosomiasis was absent until the nineteenth century. Eventually, deforestation progressed to such a degree that grasslands replaced large areas of forest. The grasslands then attracted a second wave of migration—Nil pastoralists and Bantu cultivators. The combined pressures of grazing and agriculture suppressed forest generation and thus maintained a free area beyond the forest fringed the lake.

In the nineteenth century this society was devastated by the twin plagues of smallpox and rinderpest. Before the population had time to recover, savanna woodland succeeded the grassland. At the close of the nineteenth century the ecological stage was set for sleeping sickness. The shores of the lake were bordered by a high forest infested with tsetse vector of *Trypanosoma gambiense*. Beyond the forest *Glossina morsitans* flies capable of transmitting *T. rhodesiense* inhabited the savanna woodland. Still the trypanosome had not made its debut.

The parasite is thought to have been introduced when Sir Henry Morton Stanley, employed at one time in the Congo by the Belgians, mounted an expedition in 1887 to the Stanley's retinue, probably infected with *T. gambiense*, may have carried the seeds of the epidemic that was to decimate the population for the next ten years.

By 1910, when the Gambian sleeping sickness began to burn itself out, the number of inhabitants in the area had declined from 300,000 to 10,000. Before the epidemic, the size and number of human settlements and the effect of suppressing the fowl population; but as people died of disease or fled the stricken area,
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These tolerant breeds have not as yet been economically exploited, probably because of their small size, although the N’dama is sufficiently large to be used for meat purposes. Crossbreeding with zebu or European breeds does not result in offspring capable of developing a hyperimmune state.

Combating trypanosomiasis calls for heroic measures but side effects of the remedies may be too severe to be practicable. The battle against the disease has included massive alteration of the environment, social disruption, wholesale slaughter of the wild fauna, and mass administration of toxic drugs. A commonly employed means of control has been to deny the tsetse its required habitat by selective or large-scale deforestation. Fly-free zones can only be maintained by intensive land use brought about by the collectivization of the population into large agricultural villages and townships. This forced dislocation from the traditional, stable life in small, scattered tribal groupings has resulted in a disturbing upheaval of the social order.

Perhaps the most controversial control measure was the game destruction program carried out in east Africa during the 1950s. Designed to open land to human settlement, the logic of this scheme was faultless. Game harbor Trypanosoma rhodesiense and are the main source of blood for the tsetse; therefore, destroy the large fauna and good riddance to both fly and trypanosome. After the campaign, however, sufficient numbers of small mammals survived to support the fly population. Also, as the game were decimated, herdsman moved their cattle into the cleared areas, and the fly was diverted to feeding on the livestock and the pastoralists, resulting in a continued and intensified transmission of both animal and human trypanosomes. Finally, revulsion against this studied slaughter brought the program to a halt.

Another potential control measure has been the use of insecticides. Ironically, one researcher has proposed that this means was a major, if not prime, contributor to the great drought that recently ravaged sub-Saharan Africa. The reasoning of this hypothesis is as follows. Increasing urbanization and prosperity in west Africa precipitated a demand for meat. Traditional cattle-owning tribes increased the size of their herds to match the market. Widespread government-sponsored aerial spraying of insecticides, in conjunction with mass chemoprophylactic injections of cattle, followed, petting growth of herds not only in Sahel but also in the adjacent Guinean zone savanna. The large number cattle grazed the meager st. of grass and other plant life in fragile ecosystem, resulting in higher reflectance of sunlight in the demurred land. There is good evidence that such a situation cases increase in rainfall and in this re, proceeded to such a point as to induce climatic havoc.

Despite more than seventy years of research and effort, the freeing Africa from trypanosomiasis has been realized. Effective, practicable means of control are either lacking or too harsh. Except for limited insecticide spraying there are too few Governments in the new African countries are often too poor in economic and technical resources to maintain the anti-trypanosome and -tsetse programs begun during the colonial era.

Although human trypanosomiasis has declined due to drug treatments, infected people, the trypanosomiasis can develop resistance. Confronted with this impasse, scientists have sought the biological "magic bullet"—immunization—as a solution to the problem. Vaccination has been used to control many of the great scourges of mankind, such as smallpox and yellow fever, under control without necessitating change of the environment or turmoil to the socioeconomic order. But unlike the immunologically amenable bacterial and viral pathogens, the trypanosome has confounded all attempts to induce protective immunity. The reason for this failure stems from the parasite's ability to elude the host's immune defense by a process known as antigenic variation.

There is currently great concern over the antigenic shift of the influenza virus, a phenomenon that seems to occur about every ten years. Trypanosomiasis undergoes the same process but the antigenic variants arise every five to ten days. This tantamount to the host being assaulted by a new, personal epidermatach and every week.

During the course of a trypanosome infection the host may develop an antibody that eliminates most, but not all, the trypanosomes. These variants are of a different antigenic ch
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EUV Makes the Grade

Despite initial skepticism, Comet space in extreme ultraviolet wavelengths proved feasible.

June 1989, a world authority on spectroscopes, who was also director of a observatory in Arizona, told a San Francisco audience of his estimations of the bright prospects for astronomical observations from space. Satellites orbiting above the ring of the earth’s atmosphere, he predicted, would make it possible to study the kinds of light, such as ultraviolet radiation and X rays, that do not penetrate to the ground. However, he ruled out one end of the spectrum a priori. That the so-called extreme ultraviolet (EUV), consisting of light with wavelengths from 100 to about 1,000 angstroms, (An angstrom, named for the Swedish physicist Anders Angström, unit of length equal to approximately four-billionths of an inch. Ordinary ultraviolet light extends from 0 to 3,000 angstroms, while visible light ranges from roughly 3,000 to 7,000 angstroms. X rays have wavelengths shorter than 100 angstroms.) The expert from Arizona conceded that “space is going to be a hazy” in the EUV wavelengths, due to the absorption of that light by atoms in interstellar space, it could likely in 1989 that only the blandest, perhaps the nearest stars ever be seen in the EUV.

The course of the next sixteen years, a series of rocket and satellite experiments did indeed open up new avenues of exploration for astronomers, allowing them to map and measure the celestial sources of X and ultraviolet light. During this time, a few rockets were launched to try the EUV as well, but without current success. It was not until July 1989 that NASA astronauts participating in the joint United States-U.S.S.R. Apollo-Soyuz space mission succeeded in detecting EUV radiation from objects outside the solar system. These stellar sources included one, known as HZ 43, at an estimated distance of 210 light-years from the earth and thus well beyond the nearby stars. It appears that HZ 43 may be the hottest and brightest star of its type yet found and that these properties may help us to deduce the circumstances of its past and future evolution. For a group of physicists from Berkeley, California, the Apollo-Soyuz discoveries were the happy climax of a campaign to convince other scientists that EUV wavelengths were not, as someone had put it, “the unobservable ultraviolet.”

The rationale for attempting to survey space in the EUV was threefold. To begin with, it is a matter of record that as each new range of wavelength has been explored by astronomers, beginning with radio waves in the 1930s, unsuspected celestial phenomena have been discovered or, at least, new aspects of known objects in the sky have been revealed. It was conceivable, therefore, that the most interesting results of EUV astronomy would be exactly those that could not possibly be anticipated.

Secondly, stars with surface temperatures of about 100,000 degrees centigrade would emit light predominantly in the EUV. Although no normal-sized or large stars of such high a temperature occur, it is known that some small hot stars of those temperatures do exist at the centers of planetary nebulae. These nebulae are expanding shells of gas produced when red giant stars shed the cool, outer layers that surround their hot, central cores. The central star of a planetary nebula is the remaining hot core of a red giant.

It is believed that central stars cool down as the expanding nebulae dissipate into space, and they eventually become the well-known white dwarf stars, with temperatures of 50,000 degrees and less. However, astrophysicists disagree about the rate...
of the cooling process. If the central stars cool down rapidly to 50,000 degrees or less, then few stars hotter than 50,000 degrees will be found. But if the cooling is long and slow, then there may be many hot dwarf stars intermediate in their properties between the central stars of planetary nebulae and the common white dwarfs. These stars would be old enough to have had their nebulae dissipate and thus the only or most feasible way they might be recognized as hot dwarfs could be through their strong EUV radiation. If it were possible to count the numbers of such EUV sources, we might be able to estimate the rate of the cooling process of central stars and thus settle an important astrophysical argument.

The final reason for surveying space in the EUV is a theory about physical conditions in the interstellar medium according to which this tenuous gas in space is heated by EUV radiation. Alternative theories ascribe the heating variously to X-rays, cosmic-ray particles, or supernova explosions. EUV studies might thus establish which theory is correct.

Were there really any prospects for success in EUV astronomy? Many astronomers shared the Arizonan’s misgivings. The fundamental objection was that space is supposedly opaque to EUV light due to the strong absorbing properties of hydrogen and helium in the interstellar gas. According to one estimate, for example, even using instruments of the highest attainable sensitivity, the EUV light of our own sun could not be detected from as small a distance as only three light-years. Yet the nearest star to the solar system, Proxima Centauri, is four light-years from the earth.

On the other hand, the Berkeley scientists, led by C. Stuart Bowyer, a space physicist whose outlook is that observations are made to be overcome, argued that the astronomers’ pessimism was based on theory rather than fact. It was possible, the Berkeley group thought, that the interstellar gas is distributed in a very patchy manner, so that the EUV light of some stars might pass between the clumps of absorbing gas and thereby reach the earth. Further, they cited evidence that has led some astronomers to conclude that the solar system is located in a region of space where the interstellar hydrogen gas is thinner than average. This would allow us to “see” farther into space in the EUV than had been calculated.

Of course, they pointed out, cold kinds of stars must produce more intense EUV radiation than sun because the hotter the object, shorter the wavelength at which greatest light emission occurs. Objects like the central stars of planetary nebulae and the hot dwarfs intermediate between these stars and white dwarfs might be visible at greater distances in space than the sun, when searched for with EUV telescopes.

It was also suggested that some of the ordinary and well-known stars, with surface temperatures only 10,000 degrees, might have undetected coronas, that is, million-degree-hot, outer atmosphere coherent like that of the sun (see also “Turbulent Sun,” Natural History, November 1976). If these cores were much more extensive than that of the sun, as some calculations indicated, they would also produce EUV light because of their great size and high temperature.

The campaign to explore space in the EUV began with rather primitive instruments carried on rockets aloft to record information above lower levels of the earth’s atmosphere at various altitudes. One such rocket instrument was launched from White Sands Missile Range in New Mexico in October 1971 and again in March 1973. The experimenters suffered repeated failures and no EUV sources were detected on either occasion. The Berkeley group, following a different experimental philosophy, also built a rocket instrument and launched it from Woomera, South Australia, since it was intended to look for EUV sources that might exist in the southern sky. The results were again disappointing, but the evaluation was severely hampered by the failure of onboard visible-light camera units. Photographing the constellations during the flight and determining the direction of viewing. As a result, the data analysis was unexpectedly complex and time consuming, and it was only after the Apollo-Soyuz mission took place in 1975 that the Berkeley group could return to a detailed study of the results.
London collaborators realized unexpectedly to them, they had detected an EUV star in the
flight of the previous year. On last rocket flight, the payload
very parachute also had failed, in the destruction of the
instrument and thus dramat-
ifying what seemed at the time
as a series of consistently dis-
garding experiments.

The basic limitation of the EUV
experiments was the short dura-
tion of a typical flight. A few min-
utes after the instrument was
heralded above the absorbing region
the earth's atmosphere, it inevi-
ably fell back toward the ground. To
this sensitive observations that were
significant, a larger telescope
more complex 14½-inch-di-
eter EUV telescope developed at
the University of California claimed that the discovery of
intense EUV light from this star, Hz 43, proved that EUV research,
which "few thought possible has more potential than even the longest
most optimistic group had anticipated." The editor of the trade magazine Aviation
Week acclaimed the discovery, not-
ing that "this area previously was
tought to be forever screened from
man's observation." In truth, the
discovery was nearly missed. As the
time allotted to the EUV astronomy
measurements was running down, a
key associate of Bowyer, Bruce
Margon, discovered that one of the thirty
preselected targets apparently had
not been observed as planned. After
a certain amount of argument and re-
checking, the investigators prevailed
and the order was given to point
the telescope toward the overlooked
target. The target was Hz 43, which was
to become the great scientific success
of the mission.

Hz 43 is located in the northern
constellation of Coma Berenices. As
far back as 1971, Japanese physicists
had detected an X-ray source in the
region, as had Margon in 1974. Then
in 1975, physicists at the Massa-
chusetts Institute of Technology, using
the SAS-3 X-ray satellite, localized the
X-ray source to the region of Hz
43. From the Apollo-Soyuz observa-
tions, it became clear that this star
was indeed the source of both the
EUV radiation and the X rays, al-
though the majority of its energy is
emitted in the EUV. It also seemed
that the star must have a temperature of
about 110,000 degrees to account for
the radiation. Hz 43 is a white
dwarf star that had been studied at the
Hale Observatories in California in
1972. Analysis of its dim visible-light
spectrum, as recorded with the 200-
inch telescope on Mount Palomar,
had led a young Hale astronomer to
conclude that the surface temperature
was 50,000 degrees. Further, this
estimate was said to be accurate to
within 10 percent and was thus in
close conflict with the EUV measure-
ment. The disagreement was impor-
tant since there were no known white
dwarfs hotter than 50,000 degrees.
A world authority on white dwarf stars, after a meeting at the California Institute of Technology, publicly expressed some reservations about the EUV measure that Apollo returned to Earth. When I met him over lunch about a year later, he still held a strong preference for the lower temperature of the star. The Berkeley scientists, however, insisted that since the bulk of the star's energy, perhaps as much as 97 percent, is produced in the EUV band, that wavelength range is the most plausible one for gauging the star's physical condition. They gained support from theorists at the NASA-Ames Research Center at Moffett Field, California, and at the University of Rochester, who analyzed the EUV and visible-light data in combination and concluded that 125,000 deg F was a better estimate. On the other hand, computations done at the Harvard College Observatory in Boulder, Colorado, and at the University of Delaware suggested that the temperature of HZ 43 is actually in the range of 55,000 to 70,000 degrees, depending on the amount of helium in the star.

The Berkeley physicists seemed to have adopted a compromise value of about 80,000 degrees in August 1976, when they summarized their findings on HZ 43 at an international symposium in Grenoble, France. They concluded that HZ 43 is both hotter and the most luminous white dwarf yet found. It radiates twice as much energy as our sun, although it is slightly smaller than the earth, and such a high temperature, HZ 43 is nearly as hot as some of the central stars of planetary nebulae from which white dwarfs are supposedly formed. But its spectrum shows a trace of helium, whereas the nebulae stars always have helium. This may represent a fundamental contradiction of the theory of stellar evolution. It is also possible that there may be a less drastic and more satisfying explanation.

The Berkeley physicists point out that as the central star of a planet the nebula shrinks to become a white dwarf, its gravity will intensify. At some point, the gravity will be strong enough to cause atoms of helium in the heavier gases to diffuse downward below the visible surface of the star, leaving an atmosphere of pure hydrogen, the lightest gas. HZ 43, as a star intermediate between the planetary nebulae and the ordinary white dwarfs, may have only...
cently undergone this diffusion process. If so, it is truly a unique object for astrophysical study.

Another hot white dwarf, called Feige 24, was also detected with the EUV telescope on Apollo-Soyuz as were the stars SS Cygni and Proxima Centauri. Investigations of the latter two stars are still under way, but they too should be of considerable interest. SS Cygni is a dwarf nova, that is, a binary star in which eruptions occur at intervals. Since it was a selected target of the Apollo-Soyuz experiment, ground-based astronomers were alerted to keep it under watch. While the mission was in progress, the Berkeley group received a telephone call from the director of the American Association of Variable Star Observers in Cambridge, Massachusetts, who called to say that by a great stroke of luck, SS Cygni was undergoing an eruption at the very moment.

Proxima Centauri, as mentioned above, is the nearest star to earth beyond our sun. It is a cool red dwarf and on that account would not be expected to produce any EUV light worth mentioning. However, it is also a flare star, the occasional site of events like the flares that erup on our sun, but ones that are much more powerful. Solar flares produce strong EUV radiation for brief intervals. Since the Berkeley telescope detected EUV radiation from Proxima Centauri, one wonders whether, by a second stroke of incredible good luck, this star actually flared at just the time that the Apollo astronauts maneuvered their spacecraft to point the telescope at the star? Since Proxima is located in the deep southern sky, an astronomer at Mount John, in New Zealand, was hired to monitor the visible light of the star during the space mission. But at the time of the EUV observations, it snowed on Mount John and viewing was impossible.

The Apollo-Soyuz observations also confirmed that the solar system is located in a region of lower than average interstellar gas density. This finding explains why the optimists prevailed in EUV astronomy, for had we been located somewhere else in the galaxy, in a denser, more opaque region, the EUV wavelengths truly would have been the "unobservable ultraviolet."

Stephen P. Maran is an astronomer at NASA's Goddard Space Flight Center in Greenbelt, Maryland.
Celestial Events
by Thomas D. Nicholson

Sun and Moon  Until mid-February, the sun moves eastward through the stars of Capricornus. About the 16th, it moves into Aquarius and about March 12 into Pisces. In this part of the ecliptic—the sun’s apparent path through the stars—it shifts rapidly northward toward the equator. The lengthening of the day that results is quite apparent, with daylight becoming almost 12 hours long by mid-March.

After the full moon of February 4, the moon is in the morning sky until nearly the last week of the month. Last-quarter is on the 10th, new moon on the 17th, the early evening crescent should show up by the 20th or 21st, and first-quarter is on the 25th. In March, we will start out with a waxing evening moon, with full moon on the 5th and last-quarter on the 12th.

Stars and Planets  Three planets stand out prominently among the bright evening winter stars this month: Venus—low in the west from shortly after sundown until it sets about three hours later; Jupiter—well above and to the left of Venus and second only to it in brightness among the evening stars; and Saturn—still farther left, rising in the east almost opposite the place where Venus is setting. Jupiter and Saturn remain in the sky well into the night (Saturn nearly until sunrise), and they will be useful guides to nearby stars this month. Jupiter can help locate the two prominent star clusters in Taurus (the Pleiades, above Jupiter, and the Hyades, to its left). Saturn is in Cancer, with no bright stars near it, but it can guide you to Pollux and Castor (Gemini) and Procyon (Canis Minor) to the west (right) and to Regulus (Leo) to its east (left). The other two naked-eye planets, Mercury and Mars, are morning stars this month, but poorly placed for viewing.

February 3–4: The bright star within the glow of the full moon tonight is Saturn.

February 11: The moon is nearest the earth (at perigee).

February 16: Mercury and Mars are in conjunction with the moon, but they rise too late in the dawn to be seen.

February 21: Venus and the evening crescent moon make a pretty pair in the sunset sky tonight.

February 24: The moon has moved to the vicinity of Jupiter tonight, passing closely beneath the planet at about 5:00 p.m., EST, then moving off slowly to the east (left). It is at apogee (farthest from earth) today.

February 28: Venus reaches greatest brilliancy in the evening sky. Although it will come closer as it swings between the earth and the sun, it is now in a waning crescent phase, which dims its brightness in our sky. The crescent shape is easily resolved in binoculars. This is a good time to find Venus in the daytime if you know its position relative to the sun.

March 2–3: The bright object near the moon is Saturn.

March 8: The moon is nearest the earth.

March 14: Venus begins its retrograde (westerly) movement, taking it rapidly closer to the sun as it swings in between the earth and the sun.

March 15: Mercury is in line with the sun and beyond it (superior conjunction) and enters the evening sky.

★ Hold the Star Map so the compass direction you face is at the bottom; then match the stars in the lower half of the map with those in the sky near the horizon. The map is for 11:10 p.m. on February 1; 10:15 p.m. on February 15; 9:25 p.m. on February 28; and 8:25 p.m. on March 15; but it can be used for an hour before and after those times.
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Announcements

On February 13 Margaret Mead, curator emeritus of anthropology at The American Museum, will lecture on Keeping in Step with the Future. Unlike previous generations, ours is privileged in knowing a great deal about the future into which we are moving. Mead will discuss the kind of communication necessary to facilitate both our own participation and that of our children and grandchildren in this transition. She will also talk about the generation gap, focusing on the communication bridges necessary for three generations to experience the tremendous changes taking place in the contemporary world. The lecture will be held in the Museum's main auditorium at 3:00 p.m. Admission will be $5.50 for the general public and $4.50 for Museum Participating Members (limit of two). Tickets available by mail or at the Museum Members Lounge. For further information, call (212) 581-1810.

The first lecture in the Museum's Evening Lecture Series for Adults will begin on February 8. Nine different series will include such subjects as underwater archeology, weaving, medical entomology, the world of mammals, and a tour of the Hall of Minerals and Gems. Two of the series will be on anthropological subjects. In one, Malcolm Arth, chairman of the Department of Education, discusses his field work experiences in both a west African village and in a native American village. In the other, Paul Ja. Sanfalcon, Museum lecturer in anthropology, will synthesize present-day thinking of anthropologists concerning both tribal and modern societies. Another series entitled "The Grand Delusion" will discuss rumors and myths, ranging from Atlantis to alchemy, that still haunt twentieth-century science. Each series includes between two and ten lectures, one each week. Prices range from $10 to $60. For further information regarding enrollment, cost, and time call (212) 873-7507.

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A Sojourn Among the Indians


In the spate of outsized, sumptuous coffee table books with dramatically designed jackets and catchy titles that come tumbling out from publishers, it is sometimes easy to overlook one that is really a significant event. Especially is this true when in these days of many handsome picture books on American Indians the volume appears to be simply another one with a different title.

Ah, but this one is different, and don’t miss it, for it is the long-awaited first publication of a large and representative sampling of the original watercolors and sketches of the almost-legendary Swiss artist Karl Bodmer, whose pictorial interpretations of Indians have never been surpassed. With enormous skill and attention to detail Bodmer painted individuals and scenes of life among a score of tribes on the upper Missouri River in 1833-34. His work, known chiefly for more than a hundred years only through 81 hand-colored aquatint engravings of his more than 400 paintings and drawings, has been recognized by ethnologists, historians, and others as the ablest and most accurate artistic representation of the American Indian—and has, during all those years, whetted their appetite to see the originals.

Bodmer, 24 years old at the time, went up the Missouri in the employ of a most remarkable European explorer-naturalist, Prince Alexander Philipp Maximilian of the Prussian principality of Wied-Neuwied near Coblenz on the Rhine. A veteran of the Napoleonic Wars, the 50-year-old Maximilian had earlier published a well-received book on his explorations and observations of the Indians of coastal Brazil and now wished to do another one on some of the tribes of North America. Accompanied by his personal retainer and hunter, a man with the unlikely name of David Driadoppel, and by the youthful Bodmer, whose talented paintings had been brought to the prince’s attention by a prominent Swiss zoologist, Maximilian arrived in Boston in July 1832. The following spring (Maximilian spent the winter in Indiana, while Bodmer went down the Mississippi to New Orleans, painting wherever he went), the three Europeans started up the Missouri River as passengers on a steamboat that carried supplies to the distant trading posts of the American Fur Company.

Maximilian was meticulous, committed, and with great talent of his own: an intelligent, trained observer and perceptive reporter of all that he saw and learned. The group eventually went all the way to Fort McKenzie, a crude fur post near present-day Great Falls, Montana, some 1,500 miles up the river, meeting tribe after tribe, which although already touched and changed by contact and trade with British, French, and American fur traders, were still free and at the height of the greatest days of the short-lived Plains Indian culture. As raw material for his book, Maximilian kept a detailed field journal, which reached a total of almost 500,000 words, and made sketches and drawings of his own. But his eye was also on Bodmer, whose pictures he planned would illustrate his book and he selected the subjects, produced the artist to paint individuals, landscapes, and scenes about which he intended to write.

The trip ended in April 1834, travelers returned to Europe, from his journals Maximilian wrote a narrative of almost 300,000 words which was published in Coblenz 1839-41 and reprinted in both French and English. Filled with fascinating detail on natural history, geography, and the fur trade, as well as on life and customs of the Indians, the book was the fullest and most important account of that part of North America—still far beyond the settlements of civilization—since publication of Lewis and Clark’s Journals some thirty years before.

But it was the stunningly colorful and vivid copperplate engravings, from some of Bodmer’s watercolors accompanying the book, that made Maximilian’s text vibrant and read by his readers—and in the end eclipsed the text, good as it was.

As to the original documentary materials—both Maximilian’s journal and Bodmer’s watercolors—they remained in the possession of the pri and his family. The journals were never published, and only from time to time would one or more Bodmer’s sketches or watercolors reproduced, and then usually in a catalog or specialized publication. In the 1950s, interest in Bodmer’s original works heightened; then, following a traveling exhibition of 118 of them in the United States under auspices of the Smithsonian Institution, the Northern Natural Gas Company of Omaha, in an act of gi
Hsi-Nika, a Mandan war chief, posed for a portrait with his face painted black in honor of the death of Siniboin.
Fort Clark and the Mandan village of Mih-Tutta-Hang-Kush as seen from the eastern bank of the Missouri River.
Maximilian attributed this Snake Indian woman’s dark complexion to a liver disorder.
Three other suspects are being questioned in the case.

M. Josephy, Jr., is editor in chief of American Heritage’s magazine division and the author of numerous articles and books on American Indians.

This publishing season has been graced with a number of fine books on the American Indian:

WIND ON THE BUFFALO GRASS, collected and edited by Leslie Tillett. Thomas Y. Crowell Company, $35.00; 158 pp., illus.

Subtitled The Indians’ Own Account of the Battle at the Little Big Horn River and The Death of Their Life on the Plains, it is just that—the incidents made more vivid by the use of Indian drawings and paintings. The numerous firsthand accounts of the actual battle and its terrible aftermath will perhaps lay to rest the flamboyant “popular” versions of the tragedy and give the Indians an active voice in their own history.

SONG FROM THE EARTH, by Jamake Highwater. New York Graphic Society, $19.95; 212 pp., illus.

This is the first work for the general reader on American Indian painting. Highwater does an admirable job of presenting the Indian viewpoint and provides a framework on which to build an understanding of Indian painting and art objects. From pre-Columbian art through the vibrant work of twentieth-century artists, Highwater traces what is both universal and uniquely “Indian” in American Indian painting. A very helpful directory of collections of Indian paintings, a chronology, and a bibliography are provided at the end of the book.

THE NAMES, by N. Scott Momaday. Harper & Row, $10.00; 170 pp., illus.

Momaday, the Pulitzer Prize-winning novelist, has written an autobiographical account of his Kiowa upbringing on Indian reservations in the Southwest. Using tales he was told as a child, his memory, and his imagination, Momaday re-creates the forces that shaped his heritage. Scattered throughout the book are wonderful old family album photographs.

EDWARD SHERIFF CURTIS: VISIONS OF A VANISHING RACE, text by Florence Curtis Graybill and Victor Boesen. Thomas Y. Crowell Company, $35.00; 303 pp., illus.

Edward Curtis was a turn-of-the-century society photographer who was devoted to producing an illustrated history of the native tribes of North America. This book, one of several dealing with Curtis that have appeared in recent years, adds new information culled from his writings and correspondence and the recollections of his daughter Florence Graybill. More than 175 of his photographs are reproduced. The portfolio section of the book, made up mainly of portraits, is a dazzling display of this gifted man’s work.

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Additional Reading

Indian Rock Art (p. 42)
In The Archaeology of North America (New York: Viking Press, 1976), fuscely illustrated with black-and-white and color photographs, Dean R. S. provides archeological evidence for pervasive influence of shamanism in prehistoric North America. Miilashe's Shamanism: Archaic Techniques of Ecstasy (repr. Princeton University Press, 1964, $4.95) is a discussion of the cross-cultural nature of this phenomenon. A special digest issue of artscanada (Decer 1973/January 1974), entitled Stone, Bones and Skin, is devoted to six essays on shamanic art; see, in particular, Peter Furst's "The Roots and Currents of Shamanism" (pp. 36-60) and Vastokas's "Shamanic Trees of Life" (pp. 125-49). In their well-illustrated book, Sacred Art of the Algonkian, Study of the Peterborough Petroglyph (Peterborough: Mansard Press, 19 anthropologists Joan and Roman Vastokas interpret the shamanistic char of a group of Canadian rock carvings similar to those found in Maine. Camp Grant, a historian of aboriginal art, in his book, American Pictographs, and Pictographic sites in Art of the American Indian (repr. New York: Apollo Editions, 1972, $2.95) "California's Legacy of Indian Art" (Natural History, June-July 1973, pp. 31-41), Grant compares the significance of these prehistoric native American carvings and drawings with the famous cave paintings of France; see, for example, "Ice Age Masts of the Lascaux Cave," by De Perkins, Jr. (Natural History, A 1976, pp. 62-69).

Shotgun Houses (p. 50)
Anthropologist Melville J. Herskov, founder of the first American univer program in African studies, has written a number of books detailing how World ways survive in the acculturation situation. A central theme of his treatise, The Myth of the Negro (repr. Boston: Beacon Press, 1976, $2.95), is the positive aspect of much America's African heritage: Life in the Haitian Valley (Garden City: Doubleday, 1971, $2.50) treats similar facets of village life among the descendants of slaves on one Caribbean island. Ju

Striped Fish (p. 64)


Peter Pitseolak (p. 70)

People from Our Side, a life story with photographs by Peter Pitseolak and oral biography by Dorothy Eber (Edmonton: Hurtig Publishers, 1975, $8.99), and Pitt- seolak: Pictures Out of My Life, from recorded interviews by Dorothy Eber (Se- attle: University of Washington Press, 1972, $9.95), are unique accounts of the changing Eskimo culture. The first documents the transition through the lens of an Eskimo’s camera; the second through the remarkable graphic art of an Eskimo woman. William T. Larmour’s Uninut: The Art of the Canadian Eskimo (Ottawa: Queen’s Printer, 1968, $3.25) and George Swinton’s “Arctic Renaissance” (Natural History, January 1973, pp. 64–71) describe and illustrate the Eskimo art forms that have emerged as one of the results of the acculturative process. Edmund Carpenter’s Eskimo Realities (New York: Holt, Rinehart and Winston, 1973, $12.50) provides an incisive anthropological assessment of the disappearance of the “old ways.” In Seasons of the Eskimo: A Vanishing Way of Life (New York: New York Graphic Society, 1971, $17.50), Fred Brummer’s emo-


Tsetse and Trypanosomiasis (p. 76)


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If you’d like more information about what has to be done to assure the world’s fiber supply, please write to Dept. 200-A, International Paper Company, 220 East 42nd Street, New York, N.Y. 10017.
4 Authors

10 A Naturalist at Large Bernard Nietschmann
The Wind Caller

22 A Whooper Rally Rodney Barker
When all else fails, ask a neighbor for help.

34 Poison in a Monkey's Garden of Eden Kenneth E. Glander
Any big leaf worked for Eve, but monkeys have to be more careful.

42 Masked Messages Ann Marie Cunningham
Even the secret police seem to enjoy Korea's colorful folk dance dramas

48 Report from Mars Robert Jastrow
New questions for old speculations.

54 Life on a Cold Rock Text and photographs by Fred Brauemmer
Whales, walruses, and Russian helicopters are common sights for Little Diomedes.

66 Misleading Mantids Text and photographs by George F. Rohrmann
Science fiction can learn a lot from these insects.

72 This View of Life Stephen Jay Gould
Twin-engined Spaceship Earth

79 Book Review
Hidden Treasure

84 A Matter of Taste Raymond Sokolov
Strange Fruits

88 Ritual Enemas Peter T. Furst and Michael D. Coe
It's apparently an ancient American practice.

92 The Market

93 Announcements

94 Celestial Events Thomas D. Nicholson

96 Additional Reading

Cover
Korean masked dance drama uses grotesque masks, bright costumes, and vulgar jokes to criticize traditional society's upper crust and, by inference, the present political establishment. Photograph by David Burnett. Story on page 42.
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391. The Postcard Prize: Best of the Small Presses. Edited by Bill Henderson with the Postcard Prize founding editors. QPB: $5.95.


Editor of a weekly newspaper in Durango, Colorado, Rodney Barker became interested in whooping cranes because as an endangered species they "go right to the root of man's careless use of his resources." Barker is now photographing geologic formations in the Four Corners area of the Southwest as a free-lance project. His next self-imposed assignment will be to probe into the Old West Regional Commission's efforts to implement economic development programs for regional native Americans. When not working, Barker seeks the life-giving properties of the mountains and desert.

On leave from the University of Michigan, where he is an associate professor of geography, Bernard Nietschmann is in Australia on a grant from the National Geographic Society. A frequent contributor to Natural History, and its newest columnist, Nietschmann is studying interrelationships between dugong and sea turtle behavior, and also hunting patterns and cultural adaptations among Torres Strait Islanders. A senior research fellow at Australian National University, he will be down under until July. A veteran of numerous expeditions to Central America, Nietschmann has a book in progress on his often bizarre field experiences with the Miskito Indians of eastern Nicaragua (see "The Nicaraguan Skin Connection" in the January 1977 issue). This month's column is his first from Australia.

During an Air Force stint, Ethan E. Glander was assigned the task of caring for monkeys used for experimental purposes. Now studying anthropology at Duke University, he is five years into a twenty-year project investigating the social organization and ecology of howler monkeys. In the near future he plans to expand his research to include feeding behavior of howling, spider and capuchin monkeys to determine the difference in feeding selectivity among the species. As a sideline to his professional interest, Glander collects stamps with illustrations of monkeys.
His destiny was to die in poverty and disappointment.

Yet his genius gave the world some of the most beautiful music ever heard.

The age of 6, Wolfgang Amadeus Mozart was the talk of Europe. By the time he was 8, he had sat on the knee of Empress Maria Theresa, delighted the court of George III and composed four sonatas for clavier and violin. But people who fussed over a child were less interested in a struggling 2-year-old musician. When illness took his life at 35, he was nearly destitute... and was buried in a pauper’s grave. Yet he left the pickle world an astonishing body of music, singing, like his fortunes, from light-hearted frolics to epic tragedy... as you will discover in Time-Life Records' magnificent boxed set on Mozart—the first in a book and record series called GREAT MEN OF MUSIC.

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(Publishers' Prices Shown)
Founder and director of the Goddard Institute for Space Studies in New York City, Robert Jastrow began his career as a nuclear physicist. In 1958 he joined the newly established National Aeronautics and Space Administration as head of its theoretical division, which is responsible for conducting basic research in astronomy and the planetary sciences. In addition to his administrative duties, Jastrow is an adjunct professor of geological science at Columbia University and of earth science at Dartmouth College. Writing is his hobby, he says. He is the author of Red Giants and White Dwarfs, an astronomy book for laymen, coauthor of an astronomy textbook, and has written many magazine articles. A new book, Until the Sun Dies, from which his current article was adapted, will be published this year.

When Peter T. Furst and Michael D. Coe happened upon a chipped Maya vase in a private collection in 1974, they realized they were looking at a representation of a unknown aspect of Maya culture. Over the past several years, these poses and positions have been studied by some figures in Mayan sculpture had mystified archaeologists. The vase, showing the use and administration of hallucinogens, helped fill in gaps in Mayan chronology. A professor of anthropology at the State University of New York at Albany, Furst has studied pre-Columbian art and iconography in Mexico and Guatemala for more than fifteen years. Coe, who teaches anthropology at Yale University, is researching aspects of Maya civilization and the development of Middle American civilizations, as well as the archaeology of French and Indian forts in Massachusetts.

An intrepid investigator of Arctic life, writer-photographer Fred Bruemmer had more than his usual share of hard knocks on his expedition to Little Diomede Island in the Bering Strait. He reports: “The trip didn’t start too well. On my first flight to the island, the plane crashed into a mountainside and was a total loss. On Diomede, my reception was somewhat cold. Gradually the islanders got used to my presence and took me along on their hunting trips, provided I did my share of the work. Being able to interpret between them and visiting Eskimo from Siberia, via Russian and English, helped me fit into village life and overcome the Diomedes’ initial aloofness.” Bruemmer’s last article for Natural History, “A Year in the Life of a Harp Seal,” was published in the April 1975 issue.

George F. Rohrmann is a postdoctoral fellow in biochemistry at Oregon State University. His work is concentrated on viruses that are being considered for use as a biological control for the larvae of the Douglas fir tussock moth. It was while serving as a senior lecturer in the Department of Biology of the University of Botswana, Lesotho and Swaziland from 1970 to 1975, that Rohrmann did the field work for his article on mantids. Because they were conspicuous and photogenic, he kept several mantids as pets.
The American Museum of Natural History takes you on another
Voyage of Discovery: The Island World of Britain, June 17-July 3, 1977

Travel with Museum scientists and other scholars to see a view of the ancient peoples and natural history of Britain. Seventeen days of sights and experiences presented in the particular way that Museum friends and members have come to expect. A relaxing vacation, in good company.

This year of the Queen's Jubilee many people will be visiting Britain, but none except our travelers will see it in this unique way: a voyage sponsored by The American Museum of Natural History and operated by Raymond and Whitcomb.

From our first stop in London (where we will participate in a special event honoring the Jubilee) through our trip around the islands, you will see a variety of contemporary and ancient cultures, and learn how migrations, natural boundaries and economic movements determined cultural development. And you will learn how the forces that influenced the British peoples continued through the years and affected the development of America. You will see some of history's great archaeological sites, and you will enjoy the marvelous natural beauties of the British islands at the last time of year.

Only a ship can take you to many of these places so comfortably and efficiently. You'll be aboard the fine motor yacht Argonaut as you see these sights, some new and some familiar: Tresco, the prettiest of the Isles of Scilly; The Orkney Islands, with important neolithic sites; St. Peter's Port in Guernsey, with its exceptionally big tides; Isle of Sark; St. David, the small 12th century cathedral city in Western Wales; Isle of Skye, after the Argonaut squeezes through the Sound of Sleat narrows; Hadrian's Wall; Ullapool on Loch Broom in the northern Highlands; Snowdonia in the spectacular mountains of Wales; and much more.

Travel with these experts:

Dr. Thomas D. Nicholson, Director of The American Museum of Natural History and Astronomer, who will give evening lectures on the skies of Britain and on navigation.

Dr. Harry Shapiro, renowned Anthropologist, former Chairman of Anthropology at The American Museum of Natural History and author of "The Heritage of the Bounty," and, recently, "In Search of Peking Man."

Dr. Garrett Olmsted, Archeologist on the staff of Harvard University whose field is Celtic origins and who works at some of the sites we will visit.

Dr. Francois Vuilleumier, Ornithologist and Associate Curator at The American Museum of Natural History, who specializes in bird migrations and who will show us sea and shore birds in the British springtime.

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Please send an itinerary and other information about the Island World of Britain.

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NHM
The Wind Caller

In a native Australian village, a curious American scientist played along with the elder’s whims. Then the game got deadly serious.

Coming out of the Coral Sea, a branch of the South Subtropical Current sets west. Driven by the trade winds and deflected by the Great Barrier Reef, the current turns northwest and spills through the channels and over the wide coral shoals at the northern flanks of the reef. Into the deepwater passages of Yule, Flinders, and Bligh Entrances and through the Torres Strait, the current flows west: around the volcanic islands of Murray, Darnley, and Stephens; past the jumbled outcrop of black rocks and wind- and surf-piled coral sand known as Bramble Cay, where green turtles seasonally congregate to nest on isolated shores; across the Darnley Deep where pearl shell divers descended to depths where day became night and the water tugged so awesomely that they flapped like flags in the liquid wind.

West into the "archipelago of Islands without number," which Juan Torres first described in 1606, and which subsequent captains and crews came to dread for the chance of shipwreck in the reef-strewed waters and the island inhabitants’ practice of killing survivors. West into the water hourglass, the double funnel that separates New Guinea from Cape York Peninsula and joins the Coral and Arafura seas, of which Matthew Flinders wrote: "Perhaps no space of 3½° in length represents more dangers than Torres’ Strait." But Cook and Bligh passed safely through and their charts traced channels that others could follow.

Far perimeter of the strait. Wind and tidal-stream-aided current pours through narrow confining passages in the reefs and toward the multitude of small and large Western Islands; surges into Endeavour Strait. Past Horn Island with its refurbished airfield and its memories of scattered bombing by Japanese planes during World War II; past tiny Thursday Island and its remnant fleet of five pearl luggers, its four crowded hotel pubs and beaches littered with broken beer bottles; past rugged Moa and Badu islands; past the rich dugong and sea turtle grounds of Orman Reef; and past Australia’s northernmost border, the mangrove-lined islands of Boigu and Saibai, low and muddied in New Guinea river outwash, and Duuan, the pretty, cone-shaped, high-rising island. Westward toward uninhabited Deliverance, Kerr, and Turu islands, and Booby Island with its forlorn box, simply labeled “Post Office,” placed there in 1835 as a mail drop for ships on their way to London and Sydney.

Flood tide and current setting west into the Arafura, where it is full fathom twenty and more; reefs and island shoals disappearing beneath the rising tide.

"Tide coming up now. Strong. See, that’s new moon quarter tide, run straight, just like I tell you. Kulis going down to the west. Everything in the sea change over, turtle, dugong, fish—everything on tide."

Geland and I stood on the warming white sand beach, watching the tide come in. Kulis, the east to west trade wind time flood tide, lapped at the bottom edge of his red lavalava as he bent over to pick up something from the advancing water. "Dugong been eating on kulis, lee side of reef," he said with confidence, pointing to the frond of leaf blade he held in his hand.

I wanted to know how he had deduced that a dugong was feeding ing flood tide, in a specific reef at all from a two-inch-long clue.

"Look that torn edge, dugong on kulis, can’t hold proper stead, bottom, rip that grass. When a tide time, or gutai tide [west to ebb tide], going down, then grass proper straight across. Good to I then; good for you to take pic then, too."

Geland was a good field naturalist. Little escaped his attention and took pride in his knowledge of the currents, winds, stars, and the associated behavior and movements of marine life. At 62 he was old enough to have learned much from "time people" and their practical understanding of sea sky island worlds, and he maintained a pragmatic disdain for "these modern times." He never missed a chance to comment on the younger generation’s "back over front, messed ways," but he seldom missed a Ra Australia evening newscast, either.

"Things going to the bad, not before time," he would often say. "Our ways changing." As much possible he lived beyond the everyday problems that a purchased economy brings to a traditional society. His true delight was natural history and he radiated an infectious exuberance in his continuing pursuit to learn more about the natural world and verify the old principles learned as a boy.

Geland had asked me to meet him on the beach that morning so that could prove to me that he could "teach the wind." I didn’t have much faith that he could, despite his assurance and knowledge of "island ways" and "proper knowledge" and we we
A few of weeks into what seemed to be a crash course. I think he thought it little slow and thick headed because I didn’t readily accept all that he told me. Maybe that’s why he had ceased the pace. Or maybe I was only one around who would at all listen.

When the tide catch that mark, and will come around,“ Gelam said, indicating with a dexterous big toe scratch mark he had made in the sand with a tree branch the night before. I had been there then as well and he showed me how to call the wind. “Take small branch of gabudel M., the one I get from old chiefs’ fire, strike him on sand, then point it where you want wind to come. Call for wind in deep language, this gammon half and half they pack today.” He had called for the wind for the next day.

We sat and waited while the tide rose, pushing before it small flakes of sea debris, each wave covering a bit more of the dugong and the bones left from numerous gatherings and randomly scattered in the intertidal area. Gelam pulled a round tin of Capstan Ready Milled Tobacco, which he kept seated somewhere in his lavalava, and rolled a cigarette. Head bent to watch, a muffled “no fear, soon he’s” leaked from cupped hands.

Anxiously watched every advance that tide as it moved up the beach and the mark. There was little else to do as Gelam had become silent. He isn’t look at the mark but watched the clouds.

Sealls covered the mark and kept watching. I had my compass and was facing into the southeast, pointing my nose directly upwind so that I could feel the breeze on both my ears. So no change. I looked at Gelam and he him a palms up “what hap-

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According, began, MURRAY wanted DARNLEY could before. good changes. Abruptly, Gelam watched about the compass with me. South it was. Feet spread in a seaman’s stance, he said, “You believe me now?”

The wind change confirmed for Gelam that his “action” was still good and that the old ways still worked. I was positive about the wind change but still dubious that Gelam had caused it. According to the weather records I had copied, the Southeast Trades, after months of blowing in a steady direction, were due for change. Besides, he could have heard it on the radio the night before. It could have been any number of things—Gelam was always watching the clouds, listening for particular birds to sing out, even carefully observing the behavior of his two young pigs for signals of weather changes.

I was hesitant to tell him that I didn’t believe he had called the wind, despite what I had witnessed. Besides, I was interested in dugongs and sea turtles and was beginning to wonder what I was doing on the beach with Gelam in the first place. Apart from our mutual interests, our conceptual outlooks differed drastically. I guess I am just easily distracted, and Gelam was, after all, a pretty engaging fellow. I wanted to get back to work, to get back on the reefs. The filter in the air compressor needed to be changed; the scuba tanks refilled. I was a couple of days behind on my notes—there were so many other things I could or should be doing, rather than watching the tide come up and waiting for the wind to change.

“Ate, I began, referring to Gelam as grandfather, “I can see that the wind changed and I don’t know why it changed, but I’m not ready to say that you did it all.” I expected him to be angry with me because of the time he had spent the previous night and this morning—he had other things to do, too—so I hoped that by implying that he may have had something to do with the wind change, he would be placated and my standards of scientific observation would be only slightly tarnished. Moreover, I wanted to get back to the field research.

Gelam gave me a long, curious look, the kind that makes one want to check to see if there is a piece of mango stuck between one’s front teeth. Then he began chuckling, a deep chuckle that started in his thick belly, worked up in ripples, and shook his body until the laughter just poured out. Gelam’s sort of laughter sweeps everything before it, regardless of the circumstances. When someone laughs like that it’s not important to know what’s so funny, you just join in. We laughed together, tears running down our faces, until, gasping and choking, we wheezed to a stop for air. When it was finally over and it was possible to breathe deeply again, Gelam turned and started back up the beach, motioning for me to follow. “Come,” he said, “we’ve got more work to do on winds.”

My wife, Judi, and I, along with our son, had come to Torres Strait to do a year-long research project on the behavior and ecology of dugongs and sea turtles. Unlike most other tropical shallow-water places in the world, these animals are still abundant here because Queensland State legislation limits their exploitation to Islanders and mainland Aborigines, and because there are relatively few Melanesian Islanders, 2,500 or so, living in Torres Strait. After settling in one of the Western Islands, known for its marine hunters and surfers, we began our study.

We were especially interested in dugongs, but to study them you had to find them. We would look at tide tables, extrapolate time at high and low tide for a trip to the reefs—going through all the logistical hitches, such as getting gear ready and down to the beach—only to find that it was low tide when we arrived there. R. drying; no dugong. This happened frequently that I began to distrust tide tables and my observations of coming tides at the village beach. I would think that if it were a rising tide at the village and it tables confirmed this, that it won’t still be a rising, or high, tide for miles away. But it wasn’t always true.

I began to pay more attention to tides. I noticed curious things: a high tide on one side of the island, a low tide on the other; tidal streams dirtied the water in one spot, while quarter of a mile away the water was clear; and days when entire tide cycles would be missing—It would be high tide or low tide all day long. To find out about dugongs, I was going to have to learn much more about the complicated and apparent

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variable tides. Momentarily stymied and anxious to get on with the work, I sought out local help, never suspecting that the information I needed would be cemented in such a dense cultural conglomerate.

"What's the matter you come?" the old man asked in English after I had exhausted my repertoire of greetings in the island language of Mabulag. Taken aback by his phrasing (I later learned that it meant "why do you come?"), I pushed on to explain that I wanted to learn about local tides and that everyone had suggested that I talk to him, to Gelam. I asked if he could help me.

He sat passively for a long time, looking down at the open tin of tobacco in his hand. I didn't know if he was contemplating what I had said or what to do about his meager tobacco supply. Waiting for his reply, I looked around, absorbing fragmentary glimpses and sounds: good shade where we sat under the native almond tree; scarlet hibiscus against sun glare off clean-swept sand yard; tall, graceful coconut palms and a neat stack of husks drying beneath; a pile of blackened rocks next to a pit in the sand where a green turtle had been cooked, Islander-style, in an earth oven on a bed of hot rocks, covered by leaves, coconut mats, and a mound of sand—and from a nearby corrugated tin sided house, the strains of a guitar, as the player tried to follow "Country Road" from a John Denver tape, and the sputtering hiss of a "Handi" kerosene burner in the kitchen.

"How much you know about tides?" Gelam asked, suddenly and directly.

Startled from my languid inventory, I replied, "A little, but I have these books," and pulled out Volume III of the Australian Pilot and the latest Official Tide Tables for Queensland.

"What they say about Torres Strait?"

I read a few excerpts aloud.

"You know nothing about tides, then. Aiginga. Nothing." He frowned and shook his head sadly. Long pause. "Okay, baba, I teach you about tides and everything."

Learning about the tides took an inordinate amount of time and it was the "everything" that caused it. I had always believed that natural history was in many ways the study of cultural history, but I never imagined it was also an "everything history."

Each morning, day after day, I met with Gelam under the shade of the meke tree. He talked in part of tides and winds and currents; about kulis, which runs with the wind in the southwest season, and gutat, the good dugong and turtle tide, which runs against the wind, and of how they change during kuki, the northwest monsoon season—kulis then flowing to the east and gutat to the west. About tides that run "straight" during first- and last-quarter moons, with regular and uniform movements, but then change to the confusing patterns I had observed: missed cycles, simultaneous high and low tides on opposite sides of a small island, and sluggish low tides that seemed aslep on the coral sand flats. He told me when to look for clear-and-dirty-water periods; times of the day, month, and seasons when dugong were bunched on the reefs or scattered or in deeper waters; how currents, winds, and island and reef configurations influence tides and the occurrence and distribution of marine life; when to expect a "big low tide" so that Judi and I could go out to find dugong feeding trails on the drying shallows; how dugong "change over" from deepwater to shallow-water places as the tides and moon change; and how the turtles follow the tides.

"When dirty water big tide and want to spear dugong, like only fat one, we go to Red Fruit Island side. If go to Kuku Pad Reef, only find bad dugong, much fat. If want to look turtle and full moon, go to reefs when low tide, find them proper on top, shallow place."

Armed with this sort of information and with a new and strange set of environmental cues to aid us, we confirmed many of his observations during our afternoon and evening trips to the reefs.

Data on the marine environment and the area's natural history had to be pieced together from a thick pile of notes filled largely with tangential material. Despite my efforts to keep him to subjects that I wanted to hear about, he was not to be rushed or directed or prompted. I soon abandoned attempts to channel the cascade of personal experiences, myths and legends, local and tribal history, old hunting lore, and principles and perceptions of marine ecology that rushed from the floodgates of his mind. Never knowing when a stray piece of information relevant to our research might appear, I wrote and taped everything. He was the eldest of his clan, the historical custodian knowledge seldom required in "modern times."

He told of the time "before light came"—prior to 1871 when London Missionary Society can based on what his grandfather told him, and of "before time," when he was a young man, worked on pearl shell luggers "when crew hard work and I money"—of collecting trochus shell, "outside, breaker side of barrie and of the coral cuts, sharks, and to stench of trochus meat rotting in holds; of his days in the all-Islar Torres Strait Light Infantry Battalion during World War II, when "all boys join, fight for Australia," about American troops on Horn Island and the baseball games and waiting in the sun for something happen and of the cigarettes—"time we get tobacco proper go Yankee cigarette, taste nice." And told of the years following the war, when things began to change quickly and the young people be leaving the homeland islands Thursday Island, Bamaga, Cairns Townsville, Brisbane, and Kuri B. "Very seldom they come back. Ti forget these places. They lose the land ways."

He drew pictures in the sand constellations that signaled the pearance of seasons and the movements of sea life, outlines and lines of reefs and channels, and sketched different animals. He could imitate the swimming and feeding behavior of most sea creatures with convincing gestures. He was a wonderful server of nature.

Gelam then began to tell me about calling the wind and calling dugon. He had the "medicine" and knew "deep language" that enabled him to do these things. "Only I know these things, from older time. These younger generation know nothing but to hunt and eat. That's why plenty dugong here now—I tell them. I call them to come to this land."

And he showed me the medic and what you do with it and what you say. Roughly translated into English the call goes like this: "Don't stay sea outside, too rough. If you stay outside you will sarup. Come cloe to island. Then if you want to be sure you can with tail on reef. You're safe place now."

There was more to tell and she
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and I began to wonder when and where it would all end. We were going far beyond my original request to learn about local tides. The juxtaposition of practical and mystical knowledge made me uneasy and my mood and responses became increasingly more skeptical. Sensing this, Gelam said one morning, "The old people teach me what they knew and how to take notice of things. Everything comes from taking notice of things. I tell you what I know and then you can write it in your book. Then these new generations will read that and they'll know how it was."

I had become entangled in Gelam's desire to preserve the old traditions and the old knowledge. But my background, with its own beliefs, myths, and legends, and my training conflicted with his. He lived in a world different from the external one we shared as visitors to the island and so his perceptions were different. We reversed roles and he listened to my explanations of scientific methodology; of what caused tides and winds and the movements of some animals in the sea.

After I had finished, Gelam tilted his head and smiled. His smile meant: "You poor modern times man. You'll never know about taking proper notice of things."

And Gelam was undoubtedly correct. I would never believe in all those wondrous things that linked stars, winds, tides, animals, and Islanders together in one mysterious cosmos.

One day, two villagers, Tamu and Kadi, announced that they had to "go T.I." (Thursday Island) on personal business—it being the only commercial and administrative town in Australia's northernmost region—and asked if I wanted to come. I had a shipment of film to mail off, and this seemed like a good opportunity. Barney, my son, also came along, to buy more fishing tackle and to touch base culturally in a place where there were comic books and soft drinks. It was to be a routine, two-day, there-and-back trip in Tamu's 14-foot aluminum dinghy, and Gelam came down to the beach to see us off.

As Gelam helped push the dinghy down the beach into the water, he whispered to me, "You look for those passis and gat I tell you about," referring to the channels and reefs he had drawn in the sand. He said something else, but it was drowned out as Tamu started the motor.

Three hours later, heading south, cutting across the reefs and deep-water channels, we lost power. We drifted while Tamu and I took enough of the motor apart to confirm that it was a broken drive shaft. Perfect timing too. We were halfway through the widest stretch of open water; Thursday Island was a long way off. Our situation was difficult: no hopes of fixing the motor, no boats on the horizon, no wind; our stores, two gallons of water and a bag of overripe mangoes warming in the open dinghy. We talked about our predicament for a few minutes while the kulis tidal stream rapidly carried the dinghy toward the open sea, the Arafura.

We were in mid-channel, between reef sets, too deep and too much current to drop the anchor. We took shifts on the lead-heavy oars and rowed for the next reef, but we lost headway as we tried to cut across the channel. These channels frequently have tidal streams that run at five and six knots. At last, exhausted and anchored over the reef, and hoping for an early rescue, I asked Tamu and Kadi if many boats followed the route we had taken.

"No worry, plenty dinghies on the weekend," Kadi assured me.

I reminded him that this was Monday.

We couldn't row against the flood tide and with no wind to try an improvised sail, we waited for gutat, the ebb tide. Barney began reading Michener's Centennial—I hoped we would get to Thursday Island before he finished it. Kadi, always hungry, went to the bow to watch for maling green turtles, which drifted on the surface at this time of year. I didn't ask how he planned to cook the meat if he caught a turtle. Wearing a pink lavalava, day-glo green rimmed sunglasses, and a knotted handkerchief for a hat, Tamu sat in the stern, just looking at his motor and saying, "My or my, why you do this to me?"

And I made a little tent to protect the box of exposed film from the sun and wondered if I should start a log.

In the October calm we waited for the change of tides. The searing sun heated the boat to what felt like solar-cooker levels. Late afternoon haze, sea, and sky blended into a uniform, silvery gray Mabius band. Sea glassy over the reef, swirling in the channel. Deadwind time before the northwest monsoons.

We started to row at sundown but the slack tide was short and we didn't cover much distance until the ebb tide started. It was hard to see how we were doing in the rapidly fading light. When it was really dark, Tamu insisted that we should anchor for night on the next reef. He feared we would drift too far the other way with gutat. Anchored again, talked of turtles, Tamu taught me how to count to twenty in Mabiuag and picked mango strings from our trees.

The heavy, somnolent night lay on the sea. No breeze. We would meet the tides again tomorrow.

Eleven in the morning: Hammo Island close, Thursday Island just ahead. Prince of Wales Channel still cross, the worst one. We were tired, hungry, sore.


We quickly made a sail out of Tamu's lavalava, used the oars masts, and sat back. With this unexpected wind we would make Thursday Island easily. Near the island a three turtle hunters attracted by pink sail—you hardly see sails in part of the world, much less pink ones—changed the course of the dinghy and towed us in.

"We almost sarup out there, she's right now," Kadi said after a long pull on the water bottle. "You can book this trip."

The morning after we returned home, I found Gelam on the bench and told him about our trip. He tensed and nodded his head knowingly. Then he told me what he had done.

"When you didn't send radio message to Judi, she come and tell me. Lucky for you she did, too. I know then that something happen because you didn't reach T.I. She put worried. But I fix everything. I do that wind up. That night you out the reef, I go to beach and mark, call wind for next day. Go you push to T.I. You believe me now?"

"Let's say I believe more than I did before, ate," I thanked him, but waited for me to say something else.

"Now about this word sarup, what exactly does it mean?"

"Sarup? Well, sarup means person lost at sea. In before the big times, you sarup if your canoe size or you lose your way. You stranger to the homeland then. If you come back, they might kill you, cut off your head. But these modern times different, now we say..."

And we walked back together to beneath the meke tree.
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"A good wild oat is a dead wild oat."
A Whoopee Rally
by Rodney Barker

It's the bottom of the ninth inning for the whooping cranes . . . the cranes are in scoring position.

Since 1850, North American wildlife has changed drastically in composition and abundance, largely because of a rapid transition from pristine to civilized conditions. A prime example is the whooping crane, a bird which had ranged across marshes and prairielands of America before white man's western settlement until its breeding grounds in the United States had been abandoned. Its period of decline continued through the 1930s, until only one migratory whooper flocked remained in the wild, wintering in a single marsh on the south coast of Texas. In 1937 the United States government, in an effort to protect the species from extinction, purchased this area as a migratory waterfowl refuge, since named the Aransas National Wildlife Refuge.

Further conservation efforts were stalled by a lack of knowledge. The notebook on the whooping crane was slim. Even the whereabouts of these whoopers' nesting grounds were unknown until 1954, when they were discovered and it was learned that the birds journeyed into the Northw Territories of Canada near the Alberta border in order to rear their young.

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An accepted member of a sandhill crane flock, a yearling whooping crane forages for grain in a harvested cornfield near the Bosque del Apache refuge in New Mexico.
without interference or disturbance. The discovery of the breeding grounds in remote marshes of Wood Buffalo National Park did little to assure the salvation of the species. Only twenty-one whooping cranes were left in the wild by then, and while the isolated nesting grounds provided protection, the far northern location meant a short nesting season. If a clutch of eggs was destroyed by a storm or a predator, there would not be much time for a second nesting. Furthermore, the cranes’ migration route was long and dangerous: 2,600 miles from Wood Buffalo to Arkansas—and the whoopers made the flight twice a year.

A movement to increase the population of whooping cranes followed, and two schools of thought developed about how this could be best accomplished. One accepted that the species had been condemned to extinction in its natural environment and that captive propagation was the only hope. The other felt the birds should be left to themselves and that over time, and with stringent protection, their status in the wild would be enhanced.

There were problems associated with both viewpoints. On the one hand, captivity-induced changes could result in the loss of traits essential to the bird’s survival in the wild, and no method had yet been devised to condition captive birds in a way that would eventually allow their release. On the other hand, a wild population can be given only so much protection. For a species whose numbers had been diminished to less than two dozen, and which has a very low reproductive rate, the prospects for a natural resurgence seemed slim.

The priority at the time was to increase the whooping crane population by any and all means, and to accomplish this the U.S. Fish and Wildlife Service and the Canadian Wildlife Service began a program in 1967 that involved transporting eggs from whooping crane nests in Canada to the Patuxent Wildlife Research Center in Laurel, Maryland, for artificial incubation, hatching, and raising. The objective was to establish a captive breeding flock that would eventually produce enough birds to restock the wild population.
The feeling was that the removal of one egg from a whooper nest would not hurt the wild flock, for of the two eggs normally hatched in each nest, sibling rivalry and competition for food usually meant only one chick survived. Eggs were taken from whooper nests beginning in 1967, and by 1974 a potential captive breeding flock of nineteen birds had been reared from fifty eggs at Patuxent.

Whooper numbers, in the wild and in captivity, were on a slow upsweep, but two major factors continued to hinder the increase of the species. First, an insufficient number of birds produced in the wild were going back into the breeding flock. No one knew what was happening to them, but too many of the subadult group were vanishing before they had a chance to contribute to the breeding population. Second, the belief that animals reared successfully in captivity should exceed, by several times, the customary productivity of the species in the wild was not holding true in the case of the whooping crane.

At this crucial point in whooping crane history, Rod Drewien and Elwood Bizeau, research biologists at the University of Idaho, came forward with a proposal to start a new wild population of whooping cranes. Drewien and Bizeau had been working for six years with greater sandhill cranes, close cousins of the whooper, and had completed a comprehensive study that involved catching and banding some 700 sandhill cranes, following them up and down the Rocky Mountains on their migration route, and experimenting with egg switching. Their research indicated that cranes are imprinted; that is, their social behavior is learned through early experiences. Drewien and Bizeau then extended the implications of their studies to whoopers. They proposed that the eggs being removed from the wild for incubation at Patuxent be deposited instead in the nests of preselected sandhill cranes at Grays Lake National Wildlife Refuge in Idaho, and that the sandhills be permitted to raise the whoopers as their own. They believed that sandhill cranes would make good foster parents: both species maintain long pair bonds and family groups, both lay two eggs that are similar in size and appearance and that hatch thirty days. The biologists were convinced that the adopted whoopers would learn from the sandhills to just to a new environment.

Drewien took the view that “...face of the continent is so changing that the whoopers may not be able to reoccupy much of their historic range, which has been drastically altered or eliminated by man. The original habitats are not there anymore. We believe that the whooper is a lot more adaptable than we give it credit for. With this restoration project we are simply trying to take advantage of similarities between two species—switching eggs and then letting nature take its course.”

The objectives of the proposed experiment were multiple. Obviously it was important to increase the whooping crane population in the wild as much as possible. But to Drewien, the numbers were not the most important statistic: “...Anything more than what we have is a better number, but the total number is not as important as establishing separate flocks. A hurricane—...an oil spill at the wintering grounds could wipe out the entire flock. Whether there are 50 birds in it or 25—...would be far safer having those 25 birds in separate flocks. Security for the whoopers is in dispersal of the species.”

Past events dramatically underlined this statement. In 1940, two populations of whooping cranes existed in North America: a nonmigratory flock, living in the coastal marshes of Louisiana, and the full migratory birds that wintered at Aransas. That year a hurricane hit the coast of Louisiana, and all but six of the nonmigratory colony of whoopers disappeared. All of the Louisiana whoopers were gone by 1949.

In addition to bolstering the population, the establishment of a second and separate whooping crane flock meant the whoopers would have a different set of winter and summer ranges. No migratory species can be kept on a managed habitat or under protective observation all the time, but the banded stock of sandhills from
You stand in the Market Square of medieval Cracow, in the shadow of the Gothic Clothiers' Hall. Atop the 250-foot tower of St. Mary's Church, a lone man sounds his trumpet four times to the four corners of the city. Just so, in the year 1241, a trumpeter warning the city of the approaching Tartar invaders was interrupted—slain by an enemy arrow. You will hear the unfinished fanfare marking every hour in that hero's memory as long as you stay in Cracow. It has echoed across these ancient rooftops for more than 7 centuries.

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which Drewien intended to draw his foster parents wintered and summered on national wildlife refuges—Grays Lake National Wildlife Refuge in Idaho and the Bosque del Apache National Wildlife Refuge in New Mexico—and on each flight, north and south, stopped over to rest and feed at, or in the vicinity of, the Monte Vista National Wildlife Refuge in Colorado. The 800-mile migratory journey from Idaho to New Mexico was less than one-third the 2,600-mile Canada—Texas trek.

Many questions stood without answers. Would the sandhill cranes accept the whooping crane chicks once they were hatched? Would the whoopers continue the same migration route of their foster parents when they had to fend for themselves? Although plumage, size, mating calls, and ritual courtship dances of the two species differ considerably, would the sandhills and whooping cranes attempt to interbreed in a wasted reproductive effort?

Calling it a grand experiment to provide a lot of answers, the U.S. Fish and Wildlife Service and the Canadian Wildlife Service approved Drewien and Bizeau’s proposal and the project was begun in May 1975. The Canadian Wildlife Service made plans for the eggs to be picked up by helicopter on May 28. There are variations in sensitivity to nest visitation among species, and no bird will stand for sustained disturbance. A direct approach, quick actions, and a short time spent at the nests of whooping cranes had been found to be acceptable during earlier operations of the Patuxent project, and it did not appear to bother the parents when one egg was removed.

The eggs were left under their natural parents until approximately one week before they were expected to hatch; at that time Ernie Kuyt, a biologist with the Canadian Wildlife Service, flew to the vicinity of each nest. He removed one of the two eggs in each nest (where three eggs were found, two were taken). The eggs were immediately placed in a portable incubator, and when the collection was complete, fourteen eggs had been taken, with seventeen left for the Canadian flock.

On May 29 the eggs were flown to Grays Lake and substituted into the nests of sandhills. Drewien drew from a stock of one hundred banded sandhill cranes, and his primary criterion for the selection of the foster parents was the predictability of their migration from Grays Lake to Bosque del Apache.

Of the fourteen eggs taken to Idaho in 1975, three were found to be infertile. This was Drewien’s first surprise. “That threw me, three eggs being infertile, I didn’t expect that—based on similar samples from sandhills. I had never run into that percentage of infertile eggs before.”

Two eggs became meals for coyotes. Of the nine eggs that hatched, six chicks reached flight stage and three were lost to unknown causes.

From the time they hatched to the time they migrated, the young whoopers were twice approached by humans: once when the nests were checked to make sure the eggs had hatched and again when the remaining young were banded at two months of age.

One more bird was lost prior to migration on October 8, when the first whooping crane wheeled upward in circular flight with its sandhill parents and headed for the Monte Vista National Wildlife Refuge, 500 miles away. By October 20, four whoopers had arrived in the San Luis Valley of Colorado at or near Monte Vista National Wildlife Refuge to rest and feed. The four foster parent families continued on to New Mexico; two settled in the Bosque del Apache refuge, a third family stopped at the Bernardo State Game and Fish Department Refuge, and the fourth came to rest on a dairy farm near the town of Los Lunas. Reports of a large white bird wintering with a sandhill crane flock in northern Mexico left hope that all five had safely completed their annual southern migration. With one bird not officially accounted for, adding these four whoopers to the eight chicks raised by the 49-bird wild flock in Canada represented the largest annual increase in the wild whooping crane population ever recorded. That made a total of 85 wild and captive whooping cranes in existence in 1975.

Drewien followed the birds to Bosque del Apache refuge, monitoring their activities and behavior and watching the interactions between the young whoopers and their foster parents and other sandhills. It appeared that the whoopers were acting like normal sandhill young and being treated as such by their foster parents, but not by other sandhills. There was a tendency for the whooper families to feed on the edge of the flock because the young whoopers were frequently harassed by other adults and their roosting and feeding cycles.

Drewien and wildlife officials were optimistic about the whoopers’ ability to pass their upcoming test. Would they follow their foster parents back along the migratory route to Grays Lake? And what was going to happen upon their arrival at the breeding grounds? Sandhill breeding pairs, which are strongly territorial, drive yearlings off prior to a new nesting season. Left with the protection of the mature birds is a forced to shift for themselves on unfamiliar feeding grounds, the young whoopers would enter a time when they were highly vulnerable to loss.

A short mild winter brought sandhills north one week earlier than usual, and by March 2, 1976, the four whoopers had arrived in the vicinity of the Monte Vista refuge, with fifth bird still missing.

While in Monte Vista, the young whoopers were constantly under the vigil of refuge manager Pete Bryant, who observed that although whoopers congregated with odd young sandhills, “one of the whoopers was a leader. Juvenile sandhills were attaching themselves that whooper rather than the other way around.” Bryant’s observation that the whooping cranes appeared to be dominant in the juvenile group suggested to him that a pattern of segregation was already developing that would eventually lead to natural separation when the birds reached sexual maturity and selected mates.

Then an unexpected development occurred: the sandhill parents continued their migration north, but on one whooping crane went with them. The other three stayed behind at Monte Vista.

Pete Bryant felt the birds remain “because there was nothing to move them. Conditions were good and getting better. There was plenty of wait and food around.”

Two of the young whoopers left April but two stayed until May 1. When they left they scattered to the north; only one made the full migration that the adult birds did to the grounds where they were hatched at raised. (This individual summered within twenty miles of Grays Lake.)

Drewien was not worried about this development because some sandhills followed the same pattern. B
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there was no way to measure the implications because there was no norm to compare them to. To this day, nobody knows where you...
Cranes were brought by Minolta from Alaska. As it is, the one pictured was not in the best circumstances. It had been injured in a collision with a car. Drought conditions and the resultant lack of food were blamed for the last fatalities, as a number of whooping cranes were observed in a poor condition. It was a poor year for cranes at Grays Lake.

The fate of the two eggs brought from Patuxent was consistent. Dewien had been warned that there were a developing embryo in one of the eggs; nevertheless, they were placed under sandhills. It is considered good did not hatch on its due date, but it was left on the chance it might still come through. Four days later it was eaten by ravens. The one deemed infertile was eaten—the day after it should have hatched.

Four young whoopers reached the adult stage and flew south in 1976. At Monte Vista, one of those extended a string of bad luck when it flew into an rusty barbed-wire fence and died from injuries sustained in the collision. The three survivors continued to Bosque del Apache. As it turned out, the sandhill parents that successfully reared the 1976 crop of whoopers were not the same ones that had success the previous year.

Meanwhile, the four yearling whoopers who had scattered to the north for the summer came back to their previous wintering grounds on their own. One was reported about forty miles north of the Bosque del Apache refuge in early October, but it apparently moved farther south. It hasn’t been seen since, and Dewien thinks it may have joined a group of young sandhills heading south, which continued across the border into Mexico. Two remained at Bosque del Apache and the other went the winter at the New Mexico Game and Fish Department refuge at Corry Burnardo—proof that whooping cranes placed in a new geo-
graphical area will remain in that area after they have left their parents.

Assuming developments continue as they have, the project seems on its way to ultimate success. In 1976, fifteen new whoopers were added to the wild whooper count, as the Canadian flock contributed twelve young. The previous high was also twelve, and that was in 1975. Before this project was begun the best score on record had been a ten, in 1964. (The total number of whooping cranes, in the wild and in captivity, is now about one hundred.)

After two years, the restoration project is still in its infancy, but numerical results and informative answers have justified the initial risks. "Beyond any doubt in my mind now," Drewien said, "I'm confident this method will work, as far as rearing the bird, fledging it, and taking it south." He has expressed little concern over the birds scattering to different summer grounds because while the distribution was spread over several states, it was all within the same geographical range occupied by the sandhill crane population into which they were introduced, and each area contained the same basic habitats—grain fields and wetlands—utilized by cranes at Grays Lake. "The more we see, the only real question left is will the whoopers get together and pair or will they attempt to pair with sandhills. The key to minimizing this potential problem is getting enough whoopers introduced into this flock so that when they reach the age when they start to pair, they can have an opportunity to come in contact with each other, among the thousands of sandhills."

Drewien feels the answer could very well lie in the captive breeding flock at Patuxent, for assuming everything continues as it has, then the only limitation is the number of eggs that can be gotten.

"One of the values of the captive flock, besides, of course, maintaining and perpetuating a gene pool aside from what is in the wild, is that it can contribute significantly to the restoration project. It is going to be a long program, and if Patuxent can break down the barrier of getting eggs out of the adults and get them producing—and they have approached it already with three eggs in 1975 and five eggs in 1976—then we could supplement the wild eggs with those eggs produced in captivity, and we could rapidly increase the number of whoopers. I think that to be able to depend only on eggs that come out of Canada may not be enough."

He feels a couple of dozen whoopers must be available in the new population to give them a fair chance to breed, and that once there is the capability of putting out two to four dozen eggs a year, "knowing what success we've had in bad years—25 percent coming through—we could break the barn door down on these whoopers."

The biggest problem the project has encountered thus far has been the high loss of young during the nesting and rearing period. Some of this was due to adverse environmental conditions. The past two years have been subaverage years weatherwise, as drought conditions, together with storms at the wrong time, have taken their toll. But in two years, six eggs have been lost to predators, and that is one factor that something can be done about. A coyote-control program will be administered at Grays Lake this spring (the loss of eggs to coyotes last year was due to a single pair that moved into the marsh nesting area for the first time). But if a predator-control program is not immediately effective, Drewien will consider new criteria in the selection of sandhill foster parents. Ideally he wants a pair that consistently summer on the refuge at Grays Lake and winter at Bosque del Apache, but "I might have to back up and use pairs I don't have as much information about because they have safer nest locations and are less likely to be predated by coyotes."

Besides coyotes, hunters continue to pose a threat to the whooping crane. Historically, the whoopers have been most vulnerable to being shot on their migration south because they cross middle America during hunting season. At the time of this writing, however, the young whooping cranes in the experimental project are being exposed to this particular danger because of counterproductive management practices on the Bosque del Apache refuge itself.

Restricted snow goose hunting has been allowed on the Bosque del Apache refuge for years, but in 1976 the Fish and Wildlife Service, against the recommendations of refuge personnel, proposed to considerably expand the hunt to offer greater opportunities. The bag limit on snow geese and the number of shells hunters could use were increased. A new afternoon hunt was added but the elimination ten days prior to the opening of the hunt due to political pressure.

"I'm not opposed to hunting Drewien explained, "but it should be placed in a proper context. Virtually every year since the hunt has been held at the Bosque del Apache refuge, one or more sandhill cranes have been misidentified and shot. Last year fifteen sandhills were killed. If a person mistakes a sandhill crane for a snow goose, he can certainly mistake whooper, whose color patterns resemble the snow goose much more closely."

Many people feel that the foremost objective of a national wildlife refuge should be the enhancement of wildlife that utilize the area, over all other use. And when there are conflicting programs, wildlife should be the top priority item.

In 1975, 659 hunters came to the Bosque del Apache after snow geese, the total number of visitors that year was 68,000, many of whom can to see the whoopers. In 1976, a public user, the hunt proceeded as scheduled, with refuge agents scurrying around trying to keep track of the whoopers in the morning fog, setting off sirens whenever the birds flew near the blinds, stopping the hunters until the whoopers moved on, and the starting it again with an all-clear signal. The hunt lasted eighteen days and, fortunately, ended without whooping crane casualty. But by this time it was over, the cranes in the hunting areas were out of food and almost whoopers were flying off the refuge to private lands to forage during a period when the goose hunting season was opening outside the refuge.

There are lessons to be learned from this experimental project that have valuable implications for many other endangered species. Already George Archibald of the International Crane Foundation is in the process of instituting an analogous program in Asia with the Siberian white crane using the European common crane as the foster parent. If Drewien's project works, and the ultimate measure of success will be the pairing and raising, of young whoopers in the new flock then not only will the lifeline of the whooping crane have been extended but one of the most triumphant techniques ever developed in the restoration of endangered wildlife will have been established.
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Keneth E. Glander

For howlers in a Costa Rican forest, feeding is not just a matter of plucking any leaf.

All of the howling monkeys, except for one adult female with an infant clutching her stomach, had finished feeding and had left the cane asada (Andira inermis) tree. Suddenly this female started turning in tight circles on a branch, but she completed only two revolutions before losing her balance. For about a minute, her tail hold on the limb prevented her from falling and she hung upside down. Then, convulsing spasmodically, she lost muscle control and plummeted thirty-five feet to the ground. All the while, her ten-day-old infant had kept its grasp. Although the infant was not injured, the other appeared dazed. After recovering, she climbed back into the tree, remaining sitting in the same spot the rest of the day and did not feed for the next twenty-four hours.

Her fall was one more piece of evidence that toxic substances in some of the leaves consumed by these maned howling monkeys (Alouatta palliata) not only determine a group’s feeding patterns and movements, but may also influence its social organization.

This group of howlers, made up of six adult males, six adult females, and five juveniles, inhabited two sections of forest on twenty-five acres of ranch near Cañas in northwestern Costa Rica. One is a broad-leaf evergreen forest, which runs along the banks of the Río Corobici. Here, the steady supply of water permits such trees as espavé (Anacardium excelsum) and sotocaballo (Pithecellobium longifolium) to thrive. Most of these trees are about fifty-five feet high but several magnificent specimens reach one hundred feet.

At a distance of seventy-five feet from the river banks, the ground is much drier and the gallery forest gives way to a deciduous one. During the dry season from December through April, the difference between the two forests is most dramatic: the dense green canopy of the gallery forest contrasting sharply with the bare limbs of the deciduous one. During the wet season from May to November, however, the canopies of the deciduous forest are as thick as those of the gallery forest.

In many places the canopies touch, allowing the howlers to move directly from one tree to another. But where cut or blown down trees have created gaps in their travel routes, the howlers usually hesitate momentarily before flinging themselves out into space to land safely in the crown of a neighboring tree. All of the animals, except for those younger than four months old, routinely make these jumps. When these young animals come to gaps that their mothers have already crossed, they edge out to the very ends of the branches and squeal until the mothers cross back to get them. As a result, many of the females have to jump the same gap three times. But by the time the juveniles are six months old their mothers no longer pay attention to their squeals and they must jump the gaps themselves or be left behind. During our fourteen-month study of the ecology of mantled howling monkeys, we observed over seven hundred jumps and never saw an animal miss.

My wife and I had completed only three months of our field work when we saw the mother and infant fall from the cane asada tree. There had been other, similar occurrences within a short time span. During the late afternoon of the previous day, the group had traveled from one side of the Río Corobici to the other, using a natural pathway along the limbs of trees that almost touched. They crossed safely on this occasion, just as they had many other times. We did not wade the river to follow them since darkness was already approaching, but we could see them feeding in the same tree from which the female and infant were to fall. Almost half the tree’s crown was hanging over the river, as did the crowns of some of the sleeping trees used by the group that night. The next morning one of the juveniles was missing. We suspect that the missing juvenile fell and drowned in the river because we could not find his body after a thorough search of the area.

More than a month later, the infant of the female that fell from the cane asada tree drowned in the Río Corobici. On that morning, it was riding on its mother’s back while she fed in the crown of a tree that leaned out over the river. We were following another female feeding in a nearby tree when we heard a splash. Upon searching the river, I found the dead infant in three feet of water.

In the two weeks prior to the female’s fall, six howling monkeys from other groups on or near the ranch were found dead. I recovered the intact bodies of three animals, all females, for examination, but the other three were too decomposed. During the same two-week period we also found two juvenile females from another group twitching and jerking on the ground. The younger animal, about six months old, died within four hours. The older one, some eighteen months old, recovered.

At least three of the six dead ani-
imals and both of the sick ones had been feeding on the leaves of either carne asada or madera negra (Gliricidia sepium) trees. The mature leaves of madera negra contain rotenone, a fatty acid called archidich, and an unknown alkaloid. Rotenone is one of the ingredients in some insecticides. In Venezuela, Indians crush madera negra leaves and mix them with water and rice or seeds for use as a rat poison. The leaves of carne asada contain the alkaloid andirine. Five grains of andirine will make a human nauseous. Colombian Indians poison fish by putting crushed carne asada leaves in lakes and rivers.

The unexpected and unusual concentration of dead and sick animals, and our knowledge of what some of these animals ate just before they died, provided us with an opportunity few other field researchers have. The combination in tropical forests of rapid decomposition and efficient scavengers, such as insects and vultures, makes the remains of dead animals quickly disappear. When remains are found, it is usually extremely difficult to discover what the animals consumed just before death.

Tests carried out by the Microbiology Department of the University of Costa Rica ruled out the possibility that the monkeys died from herpes virus, rabies, or yellow fever, and extensive autopsies of the animals produced no apparent pathologies. We were left then with strong circumstantial evidence of natural poisoning by ingestion of toxic leaves.

In order to verify or negate this hypothesis, we began to analyze all plant materials in our study site. The present emphasis is on testing for alkaloids. Although the procedure is accurate, it shows only the presence of alkaloids, not the type. The results are promising, but chemical analyses are just beginning.

We have a much more substantial amount of information on the feeding behavior of the howlers. My wife and I have now spent more than 5,000 hours in the field, either observing the animals in their daily activity or studying their habitat. We have systematically documented the distribution of their food resources by marking, measuring, mapping, and identifying the 1,699 trees in the study area. While in the field, we also kept weekly records on the leafing, flowering, and fruiting of the trees.

The annual rainfall in the howlers’ habitat area is about 70 inches, but when we did our study in 1972 and 1973 only 56 inches fell during a twelve-month period, most of it from May through September. No rain fell in January, February, or March. In the wet season, the dense leaves provided shade for us and the animals.

During the wet season, the howlers begin feeding at about 6:30 in the morning and intersperse feeding bouts with periods of moving from one feeding area to another. Toward the hotter middle hours of the day, when temperatures reach about 85°F, they usually move to the lower canopy to seek a shady place for resting. Here, an animal stretches out with its legs straddling a branch and its tail wrapped around it. Infants and juveniles often explore the immediate area around their mothers or play in the tops of the trees during these periods. In a resting position a howler is often difficult to spot from the ground because its coat color blends with the shifting patterns of sunlight and shadows filtered through the tree branches. A second peak of feeding usually begins about mid-afternoon and continues until the group settles into sleeping places at about six o’clock in the evening.

The pattern of daily activity is similar during the dry season. except that the first feeding occurs at about five o’clock in the morning; by seven all the animals are resting again. Temperatures during the dry season are hotter, often reaching 100°F. By feeding earlier, the animals can rest in the shade through the hottest part of the day and feed again in the cooler late afternoon.

When we observed the animals during daylight hours in the wet season, they spent an average of 7.9 hours resting, 2.3 hours feeding, and 1.4 hours moving, as compared to an average of 6.4 hours, 3.0 hours, and 1.3 hours, respectively, during the dry season.

The tree parts that the howlers eat, and the time they spend doing so, vary from day to day and from season to season. During an average wet-season day, the animals might spend 38 minutes eating mature leaves; 47 minutes, new leaves; 23 minutes, fruit; 32 minutes, flowers; and 28 minutes, leaf stems.

During the average dry-season day they spend 21 minutes eating mature leaves; 104 minutes, new leaves; 15 minutes, fruit; 33 minutes, flower, and 18 minutes, leaf stems. The linear distance covered in search of the food may be as much as 1,500 feet.

Although the time spent consuming each vegetational component varies according to season, leaves are unquestionably of great importance all the time. Since leaves are always available in a tropical forest, researchers have traditionally thought that these leaf-eating monkeys had a food that is unlimited supply of food.

The results of our study appear to first glance to support this, since the howlers that we observed obtained all of their food from only 331, or less than 20 percent, of the 1,699 trees in their habitat. Even more surprising was that the animals spent 75 percent of their total feeding time in only 8 trees. This might suggest some discernible pattern in the animals’ feeding. Do they select certain trees or tree species over others? Is there anything unique about the trees they use, or those they do not use?

Indeed, the animals are very selective, showing preference not only for specific tree species but also for certain trees within a species. Furthermore, they do not divide their time equally among species or individual trees. In many instances howlers feed in only a few trees of a particular species, totally ignoring other individuals of the same species that appear to have identical food resources.

The howlers demonstrated their selectivity in a most dramatic way. There are 149 madera negra trees in their home range. A common tree is almost every part of Costa Rica, it often used for fence posts. Once a limb is placed in the ground as a pos it frequently sprouts roots and begin to grow, resulting in living fence rows. The tree seldom grows taller than forty feet and has a spindly gnarled trunk. The bright pink flowerers, often fried and eaten in Costa Rica and Venezuela, grow in dense masses at the ends of the branches. The fruit resembles an enlarged pod, and the leaves grow in pinnate clusters of seven to fifteen leaflet each.
Although mature leaves are toxic to dogs, rats, mice, and horses, howling monkeys eat them, but not indiscriminately. The howlers of the group we studied, for example, ate the mature leaves of only 3 of the 149 madera negra trees available to them, always returning to the same 3 trees. Members of another howler group, which occasionally visited part of the study area, also fed on the mature leaves of the same 3 madera negra trees.

Two of these trees grew next to each other on one side of the Río Corobici, while the third was more than 900 feet away on the opposite side of the river. Although the howlers moved through many of the other 146 madera negra trees scattered throughout their range, they did not feed on the mature leaves of any of these, although they passed through some of them when traveling among the 3 trees. This suggests that there was something different about these trees, something the monkeys could detect. Our laboratory tests revealed that the leaves of these 3 madera negra trees did not contain alkaloids, while the leaves of adjacent individuals of the same species contained fairly large amounts of alkaloids.

If this difference exists for alkaloids, it could also be true for other compounds. The leaves of one of the madera negra trees, for example, did not have cardiac glycosides while its neighbors had large amounts. Like the production of leaves, flowers, fruits, and nectar, the production of secondary compounds is a variable factor. Whatever the results of tests for these other substances show, the presence or absence of alkaloids appears to be critical to whether howlers in this area eat the mature leaves of madera negra trees.

It would seem advantageous then for the howlers to avoid all potentially toxic foods. The problem is that all

Howlers sometimes feed by hanging from their tails and back legs, although this behavior is rare in other New World monkey species. This adult female is eating leaves from a species of Ficus tree.
plants contain substances, known as secondary compounds, that vary in their toxicity. Some tree species in the study area contain more than ninety different secondary compounds. Even such common human foods as celery and spinach contain oxalic acid, 30 and 658 milligrams per 100 grams, respectively. The primary cause of animal deaths from oxalic acid poisoning is kidney failure, resulting from the precipitation of crystals in the kidney tubules. Oxalic acid and many other secondary compounds—tannins, glycosides, organic acids, saponins, essential oils, resins, sulfur oils, toxalbumins—pose a problem for any animal that ingests plant parts containing these compounds.

These secondary compounds protect the plants against insect damage and do not have to kill to be effective. They may serve as repellents by being unpalatable or toxic; they may affect viability of insect offspring or disturb normal reproductive cycles. They also interfere with nutrition by binding certain nutrients, effectively making them unavailable to predators. Tannins, for example, bind proteins. Obviously, not all plants contain the same substances nor is any particular substance effective against all predators.

Among these defensive substances are the irritating oils present in the poison ivy family; hemagglutinins in legumes, which act to disrupt red blood cell functions; peyote alkaloids in the cactus family; cardiac glycosides, which interfere with muscle contraction in the heart; cyanogenic glycosides, which on contact with water yield cyanide; and stimulants, such as caffeine (in coffee and tea) and nicotine (in tobacco).

Any organism that feeds extensively on plant parts must have some means of detoxifying the ubiquitous secondary compounds in order to survive. Detoxification mechanisms vary. One means is through the addition of a molecule of glucose to the toxin, which facilitates its excretion through the urine. This kind of detoxification, as well as other, similar methods, takes place mainly in the liver and kidneys. Another kind of detoxification occurs when bacteria in the intestines break down the chemical structure of the toxins.

As leaf eaters, howlers must acquire food in spite of the toxins present in that food. The role played by the tree's defensive secondary compounds in determining what resources are really available to the howlers must be seen as part of a dynamic relationship between the tree, as prey, and the animal, as predator. A food rich in nutrients is useless unless an animal can handle the toxin that may also be present in it. A dead monkey has little use for nutrients. Howlers certainly have a detoxification system, but they also counter the plant's defenses by preferentially selecting those parts of the tree with the lowest level of toxins. These are the ripe fruits, flowers, and new leaves. When these tree parts are not available or do not provide the proper nutrients for the howlers, they must ingest mature leaves—that part of a tree highest in alkaloids and secondary compounds.

However, the howlers rarely eat the mature leaves of most tree species or, if they do, they consume a limited amount. Instead, they prefer only the petioles (leafstalks). By doing so, they demonstrate their ability to choose plant parts with the least amount of alkaloids.

The selective feeding on particular parts of certain tree species accounts for the animals' dropping large numbers of leaves, a behavior thought by other observers to be wasteful feeding. On the contrary, the animals are selecting that part of the leaf with little or no toxin while disposing of the poisonous part.

The amount of secondary compounds in the leaves and the amount of toxins the detoxification system in the animal can process determine the total number of mature leaves ingested from any one tree species. Depending on these variables, the howlers control the consumption of any one toxin by feeding on a variety of tree species rather than by concentrating on one or two. This strategy may explain why howlers and other leaf-eating animals usually leave a tree before stripping it bare. By eating only small amounts of each kind of leaf, they give their systems time to detoxify the toxin contained in those leaves. Such diversification of food types reduces the amount of any one toxin but requires a broader-based detoxification system to handle the different secondary compounds. Howlers must thus balance the amount and type of toxins ingested with the kinds of foods that are available.

Animals are occasionally forced by seasonality, overpopulation, or habitat destruction—to feed on unfamiliar trees or to ingest more leaves from a particular tree than they normally would. Thus overburdened their detoxification systems fail and some animals die. The death of seven howlers from other groups, the female's fall, and the juveniles' convulsions were probably due to similar sets of circumstances.

Group members, particularly older individuals, may provide a reservoir of knowledge about the habitat. On an evolutionary scale, knowledge of safe foods and the location and timing of seasonal foods could select for sociable animals living in groups since single animals or even a male-female pair would not have enough information to survive as leaf eaters.

Another selection factor for group living may be the group's possession of a pool of sufficiently diverse frugivorous animals. Detoxification systems such that an sudden change in toxins or the destruction of large amounts of preferred food would not be disastrous for the entire population. The sampling of new trees by a single adult animal may be a behavioral expression of this hedge against catastrophe. While we observed all of the adult animals sample unfamiliar tree species, we never saw more than one animal at a time attempt this.

The presence of toxins in plant foods has meaning for human as well as nonhuman primates. Researchers have cited the use of fire for cooking as a major evolutionary step for early man. The heat of cooking destroys toxic substances. But how did early man cope with toxins before the us

This howler on Barro Colorado Island in Panama is in a typical eating posture. Researchers are not certain whether the large size of these animals is due to the island's dense vegetation...
of fire? Extrapolations from studies of extant primates indicate that man depended upon a wide variety of plant parts for food. He must have thus possessed a detoxification system, a system that we still retain, as witnessed by our ability to ingest such toxins as caffeine, chocolate, and hallucinogens. Because man now cooks much of his food, however, he may not rely on detoxification to the same extent as did his ancestors. Just as the destruction of toxins through cooking may have liberated our ancestors from limited food resources and reduced the selection pressure for a nonhuman primate type of social organization, the presence of toxins in some of the food resources of howlers may limit the population size and restrict their social organization to its present form.
Adult howlers are capable of a horizontal jump of 20 feet or a vertical fall of up to 60 feet. They usually aim for a specific branch before they leap and rarely miss. Young howlers, such as the one at left, remain in constant proximity to their mothers for six months and may nurse for up to a year. Variations in the duration of nursing may affect a group’s reproductive rate. During daytime rest periods, howlers frequently straddle branches, far left, remaining in the same position for up to an hour.
Masked Messages
by Ann Marie Cunningham

In ancient Korea, masked commoners satirized nobles in dance dramas, quiet forms of political protest

"In the autumn of 1962, the author witnessed what was perhaps one of the most vulgar scenes ever portrayed on a stage. In the first act, a young woman enters and, after some comic dancing...she suddenly pulls up her skirt, stoops down, and pretends to urinate. At that moment, a black-faced reprobate monk enters from the rear, a long rosary dangling from his neck and a wooden temple block in his hand. He spies the woman, and after she moves off, bends over the soil and pretends to sniff it, in an apparent bid to seduce her, which he eventually does. That such performances do not arouse the extreme ire of the Buddhist clergy is a never-ending source of amazement...."

By his own account, Alan C. Heyman, an American specialist in Korean music and dance, was taken aback by this scene, which he saw enacted in north Kyōngsang Province, in northwestern South Korea. The drama he watched is one part of a cycle of folk plays used by the common people of Korea to satirize their social betters and their own hard lot during that nation's feudal period, which ended less than one hundred years ago. Besides vulgar, punning dialogue and situations, this type of Korean drama also incorporates lewd pantomime; colorful, grotesque masks; brocade costumes, with long, snapping sleeves; and vigorous leaping dance steps, which further exaggerate the comic masks' features.

During March and April, a visiting troupe will present Korean masked dance drama for the first time in the United States. The performers, originally from Pongsan, a North Korean city, emigrated to Seoul in 1953, when the country was divided, and they are now sponsored by the South Korean government. Troupe members are for the most part students of traditional masked dance drama, and their performances are reconstructions of a folk custom no longer seen in the countryside. However, interest in this dance form—as part of their cultural heritage and as a contemporary form of protest—appears to be growing among Koreans. At demonstrations in Seoul, students have presented masked dance dramas, using anti-establishment innuendos to criticize the South Korean government.

In Pongsan and other regional variations of Korean masked dance drama, flutes, drums, and fiddles provide a rhythmic accompaniment and, like jazz, allow plenty of room for moving around a single theme. Steps, plots, dialogue, and jokes vary, but a vaudeville spirit and plenty of slapstick are constants. Stock characters, the victims of the play's satire, also remain unchanged: Buddhist monks who all too willingly renounce their ascetic way of life for rice wine, conubines, dance, and song; an aristocrat whose pretensions are no secret to his impish valet; a loose-living monk and a nouveau riche social climber who squabble over the favors of dancing girls. (In one version, this pair try to improve their virility by vying for a butcher's offer of bull's testicles.)

Halfway through the play, a lion (made up of two or more performers) threatens to bring the degenerate humans to a richly deserved end. But he is an Oriental cousin to Oz's Cowardly Lion: he is easily distracted, and his erstwhile victims continue to make fools of themselves. High- and low-born citizens alike tangle in the eternal triangle. A husband makes up for his lack of social prestige by being insufferable at home; a poverty-stricken wife henpecks her husband over the price of carp and eventually drives him away. In the Korean peasant's life, good humor is the only winner.

The actors' papier mâché masks—originally made of gourds, wood, bamboo, leather, cloth, or clay—furnish clues to the plays' cultural and historic origins. Their cartoonish features betray the characters' naturalness to the audience. Eyes pop and cross, foreheads wrinkle and ripple like sand, mouths twist, and teeth are bared in fury. Disfiguring lumps and bumps identify regulars like the Monk with Boils (being a reprobate he may have leprosy, thought to be a venereal disease) or the equally ugly, Pockmarked Monk, who may have been possessed by the dreaded smallpox god.

The masks indicate that the play have their roots in magic. Up to the sixth century A.D., ancient Korea consisted of close-knit country villages of 200 to 1,000 souls, who thought themselves surrounded by scores of benevolent or malicious gods. In such communities, the masked women—blessed all significant village events: spring plantings, August harvest, Buddha's birthday, weddings, and funerals. She also cure disease, communicated with the dead, cast out demons. She, and the villagers who participated in these rites, used masks to scare demons or to assume the form of an exorcise devil. The masks' colors represent the points of the compass: blue for east, red for south, black for north, yellow for west, and white for the center. Black, representing evil, came to be used for a monk's mask when white was appropriate for a young girl, and red, a powerful color (real tablets were placed in front of house to ward off plagues), stood for virility.

The masks' colors also signify the five guardian gods who watch over the heavens; the colors were believed to ward off evil spirits.

One traditional character of masked dance drama is the party-loving prodigal. His red mask and vigorous dancing symbolize drunken virility.

David Burns
over any site. To honor these guardians, the plays, when they were performed in villages, opened with a twilight procession through bamboo groves to music based on folk songs or on shamanistic or Buddhist invocations. A bonfire would be lighted, and in an open field adjacent to a sloping hillside, the play went on until dawn, when the masks and costumes were burned, being too sacred to use again except as offerings to the gods.

At an outdoor masked dance drama at Kiang Hye University in Seoul, a student dancer, left, performs in a contemporary mask. Below, a performer prepares backstage.

Acrobats and traveling players (kwangdae) took the shamans’ masked dances to the provincial market, where people from surrounding villages gathered every five days or so. Here, the village rites at first retained some religious significance. The market, compared in Korean folk tales to a battlefield, was a noisy place where people from all over the province, living under the protection of different spirits, crowded together in one spot. To calm their attendant gods, the kwangdae performed appropriate rituals before and after performances.

In the Korean market, a social as well as an economic event, masked dance drama became an entertainment, a spectacle. Male actors (in Asian drama, men frequently play all the parts) set up their small stage

David Burnett, Contact

45
among snake charmers and fire eaters, fortune tellers and medicine men hawking ginseng, boiled toad, and serpent. Marketeers seized only opportunities to drink with their kind. Reeling out of wine houses, they would come upon the play in progress. Masked dance drama, like tabehan theater, acquired a par- ticipating audience whose shouted retorts and comments became an integral part of the ribald action. Camaraderie between audience and players prevailed, in part, because both occupied the lowest rung of the social ladder. Confucianism arrived from China during the seventh century A.D., and as a secular religion, placed the king at the top of the heap and froze everyone below into a rigid caste system. Shamen, representatives of ignorant country people and their superstitions, sank to the lowest caste. Confucian scholarship was the only valid means of social advancement. Customers could not smoke in front of a shop, and butchers, as the very least, could not mingle with other human beings, much less the upper classes.

In 1392, the Yi dynasty—which flourished until Japan annexed Korea in 1910—came to power and adopted Confucianism as the state religion. The social pecking order became more rigid. Clothes made the man and his position; laws governed the width of sleeves and hat brims, the length, and style of shoes appropriate to each class.

Although it had no use for the peasantry, the Yi dynasty, which was ended by a music lover, did establish a governmental post to supervise the performance of masked dance dramas at court for visiting Chinese emissaries. Perhaps the government thought that it would be useful to institutionalize the commoners' moral protest, that allowing a pressure valve would forestall revolution. Masked dance drama drew a critical bead on the social polarities that eventually brought down the feudal state.

Pockmarked, boil-covered monks' masks revealed, like Dorian Gray's portrait, the unattractive side of monkish characters. For many Koreans, the term 'Buddhist monk'—a clergyman dedicated to vegetarianism, celibacy, and meditation—was synonymous with 'hypocrite'—a holy man who drinks in secret and keeps women on the side. As for the aristocrat, he is always a fall guy for his cheery servant and for the

outrageous butcher hawking bull intestines. He is portrayed as a bombastic peacock who holds his nose at the approach of a commoner, lovingly strokes his well-groomed beard, and shows off his scholarship by delivering quotes in Chinese. Like the monk, he is easily swayed by the dancing girls, who represent all the blandishments of the flesh. Female masked dance characters cannot seem to win: the entertainers are fair game for male passersby; the wife triumphs at the concubine's expense; the housewife, a virtuous woman in society's eyes, is her husband's drudge, and when she complains, he leaves her.

While the court's Chinese visitors were laughing at these caricatures, imperial gaiety was being underwritten by heavy taxation of the much despised and increasingly angry commoners. Unemployed farm workers organized an abortive rebellion in 1786, and royalty suspended its patronage of masked dance drama as too volatile an expression of popular ire.

By the eighteenth century, however, merchants were prospering in busy market towns like Pongsan, on the main trade route to China through the Korean province of Hwanghae. A region with particularly strong class divisions, home to aristocratic literati who had not left for Seoul when the Yi dynasty moved the capital south from Sando, Hwanghae probably provided broad targets for masked dance dramatic tradition. Traders, manufacturers, and provincial officials with money to spare became patrons of the plays; the silk trade provided handsome costumes; and Chinese diplomats passing through on route to Seoul had to be entertained. The sponsors often wrote plots, putting in snippets of Chinese poetry, perhaps to impress their visitors or to show off their own scholarship.

Having traveled from the villages to market to court, and back to the marketplace, masked dance drama flourished in the provinces until Japan's takeover in 1910. Initially suppressed, the plays continued as the Japanese came to appreciate them. When the Pongsan troupe moved south to Seoul in 1953, masked dance drama once again acquired official sponsorship.

In North Korea, the government has for some years been encouraging language "purification"—purging native Korean of Chinese and Japanese forms. Masked dance drama, especially if, like the Pongsan variety, it is presented in North Korean dialect, may also be part of a cultural revival in the north.

Since the traditional society it criticized no longer exists, the Pongsan masked dance drama is a historical artifact, rather than a court entertainment with overtones of social protest. In contemporary South Korea, it cannot be too vociferous a voice of political disidence, but it does consistently manage to undercut government censorship, which expurgates all sexual references from media. Recent visitors to Seoul joke that entertainment there is like an American soap opera: everything has to do with sex, but nothing is explicit. Consequently, the country vulgarity of the masked dance drama, even as a historical artifact, is a rebellious protest against the ruling class's definition of virtue.
Although the Viking experiments have contradictory elements, they seem to indicate that life, or some process that closely imitates life, exists on Mars today.

It was late in a midsummer afternoon on the Plain of Chryse. The sun was low in the bright orange sky of Mars. The heat of the summer day had warmed the air to -40°F, and a gusty breeze of ten knots stirred the dust. The eyes of a giant, insectlike automaton rotated slowly from side to side, surveying the desert scene. A long proboscis uncurled and reached out to scoop up a sample of the orange-red soil, then drew back within the metallic body. The search for life on Mars had begun.

The automaton had been carried to Mars by the Viking spacecraft in 1976 and set down at a carefully selected site on the surface of the planet, chosen for its proximity to past or present sources of water. The automaton, known as the Vikinglander, contained instruments that could sense the presence of life in several ways. Its wide-set TV eyes offered stereoscopic color vision to search out the fossilized remains of once-living plants or animals or to scan the horizon for signs of movement. After the sample of Martian soil had been ingested, instruments inside the Vikinglander could test it for microbes and other simple forms of life.

But to what purpose? Why should it matter whether microbes exist on Mars? The answer has to do with man's place in the cosmos. Many scientists see life as a natural outcome of the laws of physics and chemistry; they regard the earth as an undistinguished planet circling an ordinary star; and they are confident that wherever similar solar systems exist—and there are billions in the universe—life will emerge. According to the latest findings in astronomy, our solar system is roughly five billion years old, but the universe is twenty billion years old. It follows that man is one of the younger denizens of the universe and, perhaps, far from the exalted state of other, older forms of life.

However, this conclusion depends entirely on the assumption—really no more than a wishful thought—that life is common throughout the cosmos. Yet the contrary may be true; the creation of life out of inanimate matter may require the simultaneous occurrence of so many specific circumstances that it has only happened once.

How can we determine whether that is so? The discovery of life on Mars would settle the question. If life has arisen independently on tens of planets in a single solar system, must be a fairly probable event. Billions of inhabited solar systems must surround us in the galaxy, swarming with assorted organisms.

Why Mars? The reason is that Mars offers more earthlike conditions than any other planet in this solar system. It is true that water—the quintessential ingredient of life—is in very short supply there, but evidence has come to light that this precious su
once was once present in great abundance on the planet. Numerous closeup photographs of Mars show channels that look like arroyos or riverbeds carved by flash floods that occurred millions of years ago. It is difficult to imagine a process other than the flow of enormous volumes of water that could have produced those channels.

Furthermore, the north and south polar caps of Mars are covered by thick layers of ice that show signs of having been partly melted and refrozen several times. Not only has Mars been wet; it has also been warm in the past. No developments more encouraging for predictions of Martian life could be imagined. If life could have gained a toehold on Mars during those periods of warmth and moisture, it might have adapted by slow degrees to the harsh conditions that befell the planet later on. Of course, this life would be simple and perhaps no higher than the level of a microbe. There is no chance of finding intelligent Martians because all evolutionary progress on Mars was surely slowed down many hundreds of millions of years ago, when the planet’s water supply diminished and the temperature dropped. However, the tests for life by the Viking lander were designed with these circumstances in mind. They should work if any kind of living organism exists on Mars, no matter how primitive.

The first test is based on the reasoning that all organisms known on the earth give off gases as waste products. For example, plants release oxygen as a waste product, and animals and most kinds of microbes release carbon dioxide. If the Martian soil contains organisms resembling plants, a pinch of soil placed in a chamber will produce a small amount of oxygen. If the soil contains microbes or animals, carbon dioxide will be produced. An instrument adjacent to the chamber can detect these gases.

When the test for gases was carried out in 1976, carbon dioxide was released from the soil, indicating that small animals or microbes might be living in it. At the same time, a substantial amount of oxygen appeared, suggesting that the soil might contain plant life. The carbon dioxide was released slowly and steadily over a period of several days, as would be expected from a population of microbes in the soil. The oxygen, however, came off in a burst in the first few hours of the experiment. This was a surprise, because if plants were producing the oxygen, it would be released at a slow, steady rate, like the carbon dioxide.

The rapid release of oxygen was more consistent with a chemical reaction in the soil, rather than a biological process. One theory proposed that the chemical reaction might involve

Early morning on the Plain of Chryse. The landscape is reminiscent of some desert areas of the Southwest, with sand dunes and other windblown formations and scattered blocks of volcanic debris. The large rock at the left is about three feet high and lies twenty-five feet from the Viking lander.
a compound called peroxide. According to this theory, solar ultraviolet radiation falling on the Martian surface would produce molecules of hydrogen peroxide, which could adhere to the grains of rock in the soil. If the grains of rock were then moistened, the hydrogen peroxide molecules would break up very rapidly into water and oxygen. Other chemical theories propose that the soil contains peroxides of calcium or metallic elements instead of hydrogen peroxides, but the end result is the same: if any peroxide is present, moistening of the soil releases a burst of oxygen.

Since the initial step in the Viking experiment was the exposure of the soil to moisture, the release of a burst of oxygen could readily be explained by the chemical reaction just described, without recourse to life processes.

The second life test was designed primarily for microbes. In this test, another pinch of soil was placed in a chamber and moistened with a nutrient broth containing amino acids and other food substances. These substances, like all foods, were made from atoms of carbon, oxygen, nitrogen, and other chemical elements. If microbes existed in the soil, they would consume the food and digest it. Most of the atoms in the food would be incorporated into the bodies of the microbes as they grew and reproduced, but some carbon atoms would be released to the atmosphere in the form of molecules of carbon dioxide. All animals and most microbes exhale carbon dioxide in this way as a by-product of their metabolism.

How could scientists on the earth find out whether that complicated process was taking place in a chamber on Mars, more than 200 million miles away? The solution is ingenious. Before the flight to Mars, a special kind of food had been prepared, in which some of the carbon atoms were radioactive isotope of carbon, C\(^{14}\). Martian microbes were present, they would digest the C\(^{14}\) atoms and excrete radioactive carbon dioxide. Find out if this was happening, a detector sensitive to radioactivity was placed in an adjoining chamber, located above the first one and separated from it by a thin tube. If the detector signaled the arrival of radioactive carbon dioxide, that would suggest that Martian microbes exist in the chamber below.

When the test was carried out, the detector indicated that a large amount of radioactive carbon dioxide had been produced in the pinch of soil below and had passed through the tube into the upper chamber. Thus this test indicated the presence of Martian life.

But the test for microbes, like the first test, could also be explained by a chemical reaction that did not involve living organisms. Suppose the Martian soil contained hydrogen peroxide or some similar compound, seemed to be indicated by the release of a burst of oxygen in the previous experiment. When the soil was moistened by the nutrient broth, the peroxide compounds would decompose into particles of food in the broth, breaking them up into smaller molecules including molecules of carbon dioxide. The carbon dioxide would be released to the atmosphere. Some of this carbon dioxide would be radioactive. In that way, a purely chemical reaction could simulate the presence of microbes in the soil.

The third test for life was designed to detect the presence of plantlike organisms on Mars. Plants require air, water, and light for their growth. They grow particularly well in an atmosphere of carbon dioxide, which happens to constitute 95 percent of the Martian atmosphere. In the experiment, an artificial Martian atmosphere of carbon dioxide and water vapor was created in a closed chamber, while a lamp bathed the interior of the chamber in unfiltered Martian sunlight. Presumably, a Martian plant would find these conditions favorable for growth. Next, a fresh pinch of soil was placed in the chamber. If plant existed in the soil, they would also

A Martian channel approximately 200 miles long, with tributaries feeding into the main "stream" and a characteristic pattern of meanders in one section, is evidence that water in abundance may once have flowed on Mars.
carbon dioxide and water from the atmosphere; then, using the energy in the artificial sunlight, they would break up these substances and combine them into the compounds known as carbohydrates, giving off oxygen as a by-product. This complicated process is called photosynthesis. Some microbes also depend on photosynthesis for energy and growth. If photosynthetic microbes existed on Mars, the test would detect them too.}

The essential element in photosynthesis is the buildup of carbohydrates out of carbon dioxide and water. Following the same strategy used in the microbe test, the experimenters decided to find out whether this was happening by using specially prepared carbon dioxide in which the carbon atoms were radioactive. Martian plants in the chamber would absorb the radioactive carbon atoms and build them into their bodies in the form of radioactive carbohydrates. If a test indicated that something in the soil had become radioactive, that would suggest that the soil contained living plants.

This test, like the other two, gave a positive result; after an incubation period of several days, the soil was found to be strongly radioactive. The implication was that it contained plants or plantlike organisms. That interpretation was supported by the fact that when the test was repeated with the artificial Martian sunlight turned off, the radioactivity dropped considerably. Apparently Martian plants, like terrestrial plants, grow more rapidly in the light.

While the first two tests can be explained by a simple chemical reaction involving peroxides, the third test cannot be readily explained in this way. Chemical theories that could explain it have been suggested, but they involve different chemical compounds and complicated reactions that have not been tested in the laboratory. Thus, a chemical explanation for this test is not as acceptable as it was for the other tests. Moreover, the chemical reactions proposed for the photosynthesis test would not be appreciably affected by the presence or absence of light; that property would be more characteristic of a plantlike biological process. These circumstances make the photosynthesis test a relatively strong item of evidence for Martian life.

Additional information came from still another experiment in which the soil was tested for organic molecules such as amino acids. Every living organism on the earth, whether plant, animal, or microbe, is made up of various combinations of these two dozen or so basic molecules. If life exists on Mars and is chemically sim-

This photograph of a 100-mile section of the north polar cup of Mars was taken on October 14, 1976, during the Martian northern hemisphere summer. A thin cover of frozen carbon dioxide, or dry ice, has evaporated, exposing underlying cakes of ordinary ice. The terraced slopes are believed to be evidence of cycles of climatic change that alternated from warm to cold perhaps every few hundred thousand years. These layers have led to a new picture of Mars as a planet currently in the grip of an ice age, but with past episodes of warmth and moisture during which conditions may have been congenial for the evolution of life.
ilar to earth life, the same familiar molecules should be present in abundance in the Martian soil. Yet the chemical experiment failed to reveal any. This result would seem to prove that life does not exist on Mars.

The photosynthesis experiment and the organic molecule test tend to cancel out one another, leaving the question of Martian life as uncertain as it was before the Viking lander touched down. But when all the tests for life were repeated by a second automaton, which had landed at another site 4,000 miles away, evidence against the chemical explanation was obtained and the case for biological processes was strengthened. The test for release of gases was performed again at the second site, but this time only a tenth as much oxygen was released as on the previous occasion. Since the burst of oxygen was believed to be due to peroxides, it appeared that the soil in the second landing site must contain a much smaller amount of peroxide compounds than the soil at the first site.

That discovery had a bearing on the interpretation of the microbe test. If the positive results from that test had also been triggered by peroxide compounds in the soil, one would expect the yield of "microbes" to go down when the amount of peroxides went down. But instead, when the microbe test was performed at the second site it yielded 30 percent more radioactive carbon dioxide than it had at the first site.

This result seems to indicate that chemical reactions involving peroxide compounds cannot be the source of the lifelike signals obtained in the

The extendable arm of the Viking lander pushes aside a rock to get at the underlying soil, which has been protected from the destructive effects of solar ultraviolet radiation. At far right, the arm has scooped up the soil and deposited it in the lander for biological and chemical tests. The results of these tests tended to confirm the existence of Martian microorganisms.
microbe test. With the chemical theory for that test eliminated, a biological process is the most straightforward explanation remaining.

Confirmation of the existence of Martian life would tell us that the evolution of life is a fairly easy process, one that has probably occurred in a multitude of solar systems in the cosmos. Man's views on his uniqueness would be influenced by that disclosure. With these large issues at stake, the Viking scientists exercised extreme caution in the interpretation of the results and carried out additional tests in an effort to discriminate between the chemical and the biological explanations for the findings. In one experiment, a rock near the second landing site was pushed aside by the boom and shovel attached to the lander and a sample of soil was collected from the region under the rock. This sample, when tested for release of gases, yielded much less oxygen than had been obtained from the surface soil sample. However, the microbe test yielded nearly as much radioactive carbon dioxide as had been obtained from the surface samples. This result confirmed the previous indication that the results of the microbe test were in fact due to microorganisms, rather than chemical reactions triggered by peroxide compounds.

In still another check, the Martian soil was heated to a temperature of 120°F, and the microbe test was repeated. Some radioactive carbon dioxide was produced although substantially less than in the test with unheated soil. This result would be expected if the soil contained a population of microbes, since their growth would be inhibited by the high temperature. However, this relatively moderate change in temperature would not be expected to have a serious effect on chemical reactions in the soil. Again the tests seemed to work against the chemical interpretation and in favor of the biological one.

An unambiguous resolution of the question of Martian life may not be obtained for decades. Nevertheless, although the Viking experiments have contradictory elements, they seem to indicate that life, or some process closely imitating life, exists on Mars today.
Despite miserable weather, Soviet patrols, and changeable American policy, the Eskimo of Little Diomede Island have remained aloof, hearty, and the best walrus hunters around.

In early summer, children at the Eskimo village of Iginaluk on Little Diomede Island grub with hope, enthusiasm, and old spoons in the mud carried down toward the beach by the spring melt. From time to time a happy yell announces a find. It is washed in the nearby sea and avidly examined. Usually it is just a bit of bone or ivory, a broken harpoon, an ancient lance. Metal pieces are usually rusted beyond recognition. A tiny brass bell has survived in better condition. Chunks of fossil ivory are handed to fathers who will carve them into bracelets, letter openers, pickle forks, and pendants. Tiny beads, usually bright blue, some of glass, some of stone—perhaps lapis lazuli—are eagerly collected.

The bell and beads came from Europe, via Siberia, centuries ago. Otto von Kotzebue, the Russian explorer, visiting these shores in 1816, was “struck . . . very much” by the great amount of glass beads and other goods from Siberia owned by the Eskimo. Now the children gather them carefully. Their mothers restocking the beads. Collectors pay high prices for them.

Set in the chill and lead gray Bering Strait midway between Alaska and Siberia, usually wrapped in dismal fog and haunted by northerly storms, Little Diomede seems singularly unattractive. (During my first two months there, in spring, we had four sunny and five nearly windless days. Summer was a bit better; fall and winter, worse.) Its village sits atop a giant, frozen midden, the debris of two millennia of people who lived on this lonely rock and set forth in their skin boats, as they still do, to intercept the vast throngs of marine mammals migrating through Bering Strait each spring and fall.

Little Diomede is about 2½ miles long, ½ miles wide, and rises steeply on all sides to its 1,309-foot summit. It is an ancient crag of granite mixed with masses of limestone that, weathered and worn, has shattered into boulders and rocks, covering many slopes—the breeding places of hundreds of thousands of seabirds. Sheer cliffs rim much of the island. Only at its northwest corner is the slope gentler, grading down to a narrow strip of boulder beach. That is where the village has been tacked against the mountainside, facing its sister island, Big Diomede (or Ostrov Ratmanova, its Russian name), three miles west and about three times bigger. Occasionally a Soviet helicopter rises from Big Diomede and flies east. After 1½ miles it halts abruptly, as if it had hit a glass wall, flies north or south along this line and returns.

That borderline, precisely in the middle between the islands, divides two worlds: Asia and America, the United States and the Soviet Union, communism and capitalism. Russia’s farthest east and America’s far west. It even separates today and tomorrow, for here the border coincides with the international date line. When we passed this line on our hunting trips, we moved from one day to the next and back again on the way home.

What is now a border and a barrier was once a bridge, the Bering Land Bridge, or Beringia, a vast, vanished land. During the ice ages of the Pleistocene, immense mile-thick ice sheets covered about six million square miles of North America and large parts of Eurasia; eight million cubic miles of water were locked within this monstrous mass of ice. The level of the world’s oceans was nearly 400 feet lower than it is now and a 1,000-mile-wide land corridor connected Asia and America. Across it from Asia came many of today’s North American mammals. Traveling in the other direction were the ancestors of the Eurasian mammals. Traveling in the other direction were the ancestors of the Eurasian mammals.

Among the last to cross the great tundra plains of Beringia, perhaps past the craggy mountains whose top today stick out of the sea as the Diomede Islands, was man, the ancestors of the Indians and Eskimo.

At the end of the last Ice Age, the ice sheets melted, releasing the store of water and, like an Arctic Atlantis, Beringia disappeared beneath the rising sea.

Then it became Bering Strait with the two Diomede Islands in the middle, handy stepping stones for any latecomers, who may have come in boats or could have crossed on winter ice. Bering Strait rarely freezes over completely. The area between the

A woman cuts up walrus meat which is dried on racks for later consumption. Government subsidized houses of recent vintage (background) have replaced most of the traditional shelter on Little Diomede Island.
two islands is always frozen in winter, but it is rare that both the 27-mile-wide Siberian channel and the 24-mile-wide Alaskan channel are bridged by ice floes jammed together. Yet in some years one or the other may be. Old people living on Little Diomede have made the chancy trip across the ice (one recalled that his father had done it carrying a keg of liquor), both to Siberia and Alaska.

The current, rushing north through Bering Strait, carries mineral-rich waters into the shallow Chukchi Sea, the basis for an exceedingly rich planktonic and benthic flora and fauna. It is this great food wealth that each year attracts the immense migrations of sea mammals: bowhead whales, gray whales, walruses, harbor seals, bearded seals, ringed seals, and ribbon seals are common in the strait; white whales, finbacks, and humpback whales pass it occasionally. Coming from the great expanse of Bering Sea, all must funnel through the 57-mile-wide strait, making it, in spring and fall at least, one of the richest and most varied sea-mammal areas on earth, and a sort of Eden for sea-mammal hunters possessing both the equipment and the courage to pursue such large prey in a foggy, stormy, ice-jammed sea.

As the men in the middle, the Diomeders were ideally placed to exploit this marine wealth. They were always famous for their skill and daring. Even today they have no equal as walrus hunters and enjoy a slightly ambiguous reputation as “Vikings of the Arctic Sea,” which they rather cherish. One day, two boat crews were in the Alaska mainland village of Wales and saw a film about Genghis Khan and the Golden Horde. Back on Little Diomede, they were asked by a visiting biologist how they liked the film. One man grinned and said, “Nothing special. Just a bunch of Diomeders on horseback!”

The Diomeders were also ideally placed to be middlemen in the once flourishing, and probably very ancient, trade between Siberia and Alaska. For people having the superlative seaworthy, large skin boats known as umiaks (a 40-foot umiak can carry more than forty people or five tons of cargo), the trip across the strait was easy. On a rare fine day, one can clearly see the Diomede Islands and Siberia’s East Cape (Mys Dezhneva) from Alaska’s Cape Prince of Wales, and Alaska, of course, is equally visible from the other side. Given a favorable wind, the strait could be crossed with paddles and sail in about a day. In the nineteenth century, Siberian Eskimo and Chukchi occasionally made the 200-mile trip from East Cape to Saint Michael and, quite regularly, the somewhat shorter journey to the “trade fair” in Kotzebue. When early-nineteenth-century explorers visited Alaskan Eskimo villages, they found the people well supplied with Asian trade goods.

One hindrance to even more extensive trade was probably that the Asian and Alaskan natives did not exactly look kindly upon each other. Edward W. Nelson, of the Smithsonian Institution, traveling in this region between 1877 and 1881, wrote that “in ancient times the people of Bering Strait were constantly at war with one another, the people of the Diomedes being leaguered with the Eskimos of the Siberian shore against the combined forces” of Eskimos along the American side of Bering Strait. Occasionally, alliances changed, and Little Diomede fought on the American side, against their erstwhile allies on Big Diomede and Siberia. In 1926, when Canadian anthropologist Diamond Jenness du at Little Diomede, one of the most common artifacts he came upon (still found now) were rectangular Ivory plates, once part of the warfaring Eskimo’s imbricated body armor.

Under Russian rule of Alaska (no too popular; to this day Diomeders call a disliked white a "gussuk,"
sailed blithely to Siberia whenever they felt like it, usually once a year. The Siberians then were short of trade goods but had an abundance of furs and ivory. Little Diomeders took over the needed items and returned with such valuables as white fox pelts worth (in 1927) $42 in Alaska and blue fox furs worth about $150. It was a pleasant, prosperous time.

This happy if somewhat anachronistic state of affairs came to an abrupt end in 1948 when the cold war reached the Diomede Islands. The Iron Curtain clanked down and two boats from Little Diomede were caught on the wrong side of it.

That summer eighteen Little Diomedes in a happy holiday spirit sailed to visit their neighbors on Big Diomede Island, only to be arrested on arrival. They were confined for fifty-two days, interrogated at length, and fed black bread and watery cabbage soup: a drastic change from their usually copious fat/meat diet. They were released only after repeated protests by Washington and returned home famished and furious; they have never really forgiven the Russians and they certainly haven’t forgotten the incident. Several men joined the National Guard, prompted at least as much by pique and patriotism, as by the desire for extra income.

For nearly a quarter century the separation was total. Officially for health reasons (there had been a “flu” epidemic), but more probably to remove any temptation for clandestine meetings, Soviet authorities resettled the Eskimo of Big Diomede on the Siberian mainland coast in 1954.

Lately, however, détente has reached the Diomedes. A few years ago, Little Diomede walrus hunters in their skin boats met, near the border in Bering Strait, Siberian Eskimo hunters in similar boats and exchanged gifts, hunting information, and news of long-separated relatives and friends. Now when Diomede boats are pushed by ice, winds, and currents into Russian waters, they are checked out by Soviet helicopters, whose pilots take a good look and fly off with a friendly wave.

While I lived on Little Diomede, we were startled one spring day to see two dark dots, barely visible through the grayish veil of wind-driven snow, coming toward us across the ice from the west. Half the village piled pell-mell onto snowmobiles and raced out to meet the visitors. (The first snowmobile came to Little Diomede in 1972. Since then so many have been bought that they have replaced all dog teams.) They were Victor and Volodia, two blithe spirits in voluminous parkas and beautifully made sealskin pants, sent from a Siberian sovkhoz (state farm) to trap arctic foxes and hunt fresh meat, on a contract basis, for the Russian border guards stationed on Big Diomede.

The visitors spoke Yuit, the dialect of nearly all of Siberia’s roughly 1,500 Eskimo, which is so different from the dialect spoken on Little Diomede that they could barely communicate with their hosts. They resolved the problem by speaking Russian and English, using me as interpreter. What, I wondered, did the border guards have to say about their excursion to meet the Diomedes? “Oh
trouble do they expect? These are our people. They are Eskimo, just like us.” That was the dominant theme of this and frequent subsequent meetings. Whatever else divided them, they were all Eskimo, united by kinship, culture, and tradition.

At the turn of the century, when great gold deposits were discovered in the sand of Seward Peninsula beaches and Nome grew into a boomtown, Diomeders and Eskimo from King Island (40 miles south of the Diomedes) came to Nome each summer to sell ivory carvings and buy provisions. The King Islanders were eventually persuaded by the government to abandon their hard-to-service island and to settle permanently in Nome. Similar pressure was exerted on the Diomeders in the 1950s and 1960s but most refused to budge from their lonely rock. Nevertheless, a few did leave, and for a while the population decreased, from 103 in 1950 to 90 in 1960 and 84 in 1970. Since then the trend has been reversed, and in 1975 the Diomeders numbered 119. Government policy changed a new, subsidized houses were built to replace the ancient Diomede dwellings—shelters dug partially into the mountainside: the inner shell made of driftwood logs enclosed with stone walls; the roof of logs and sod (in remoter times, of walrus skin), with a skylight of scraped, translucent walrus intestine. The village received a new store and, in 1976, a new $1.5-million school. All this construction not only provided employment, luring back some of the Diomeders who had left the island, but also an added boon, abundant fossil ivory dug up as land was leveled for house sites.

“‘Ivory,’” say the islanders, “‘is our gold.’ It is the basis of Diomede economy and, to some extent, is also the island’s currency. In lieu of cash, the store accepts both ivory and carvings from villagers who come to buy food, ammunition, gas, or oil. Phone calls can be paid for in cash or ivory. And on bingo nights, an expensive island passion, most cards are purchased with carvings.

Most men and several women are excellent carvers. Seated on the floor (many also prefer to eat on the floor, in the traditional fashion, with a sheet of plywood as a table), they work with speed and extraordinary assurance, turning out small walrus effigies and pendants. Many make beautiful bracelets of small ivory squares, using the ancient bow drill of bone or ivory and thong to drill twin holes through the thin (5 mm) plates. In the 1880s, Nelson had admired the Dio-

Walrus tusks are chopped out of the skulls and cleaned. Ivory is the “gold” around which the islanders’ economy revolves. Many purchases are made with ivory instead of conventional money.
Walruses are cut up on the ice floes and loaded into umiaks. These boats, laboriously constructed of steam-bent hardwood frames covered with inch-thick split walrus hide, are virtually unsinkable.
A little Diomede girl flanked two veteran walrus hunters. All visitors to the island areick by the general good
th, strength, and vigor of the inhabitants.

The islanders' skill: "Many of their carvings are really artistic, and the skill of which the animal forms are carved
relief is admirable." These old whalers were often etched, the fine lines smeared with a mixture of gun-
der and blood, leaving a dark and ominous stain. Today, Diomeder India ink. The most skilled can
make carvings worth $100 to $1,500. To a good Diomede hunter, a pair of medium-sized walrus
in this form represents a value of $1,200 to $1,500.

Late fall and winter are quiet times at Little Diomede. New ice, dark and
sharp, and vast, jagged ice
drilled from the ice travel impossible. The island is
totally isolated; only in a grave
ergency would an evacuation by
copter be attempted. Only from
March to April is the ice near the
tip firm enough for planes to land.
The islanders have food in plenty,
store, at this time, is usually well
visioned and the families' meat
—spacious, stone-lined
caves, some of great age, dug deep into
frozen mountainside—are
stocked with an abundance of food
in sea and land.

The Diomedes' diet is varied,
luxurious, and largely traditional. Their meat and fat, of which they have a virtually unlimited supply,
are eaten as meals; if a Diomeder has to go
mainland hospital, he is liable to a big jug of seal oil along because
without it, he says food just doesn't
taste right. It is also their main pres-
servative. Bird eggs (mainly murre),
collected by the thousands in early
summer, are stored, raw or boiled, in
oil and can thus be kept for about a year. Birds are preserved in meat
holes or are boiled and stored in oil.
Blubber is allowed to age until saffron yellow, then marinated in seal oil
and eaten as a zesty condiment with the bland boiled meat or with kauk
(balanced walrus skin), which is best
after it has aged in a meat hole for
about a year. A dubious-looking delicacy is 'sour liver,' raw walrus liver
kept in a large wooden dish near a
stove for a few weeks until it turns into a brownish liquid. It has a pi-
quant, somewhat vinegary taste; one
uses it as a sauce to enhance the boiled meat that usually forms the
main course.

The Diomedes collect and eat a
great variety of greens, stems, roots,
seaweed, and berries. In the past, they
obtained much of their vegetable
food on Big Diomede, where it is
more abundant than on their own
small island, and they are annoyed
that they can no longer visit there. With small mattocks they dig up the
corner of spring beauty, which look
like tiny potatoes. These are boiled
and eaten with meat or mashed with
seal oil (or occasionally, reindeer fat
bought on the mainland) into a pleas-
ant, if somewhat bland, paste. After
the frequent storms, women and chil-
dren collect the thin, narrow, iodine-
rich fronds of seaweed washed up on
the beach, dry them, and eat them raw
(they have a nice, salty flavor) or mix
them with soups and stews. Willow
shoots and young leaves, ten times
ricer in vitamin C than oranges, are
collected in early summer and eaten
either fresh or, like other greens, pre-
served in seal oil for future use.

Salads are made from the radish-
flavored leaves of Kamchatka rock
wheat, the sourish leaves of mountain
sorrel, and the leaves of Parry's wall-
flower, which grow in tight, bright
green rosettes on the mountainsides
and contain considerable quantities of
vitamin C and provitamin A. In fall,
great quantities of cloudberries are
gathered on the moist, plateau-like is-
land top; when kept frozen in pokes
(plastic bags are now used) in the
meat holes, they retain their high vi-
tamin C content for up to one year.

Diomeders tend to be finicky about
their food and have a host of rules and
recipes on how to prepare, serve, and
preserve it; as a result, meals are usu-
ally varied, copious, interesting, and
probably very nutritious and health-
ful. Most visitors have remarked on the
Diomeders exceptionally strong
and vigorous appearance. "The na-
tives . . . look sturdy," noted anthro-
pologist Ales Hrdlicka in 1926.
"None other could survive here."

Their survival and success, now as
in the past, depends on their hunting
skill and daring, and on their superla-
tive skin boats. They have seven
umiaks, four 30-foot ones, used for
walrus hunting and long journeys,
and three 18-foot ones, used pri-
marily in early spring to hunt bearded
and ringed seals among the drifting
floe near the island. Two frames
(now of steam-bent hardwood, for-
merly of driftwood) were built in
1974 (it takes a man about three
weeks to construct a frame); the
others are old, one is more than thirty
years old but still strong. They are
covered with split walrus hide. The
two-inch-thick hides of female walruses or young bulls are cut into
two-inch-thick halves, a slow and ex-
acting job left to the women. Several
hides (five for a big umiak, three for
a small one) are sewn together, streched over the frame, and lashed
onto it with walrus thong, which an-
thropologist Froelich Rainey has
called "the strongest line known be-
fore the invention of the steel cable."
A yard-wide waistcoat of canvas
(formerly sealskin) is furled against
the gunwale in calm seas, and raised
on paddles and poles around the boat
as a spray guard in a storm. The keel
is shod with the smooth, fine-grained
e bone of a whale's jaw to glide easily
across the ice. (The newest boats use
split vinyl hose for this purpose.)

Until fairly recently, the Dio-
meders paddled their umiaks and, in
addition, used a simple square sail of
seal or caribou skin, with grommets
and blocks carved of ivory. In storms,
inflated sealskins were lashed to an
umiak's side as spars. "With
their boats fitted in this manner these
people sail fearlessly along their
crarmy coasts," Nelson noted in the
1870s. They still do, only now they
usually use 40 h.p. outboard motors,
with a spare 25 h.p. motor in the boat in case of trouble. In these boats the daring Diomeders, regarded by the meeker mainland Eskimo with respect bordering on awe, will set out in nearly any weather, in storm and fog and racing ice. They claim the umiaks are virtually unsinkable, and considering the risks they routinely take, this must be true because they have never lost a boat. The frame is strong but flexible, the cover extremely tough. Occasionally, an enraged walrus rips a cover, but the men, prepared for this eventuality, plug the hole with chunks of blubber, continue the hunt, and when time permits, haul the umiak onto a floe and patch it with pieces of hide.

They carry mariners’ compasses, but fog, strong currents, and the zigzag course of hunting often make it difficult to find Little Diomede again, since the island is such a small target. They fire shots, hoping for a shore echo, study the flight of birds, and watch the drift of ice. If none of this provides a clue to their whereabouts, they turn the motor off to conserve gas, and drift, sleeping, huddled up on the thwarts, in the damp chill that seems to seep to one’s very core, hoping the fog will lift. As a last resort, they head east, for as they say, “You can’t miss the mainland.”

Spring starts quietly. The men carve or hunt seals at the floe edge, the limit of landfast ice, usually not more than a mile or two from the village. Women and children spend patient hours “crabbing” at holes chiseled through the ice, catching crabs that measure, including spindly legs, about two feet in diameter (northern cousins of the famous king crabs). The method is simple. A stone sinker and two chunks of fish as bait are lowered on a thin line to the sea bottom. A feeding crab, loath to lose food, hangs on as it is pulled gently upward. Only when it is nearly at the surface does the crab seem nervous and loosen its grip, but by then it is usually too late. The most patient crabbers, using several lines, can catch twenty or thirty crabs in a day. Others jig for tomcod and sculpins through leads in the ice. Both are popular for fish soup.

In May, the migrant animals arrive and pass, by sea and air. Some 20,000 sandhill cranes and a quarter million snow geese, which have wintered in the United States, fly across Bering Strait to their breeding grounds in Siberia, and the luminous Arctic night is filled with their loud and urgent calls. From Asia, flocks of small birds come to breed in Alaska: wagtails, arctic warblers, and wheatears. Once, while we were lost in fog and drifting north into the Chukchi Sea, an exhausted wheatear, as lost as we, landed on our boat. Everyone took care not to alarm the little passenger, and he remained with us until we came within sight of the mainland.

In May, too, the seabirds arrive to nest on Little Diomede: hundreds of thousands of sparrow-sized least auklets, tens of thousands of crested auklets, pelagic cormorants, murretaufted puffins, and pigeon guillemots. In the evening and at night, when the wind whirled around the island, their myriads of excited calls blend, filling the air with a strange, persistent, pulsating noise.

The arrival of the birds marks, for practical purposes, the end of Diomede school year. The children are on the mountain all night, sleep blissfully in school. Using slingshots with elastic bands, they may catch many birds, a few windows, and occasionally, each other. For a while the village has its share of walk-wounded. An island law forbids, with good reason, the use of the anci-

thong slings within a mile of the...
Except when used by an expert, hauling slings tend to be erratic and can be deadly.

The men haul the small umiaks over the ice to the floe edge near the east end of the island and hunt sedated seals and ringed seals among drifting, swirling, grinding floes in the pack. When nipped by ice, they roll the umiak onto a floe and ride it, until the pressure eases and they can find a way through the floes. Males pass, but they are rarely pursued. By tradition and inclination Diomeders are primarily walrus hunters. Walrus are numerous now. Once relied on by commercial walrus hunting, they are now a population of 40,000 or less. The animals have increased again in recent decades to about 150,000.

When the walruses arrive, the Diomeders switch to their large umiaks and the big hunt of the year is on. June, on Diomede, is called "the month when people do not sleep."

The four walrus-hunting boats, each with a crew of from eight to twelve men (ranging in age from 16 to well over 60), vie with each other to be best. Often they return just long enough to unload a cargo of meat, hides, and ivory, pick up more gas, and head out again. The hunt is expensive. In gas alone, it costs $30 to $40 each day (this, as well as most of the food, is supplied by the boat captain, but his share of ivory is increased to make up at least a part of this cost), and the crew may spend $20 a day each on ammunition. The boat captain usually consults with his crew during the hunt, but his is the final say. Most of the men have hunted together for years; in the risky race among drifting ice and enraged walruses, they work as a skilled and expert team.

And then, suddenly, it is all over. The last great bull walruses, bringing up the rear of the migration, have passed. The large racks at Diomede are crowded with slabs of drying meat; the meat holes are full. The crews divide the ivory and the baculums, or penis bones, which sell for nearly $100 each in Nome. (Baculums, about 1 1/2 feet long, are much sought after by tourists as conversation pieces.) The men rest and relax. They catch birds on the mountain with long-handled nets, a technique identical to the one used by the polar Eskimo of Greenland, nearly 4,000 miles to the east. They rappel down the sheer cliffs to collect eggs or "go egg ing" to Fairway Rock, a murre-crowded pinnacle twelve miles southeast of Little Diomede. They have a great hunger for greens; men, women, and children swarm over the mountain with plastic bags, collecting leaves and tender shoots. The weather is finally warm, the living easy.

Nevertheless, within a few weeks, most will leave the island: to stay in Nome or Anchorage, to visit relatives in Seattle or Los Angeles, to work on the pipeline. They will be gone for two or three months. But in September, when storms lash the sea, they return to their island like birds flocking to an ancestral roost.

There is a brief fall hunt when the walrus return, but it is rare that many animals are taken. The ice returns from the north, autumn gales screech over the strait, and the Little Diomeders again are isolated on their lonely rock between two worlds.
Both predator and prey are often deceived by false appearances

Flowering plants made their appearance among the earth's flora about 100 million years ago; their debut coincided with the evolution of a host of insect pollinators. Some 60 million years later, the ancestors of today's mantids evolved, preying upon flies, bees, wasps, butterflies, and moths associated with flowering plants. The mantids, believed to have descended from a carnivorous cockroach, occupied a niche created by the presence of flowering plants and their insect fauna. They have developed into some of the most efficient predators of flower-visiting insects, rivaling such voracious arthropods as crab spiders and robber flies.

In order to capture flower-visiting insects and avoid detection by other insectivorous predators, such as birds, lizards, and small primates, elaborate concealment mechanisms have been selected for among the mantids. A study I conducted on mantids in Swaziland, a subtropical African country, revealed a great variety of such mechanisms, based mainly on camouflage. A number of behaviors, including startle displays, attack, and active escape, were also used, in conjunction with camouflage, as defenses against some mantid predators.

Cryptic coloration is the basic mechanism by which mantids conceal themselves from prey and predators. The most common colors are green and brown, which match the vegetation in much of the mantids' habitat. Some species show polymorphism with regard to color and have a mixed population of brown and green individuals. These colors appear to vary seasonally: brown is more common during dry periods; green more prevalent during the rainy season. One species, *Pseudocreobotra wahlbergi*, changes its color to yellow, brown, green, blue, or white depending on the color of its immediate surroundings. This permits first instar nymphs to associate with a variety of different colored vegetation. Once having found a suitable location (normally a flower), a nymph will usually remain there until its final molt at the age of seven or eight months. As the flower's color changes with the season, the nymph does likewise. In the dry season when the flowering plant has died, the nymph turns a matching brown.

Anatomical structures that resemble parts of plants are another mechanism for concealment that has evolved in mantids. The physical appearance of many smaller mantid species is similar to a blade of grass, a shape that helps them blend with grassy vegetation. Another adaptation is a body structure resembling a stick or twig. The concealment value of this shape is enhanced by the mantid's behavior. When disturbed, the mantid stretches into an elongate position, with the tibiae of the forelegs folded back against the femora and held in front of the head. The mantid bends its antennae backward against its body so that they are concealed. When a mantid hangs upside down, the visual effect is that of a forked twig (with the middle and hind legs resembling side branches), a resemblance further enhanced by the barklike texture of the mantid's cuticle.

Many groups of mantids mimic leaves. In some species the nymph's leaflike abdomen is flexed over its thorax. When the nymph is disturbed it flattens its body and directs its abdomen toward the source of the disturbance. The combination of outline color, and superficial structure of the abdomen contributes to its leaf-like appearance. Looking like closely associated leaves, smaller nymphs frequently sit on the edge of a flower as ambush visiting insect pollinators.

Both the nymph and adult stages of some species have dark patches on their cuticles, giving them the appearance of aged or diseased leaves. *Phalocrenus paradoxa* has elaborate expansions on its legs, abdomen, and head, and its wing tips are curiously colored to resemble a dead leaf.

Floral mimicry is a method of concealment characteristic of *Pseudocreobotra wahlbergi*. The nymph of this species possesses spines on the underside of the abdomen, which when observed in the flexed position effectively imitate the clustered reproductive structure of a flower. The nymph perches on the petals of a flower with its flexed abdomen in close association with the stamens and pistils. Incoming insects attempt...
The first instar nymph of *Pseudocreobotra wahlbergi* exhibits color change and floral mimicry. It is able to adopt the color of a number of different flowers. When one particular flower is chosen, the nymph remains in association with it, changing color along with the flower in the latter's progression from full bloom to death. The nymph's flexed spines imitate the flower's reproductive structures and act as a deadly lure to pollinating insects.
play, adding to the threatening attitude of the disturbed mantid.

Such startle displays have been observed to discourage lizards, small primates, and cats who have detected the mantid despite its concealment mechanisms. If the startle display fails, the mantid is likely to strike out with its forelegs in an attempt to fight off an attacker. If everything else fails, a mantid will beat as hasty a retreat as possible.

Startle displays are more typical of the larger mantid species, which are clumsy and readily captured if they attempt a simple escape. Smaller mantids generally move faster and are more easily obscured by vegetation. These species normally do not produce startle displays nor do they attempt to fight off attackers.

Although camouflage and adaptive behavioral patterns protect mantids as nymphs and adults, the developing embryos are extremely vulnerable to predation. The female mantid lays her eggs in an elaborate ootheca composed of foamylike, proteinaceous membranes that harden upon drying. Attached to the branches of trees and shrubs, oothecae come in a variety of shapes depending on the species of mantid. Female chalcid wasps are capable of identifying an ootheca and use their long ovipositors to deposit their eggs within its chambers. The wasp eggs develop at the expense of the mantid embryos; in some instances no mantids will hatch. If any mantid embryos do survive, and hatch concurrently with the wasps, the tables are turned and the young wasps become the mantid nymph's first meal.

Mantids—an estimated 1,500 species confined largely to the warmer regions of the world—have succeeded in exploiting the association of flowering plants and insects. The range of adaptations present in mantid populations reflect the character of their environment. In contrast to Swaziland, for example, many areas of Africa such as the Kalahari Desert receive only brief seasonal rains and are covered with sparsely foliated bush and grass. Their mantid populations lack the variety of floral mimicry of species from wetter climates; however, they show an equally diverse array of adaptations to the bark, twigs, and stems that are the most prevalent plant components in arid regions.

en threatened, some mantids use startle display as defense. In a version, a mantid sways from side to side and makes a hissing sound by rubbing its second pair of wings against its abdomen.

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71
Because of its size, earth is atypical among the inner planets of our solar system

Charles Lyell expressed in no uncertain terms the guiding concept of his geologic revolution. In 1829, he wrote to his colleague and scientific opponent Roderick Murchison:

My work . . . will endeavor to establish the principle of reasoning in the science . . . that no causes whatever have from the earliest time to which we can look back, to the present, ever acted, but those now acting; and that they never acted with different degrees of energy from that which they now exert.

The doctrine of slow, stately, essentially uniform rates of change had a profound influence on nineteenth-century thought. Darwin adopted it thirty years later, and paleontologists ever since have been searching for cases of slow and steady evolution in the fossil record. But what was the origin of Lyell’s preference for gradual change?

All cosmic generalizations have complex roots. In part, Lyell merely “discovered” his own political prejudices in nature—if the earth proclaims that change must proceed slowly and gradually, encumbered by the weight of events long past, then liberals might take comfort in a world increasingly threatened by social unrest. Nature, however, is not merely an empty stage upon which scientists display their prior preferences; nature also speaks back. Many of the forces that shape the surface of our planet do act slowly and continuously. Lyell could measure the accumulation of silt in river bottoms and the gradual erosion of hillslopes. Lyell’s gradualism, while far too extreme in his formulation, does express a large part of the earth’s history.

Our planet’s gradual processes arise from the action of what my colleague Frank Press and Raymond Siever call the external and internal heat engines of the earth. Our sun powers the external engine, but its influence depends on the earth’s atmosphere. They write:

Solar energy drives the atmosphere in a complex pattern of winds to give us climates and weather, and it drives the ocean’s circulation in a pattern that is coupled to the atmosphere. The water and gases of the oceans and atmosphere chemically react with the solid surface and physically transport material from one place to another.

Most of these processes work gradually, in a classic Lyellian manner; their large results are an accumulation of minute changes. Running water wears the land away; dunes march over deserts; waves destroy the coastline in some places, while currents transport sand to extend it elsewhere.

Heat derived from radioactive decay powers the internal engine. Some of its results—earthquakes and volcanic eruptions, for example—strike us as sudden and catastrophic, but the basic process, discovered only a decade ago, must be a source of joy for Lyell’s shade. Internal heat puts the earth’s surface in motion, driving the continents apart at minute rates of centimeters per year. This gradual motion, extended over 200 million years, has separated the single land of Pangaea into our present, widely dispersed continents.

Yet our earth is decidedly atypical among the other inner planets of our solar system: Mercury, Mars, and our own moon. (I exclude Venus because we know almost nothing about its surface; only one Russian probe has successfully penetrated its dense atmosphere to send back two ambiguous photos. I also exclude Jupiter and the large planets beyond. They are much larger and less dense than the inner planets that they belong to; a very different class of cosmic bodies.) No geologist, no matter how strong his prior preferences, could have predicted a doctrine of uniformity on the surface of any inner planet except the earth.

Craters made by meteoritic bombardment dominate the surfaces of Mars, Mercury, and our moon. Indeed, the surface of Mercury is littered with a field of tightly packed superimposed craters. The moon’s surface is divided into two major areas: densely cratered highlands and the more sparsely cratered maria (“seas” of basaltic lava). Lyell’s gradualism, so applicable to our earth, cannot possibly describe the history of our planetary neighbors.

Consider, for example, our moon’s history, as inferred from data collected during the Apollo missions and summarized by Columbia University geologist W. Ian Ridley: The moon’s crust rigidified more than 4 billion years ago. By 3.9 billion years ago, the greatest period of meteoritic bombardment had ended, the mare basalt had been excavated, and the major craters formed. Between 3.1 and 3 billion years ago, radioactively generated heat produced the basaltic lavas that filled the mare basins. Then the generation of new heat failed to match its loss at the lunar surface and the crust rigidified; by 3.1 billion years ago, the crust became too thick to permit the ascent of any more basalt, and activity at the lunar surface essentially ended. Since then, not much has happened beyond the very occasional impact of a large...
by Stephen Jay Gould

gorite and the constant influx of small ones.

e view the moon today much as we did 3 billion years ago. It has an atmosphere to erode and recycle material of its surface, and it can generate the internal heat to churn and change its visage. The moon is dead, but it is certainly ques-
tive. The concentration of moon-rock at 800-1,000 km below the surface suggests a rigid crust of this thickness, compared with 70 km or so of the earth's lithosphere. (To convert kilometers to miles multiply by 0.6.) A partially molten zone may lie beneath the lunar crust, but it is far down to influence the surface. 

The moon's surface is ancient, and its record is the story of its cataclysmic past—massive meteorites and upwelling lava. Its early history was marked by violent change; its last 3 billion years by very little indeed.

Why is the earth so different from its neighbors in recording a history in such a large part by cumulative processes, rather than ancient impacts? Readers might be tempted to think that the answer lies in the earth's larger size. But it is possible that some complicated difference in composition. But all the inner planets are basically similar, so far as we can see, and in density and mineralogical composition.

I wish to argue that the difference arises from a disarming and obvious fact—size itself, and nothing else. The earth is a good deal larger than its neighbors.

Galileo first discussed the cardinal importance of size in determining the distribution and operation of all physical observers (see my columns of January and February 1974). As a basic fact of physics, large bodies are not subject to the same balance of forces as small objects of the same shape (all else being equal).
spherical). Consider the ratio of surface to volume in two spheres of different radii. Surface is measured by a constant times the radius squared; volume by a different constant times the radius cubed. Hence, volumes increase faster than surfaces as objects of the same shape become larger. This simple principle explains an astonishing array of disparate phenomena. Why can flies, but not people, walk up walls? (Small animals have enormously greater ratios of surface to volume than we do; forces of surface adhesion acting on a fly’s feet are relatively great, while gravitational forces acting on its weight are negligible.) Why are all the largest birds flightless? (Lift must be generated by the surface area of wings, while the body’s weight increases as the cube of its length—don’t believe the giant ants of Them for a minute.)

I maintain that Lyell’s insight is a contingent result of the earth’s relatively low surface/volume ratio, not a general characteristic of all change, as he would have argued. We begin by assuming that the earth’s early history did not differ much from that of its neighbors. At one time, our planet must have been scarred by abundant craters. But they were effaced billions of years ago, destroyed by the earth’s two heat machines: churned up by internal machine (uplifted in mountains, covered by lava, or buried in the depths of the earth by subdue at the descending borders of lithospheric plates) or quickly obliterated by atmospheric or fluvial erosion of the external machine.

These two heat machines operate only because the earth is large enough to possess a relatively small surf and large gravitational field. Mercury and the moon have neither an atmosphere nor an active surface. The internal machine requires an atmosphere for its work. Newton’s equation lates the force of gravity directly to the mass of two bodies and inversely to the square of the distance separating them. To calculate the force holding a molecule of water vapor at the surface of the earth or moon, we must only consider the mass of the place (since the mass of the molecule constant) and the distance from planet’s surface to its center. A planet gets larger, its mass increases as the cube of its radius, while surface distance from surface to center is simply the radius squared. Hence, as a planet gets larger, its gravitational pull on a potential atmospheric particle increases as \( r^2 \) (where \( r \) is the planet’s radius).
noon and Mercury, the gravitational force is too small to hold an atmosphere; even the heaviest particles do not abide long. The earth's gravity is sufficiently strong to hold a permanent atmosphere to act as a kind of its external heat machine.

Internal heat is generated radioactively over the volume of a planet. It diffuses out into space at a planet's surface. Small planets, with their high ratio of surface to volume, quickly lose their heat and solidify their outer layers to relatively great depths. Larger planets retain their internal and the mobility of their surfaces.

The ideal test for this hypothesis is a planet of intermediate size, for we predict that such a body would display an intermediate mix of early cataclysms and fluid processes. Mars, obligingly, is the right size, nicely intermediate between the earth and our moon Mercury. About half of the Martian surface is cratered; the rest reveals the activity of rather limited internal and external heat machines. Martian gravity is weak compared to that of the earth, but it is strong enough to hold a slight atmosphere (about 200 times thinner than ours). Winds course over the Martian face and dune fields have been observed. The evidence for fluvial erosion is even more impressive, if puzzling, given the paucity of water vapor in the Martian atmosphere. (The mystery has been somewhat alleviated by the discovery that Mars's polar caps are predominantly not water, not carbon dioxide, as was previously conjectured. It also seems likely that a considerable amount of water lies frozen as permafrost in the Martian soil.) Carl Sagan has shown photos of relatively small craters with lobate extensions in all directions. It is hard to interpret these features as anything but liquefied mud, a process that had its sources in the crater surrounding. They cannot represent ancient because the meteorites that formed the craters were too small to erode enough heat on impact to melt rock.)

Evidence for internal heat is also abundant (and rather spectacular). Some recent speculation plausibly links it with the process that drives the earth's plates. Mars has a highly mobile province with giant mountains surpassing anything on earth.

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Now, the speculation: Many geologists believe that the Earth’s plate are moved by plumes of heat and mantle material rising from deep within the Earth (perhaps even at the core–mantle boundary, 3,200 km below the surface). These plumes emerge at the surface at relative fixed “hot spots,” and the Earth’s plates ride over the plumes. The Hawaiian Islands, for example, are essentially a linear chain increasing in age toward the northwest. If the Pacific plate is slow moving over a fixed plume, then the Hawaiian lands might have been formed one at a time.

Mars, with its intermediate size, should be more dynamic than the Moon, less so than the Earth. The Moon’s crust is too thick to move at all; internal heat does not reach the surface. The Earth’s crust is thick enough to break into plates and move continuously. Suppose that the crust of Mars is thin enough to allow hot spots to rise, but too thick to break up and move extensively. Suppose also that the plumes exist both on the Earth and Mars. Giant Olympus Mons may represent the locus of a plume, rising under a crust that cannot move—Olympus Mons, if you will, may resemble all the Hawaiis, piled one at the other. The Vallis Marineris may represent an unsuccessful “try” plate tectonics—the crust fracture but could not move.

Science, at its best, is unifying. It strikes my intellectual fancy to learn that the principle regulating a feature on my ceiling also determines the uniqueness of our earth among the inner planets. Pascal once remarked in planetary metaphor, that knowledge is like a sphere in space; the more we learn—that is, the larger the sphere—the greater our contact with the unknown (the planet’s surface). True enough—but remember the principle of surface and volumes! The larger the sphere, the greater the radius of volume (volume) to unknown (surface). May absolutely increase ignorance continue to flourish with relatively increased knowledge.

Stephen Jay Gould teaches biology, geology, and the history of science at Harvard University.
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*minck's tragopan*
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Slow lor
which agreed to pay the modest fees of the Chinese artists. The drawings were done in stages, with the artists first pencil sketching the outlines, then coloring the invertebrates with watercolor paints, and then coloring the watercolor with the watercolor. Many were accurate enough to be used in describing new species and some were of species that were completely unknown in Europe.

The beauty and scientific importance of these watercolors has already been confirmed to those few who have access to the collection in the British Museum. But now, in a large, neat, limited-edition volume, many of these outstanding artistic works have been reproduced to give a sampling of both animal and botanical subjects, with an introductory text looking at the historical background of the collection. To do justice to the data work of the artists, the paintings were reproduced by the Collograph process, a printing method that achieves an almost exact color match and even reproduces the finest details of the original penciled drawings underlying the watercolors.

Carol Breslin

BOVINUS LEO

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Strange Fruits

Hurrah for the tasty aliens trying to make it on these shores!

Last Sunday I dined on stewed kiwi at the home of a lonely gold-digger.

Walter Buller
Birds of New Zealand (1888)

In Buller's day, a kiwi was always a bird, a flightless bird with a Maori name. Scientists might call it Apterxy. New Zealanders might adopt it as their nickname, and a shoe polish manufacturer might take kiwi for his logo and his trade name. But none of this exploitation of a long-beaked fellow creature disguised the fact that a kiwi was a bird. Indeed, the only unexceptional piece of kiwi lore, until recently, was that Buller would, despite professional ethics, eat one.

Today, if I announced to up-to-date company that I had just been fed a kiwi by a solitary gold digger, eyebrows would rise. My audience would assume that I had supped, not with a sourdough, but with a vamp. And these days, who would have any more kiwi? (see article below.)

The kiwi is only the latest exotic fruit to enter the American market. It joins a distinguished succession of luscious hybrids and tropical plants, ranging from the avocado to the mango. Some of these tasty all have never really caught on. The cherimoya (Annona cherimola) of the Andes has been cultivated here, but a leading New York fruiter returns that he sees them "may be about every fifteen years, and they come from Hawaii or New Zealand.

We have never tasted the reportedly batlike flesh of the cherimoya, but we would pay dearly for the chance to try Mr. Mark Twain called the cherimoya "deliciousness itself." Tropical fruiticulturist Wilson Popeneo quotes even more expansive opinion from a botanical colleague named Scen...
by Raymond Sokolov

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moya in 1920 yielded, four decades later, to resignation, for experimentation had by then shown that the plant’s climatic requirements were precise. It had to be grown where the air was neither too hot nor too dry. Otherwise, if it did grow, its flowers had to be extensively and laboriously hand pollinated. Poponec and Fairchild could look proudly on firmly rooted grapefruit and soybean industries. But they—and we—must lament a host of lost opportunities. Perhaps they are really opportunities not yet seized. At any rate, join me in this plea to the fruit industry, for mango-stones and cherimoyas, for baels, carissas, ramontchis, and ketembillas.

Meanwhile, while we are waiting for them, we ought to salve growers and distributors who buck the overwhelming trend toward limiting the variety of fresh produce in our markets. Hail to the Florida orchards that bring us fresh litchis in midsummer. Hail to the tangelo men. Hail to the green thumbs behind the fragrant pear-apple. And a friendly salute to the kiwifruit importers. I wish some enterprising American would plant them and bring the price down. But even now, who can resist? If only the Indonesians would wise up and send us a few mangosteens... .

Kiwi Tart

Based on the idea of the Restaurant Troisgros, Roanne, France.

Short piecrust dough for a single crust, 9-inch pie

Dry beans
2¼ cups heavy cream
2 eggs
½ cup sugar
3 tablespoons kirsch
7–8 kiwis, peeled and sliced crosswise and about ½ inch thick

1. Set a 9- to 10-inch flan ring on a baking sheet. Roll out the dough and press it onto the ring. Trim around the top edge. Line the inside of the crust with a layer of aluminum foil and fill the foil with enough beans to weight it against the bottom and sides of the crust. Refrigerate for an hour or more.
2. When ready to bake the tart, preheat oven to 400 degrees.
3. Simmer the heavy cream (which preferably should not be ultrapasteurized) until it is reduced by half, to approximately 1 cup plus 2 tablespoons.
4. Mix together the cream, the eggs,
Raymond Sokolov's most recent cookbook is The Saucier's Apprentice, a guide to French sauces.
The reexamination of a classic Maya vase has solved an intriguing mystery about this complex society.

When the Spaniards conquered Mexico in the sixteenth century, they were at once fascinated and repelled by the Indians’ widespread use not only of alcoholic beverages but also of numerous hallucinogenic plants.

From the Spaniards’ point of view, however, both served the same purpose—to conjure up visions of demons and devils and to take imbibers from their daily life to supernatural realms.

Distillation was unknown in the New World before the conquest, but Mesoamerican Indians were making, as they still do, a variety of intoxicating ritual drinks, principally by fermenting cactus fruit; agave, or century plant, sap; or maize kernels.

Among the Maya, the ritual beverage was balche, made from fermented honey mixed with a bark extract of the balche tree, Lonchocarpus gistyus. These concoctions were taken orally.

But according to a Spanish writer known only as the Anonymous Queror, the Huastec people of northern Veracruz and southern Tampas had pulque (fermented a-
Mushrooms also played an important role in preconquest Mesoamerican Indian life. Certain species, most of them now known to belong to the genus Psilocybe, were perhaps the most extraordinary natural hallucinogens in use in Mexico. The Aztecs called them teonanacatl, or “God’s flesh.” Psychedelic fungi were widely employed in Mexico when the Spaniards came, and their use in divination and supernatural curing survives to this day in central Mexico, as well as in the state of Oaxaca (see “Drugs, Chants, and Magic Mushrooms,” Natural History, December 1975). The Indians even used tobacco to induce ecstatic trance states, which the Spanish only saw as diabolic communication.

While Spanish writers of the sixteenth and seventeenth centuries left us relatively detailed accounts of the use of hallucinogens in central Mexico, there is little mention of this intriguing evidence of native religion among the Maya. There is scattered evidence of a very early cult of sacred mushrooms in the Maya highlands of Guatemala and the adjacent lowlands, in the form of more than 250 mushroom effigies made of carved stone, many dating to the first millennium B.C.

The Maya were an integral part of Mesoamerican civilization and shared many of its basic assumptions about the nature of the universe and the relationship of humans to the natural and supernatural environment. Like the central Mexicans, they divided the cosmos into upperworlds and underworlds with their respective gods, believed in the cyclical destruction and regeneration of the earth and its inhabitants, and followed the 260-day ritual calendar. In view of many of these similarities, as the Maya scholar J. Eric Thompson has written, it was hard to believe that the Maya did not use intoxicating plants. Thompson searched the pages of sacred traditional books of the Yucatec Maya, set down in the European alphabet in the colonial period, for hints of ecstatic visionary trances through which the priests made their prophecies. In the Books of Chilam Balam (jaguar-priest) of Tizimin and Mani, he found mention of trance-like states but no hint whatever of any hallucinogenic plants. He also discovered scattered scenes in Maya relief sculpture that suggested visionary experiences characteristic of hallucinogenic ritual.

This is slim evidence, however, compared with the data from central Mexico, and some Maya scholars are not convinced that the Maya practiced the kinds of ecstatic shamanistic rituals or vision quests with botanical hallucinogens that played so pervasive a role in central Mexico, or among the Zapotecos, Mixtecs, Mazatecs, and other peoples of Oaxaca.

The silence of Spanish colonial writers on the subject of hallucinogenic plants or rituals among the Maya accords well with the view, once widely held among scholars, that the Maya were quite unlike their Mexican contemporaries in temperament, being less preoccupied with warfare and the Dionysian excesses than with the contemplative interpretation of the heavens and the passage of time. But the discovery at Bonampak, Chiapas, of mural paintings that depict, among other events, a fierce battle among Maya warriors, indicates that this traditional view is very widely to be seen.

As specialists have more closely examined Maya art and iconography in recent years, they have accumulated increasing evidence that among the classic Maya, ecstatic ritual was important. One suggestion for this is that some of the major Mexican hallucinogens—among them the morning glories and the hallucinogenic mushroom Stropharia cubensis—occur in the Maya country. These and other psychedelic plants were undoubtedly known to the Maya.

Had Maya specialists looked more closely at the earliest dictionaries of the Quiche and Cakchiquel languages, compiled in the first centuries after the conquest of highland Guatemala, they would have discovered mention of several varieties of mushrooms with hallucinogenic
properties. One is called xibalbaj okox (xibalba means "underworld," or "land of the dead," and okox, "mushroom"), said by the sixteenth-century compiler to give those who eat it visions of hell. If the association of this species with the Maya underworld left any doubt of its psychedelic nature, it is dispelled by a later reference to the same species in Fray Tomas Coto's dictionary of the Cakchiquel language. According to him, xibalbaj okox was also called k'aiizala okox, which translates as the "mushroom that makes one lose one's judgment." Still another fungus, k'ekc'un, had inebriating characteristics, and another, muxan okox, apparently brought on insanity or caused one to "fall into a swoon."

We have recently come across a wholly unexpected use of psychoactive substances among the Maya—the ritual use of intoxicating enemas, unmistakably depicted in classic Maya art of the first millennium A.D., but not mentioned either in the colonial or the modern literature. This practice is well documented among the inhabitants of South American tropical forests as well as among the Inca and their contemporaries in the Andes, where archeologists have discovered enema syringes.

Sixteenth-century sources describe the Incas as regularly intoxicating themselves with infusions of willka, now known to be the potent hallucinogenic seeds of the acaialike Anadenanthera colubrina tree. Lowland Indians also used tobacco enemas.

South American Indians were the first people known to use native rubber tree sap for bulb enema syringes. While medical enemas had a long history in the Old World, having been used by ancient Sumerians and Egyptians, as well as by Hindus, Arabs, Chinese, Greeks, and Romans, the rubber bulb syringe was unknown in Europe until two centuries after the discovery of the New World. The native Amerindian enema was distinguished from its Old World counterpart in that its primary purpose was to introduce medicines and intoxicants into the body, while the Old World enema was employed principally to clear the bowels. During the seventeenth and eighteenth centuries, the enema as a relief for constipation, real or imagined, became a craze in Europe—so much so, that Louis XIV had more than 2,000 enemas administered to him during his reign, sometimes even receiving court functionaries and foreign dignitaries during the procedure.

The wide dissemination of the intoxicating enema in South America suggests the discovery by Indians that the rectal administration of intoxicants could radically alter one's state of consciousness more rapidly, and with fewer undesirable side effects, such as nausea, than oral administration. The physiological reason is simple: Substances injected into the rectum enter the colon, the last segment of the large intestine; the principal function of the large intestine is the reabsorption of liquids into the system and the storage of wastes until they can be evacuated. The absorbed liquid immediately enters the bloodstream, which carries it to the brain. An intoxicant or hallucinogen injected rectally closely resembles an intravenous injection in the rapidity of its effects.

The first evidence that not only the Huastecs, whose language is related to the Maya languages, but also the classic Maya knew of and employed the intoxicating enema came to light this past year through the examination of a painted vase in a private collection in New York. This polychrome jar, with a high, vertical neck and flaring rim, was probably painted in the heavily forested Petén district of northern Guatemala during the classic Maya phase, which dated from the third century A.D. to the first decades of the seventh century. Seven male–female pairs, the women easily distinguished by their robes and long hair, are depicted in two horizontal rows. That one woman is fondling a child suggests a familial setting. The activity being portrayed would have brought blushes to the cheeks of the traditional Maya specialist, for while one man is inserting a syringe into his rectum, this delicate task is being carried out for another male by his consort. One male also has a bulb enema syringe tucked into his belt.

Nine vases, identical in shape to the actual vessel, are painted between the couples, and painted dots at the mouth of each represent a foaming, fermented liquid that is probably balche, the common alcoholic drink among the Maya at the time of the conquest. We must conclude that the people on the vase are taking intoxicating enemas, a practice previously unrecorded for this culture.

An understanding of the scenes depicted on the Maya vase was only a first link in a chain of iconographic discovery of the Mesomeran enema phenomenon. Suddenly, eral previously enigmatic scenes of objects in classic Maya art had meaning. A small clay figure is a burial excavated in 1964 by Mexican archeologists on the island of Jaina, in the Gulf of Campeche; it depicts a male in squatting position, hand reaching back to his rectum. A long time Maya experts were puzzled because the figure's pose seemed to represent defecation, would the Maya have interred such a scene as an offering to their deities?

A small hole in the anus suggests that a piece was missing—that some small object previously inserted had either become lost during excavation or had been made of some perishable material, long since decayed. The discovery of the enema vase from the Petén district seems to have solved the riddle. The little Maya probably not defecating but was in fact giving himself an enema.

The gods themselves were also depicted as indulging in the enema ritual. One Maya vase has the figure of thirty-one underworld deities painted on it. A naturalistically depicted enema syringe dangles from the paw of one of the principal figures. Maya experts did not recognize the significance of the object until they had examined the enema vessel in the New York. As another example, a polychrome bowl from Yucatán in the National Museum of Anthropology in Mexico City, shows naked being with a pointed headjecting himself with liquid.

The ritual importance of the intoxicating enema is highlighted by the involvement in the rite of one of the greatest underworld deities, an lord associated with earth, water, agricultural fertility. The Maya have believed that this god—identified by Mayanists only by the letter N, but very likely the god of fertility as the ancient Yucatecan Pauhatun—consisted of four parts, each part living in the underworld and supporting the four corners of earth.

The quadrupartite god is depicted on a fine vase in a private collection in Chicago. Each of the four parts has a characteristically chalchihuitlic feature: Four young and fetching consorts apparently preparing each of the god's representations for the enema. Enema pots with syringes on
In front of two of the consorts, female consorts may well represent the important Mother Goddess of Maya, known as Ixchel, as several figurines of the god Nacchiracing this goddess have been found. The same association of the god Nacchir and enemas is depicted on a pottery vase, with a consort standing behind each god, superimposing the loincloth. In, the same enema pots are in use of the consorts. So often are the archaic forms and syringes encountered together that we must conclude they were commonly used in the rite.

An explicit depiction of enema rite on Maya vases has led us to take a look at a hitherto puzzling type of figurine from central Vera
cruz, which also dates from the clas
tula period. Some archeologists interpreted these curious sculptures as representing human sacrifice. They are usually of males whose facial expressions suggest pleasure or ecstasy, not death. Their legs are raised, either draped over a high stool or some other type of support, while feet are slightly spread, with the feet up in the air. The posture—and the enaptured look—suggest the intoxicating enema. The reclining position also conforms to the Anonymous Conqueror's description of the method of enema intoxication among the Huastecs.

The hallucinogenic, or intoxicating, enema is by no means dead in Middle America. While conducting linguistic research among the Huichols of western Mexico, ethnographer Tim Knab was shown a peyote enema apparatus used by an elderly woman shaman in the community of Santa Catarina. The bulb was made from a deer's bladder and the tube from the hollow femur of a small deer. The shaman prepared her peyote by grinding it to a fine pulp and diluting it with water. Instead of taking the mixture by mouth (Huichols normally eat the cactus whole or drink it as an infusion), she injected it rectally, experiencing its effects almost at once while avoiding its bitter, acrid taste and the nausea that even some experienced Indian peyoteros continue to feel as they chew the sacred plant.

The choice of deer bladder and deer bone as materials for the Huichol syringe is probably not a matter of practicality. Bird bone, light, slender and thin walled, would be more logical for the tube. But the Huichols hold the deer especially sacred, even to the point of deification, and they identify it so completely with the hallucinogenic cactus that peyote and deer become conceptually one and the same (see "An Indian Journey to Life's Source," Natural History, April 1973).

We do not know what materials the ancient Maya used for their syringes. To make the transition from Huichol to Maya requires an enormous jump in time and space. Fish bladders and bird bones, which are prominent in Maya art, might have served for the syringe, as might the milky sap of the latex, or rubber, tree. More important than the precise technology, however, is the discovery that, no less than the simpler folk of the South American tropical rain forests, the creators of the most flamboyant and intellectually advanced native civilization in the New World hit upon the enema as a technique of ecstasy—a practical means of ritually altering or transforming the ordinary state of consciousness.
Announcements

The recently opened Discovery Room offers children, from six to twelve years old, mysteries, puzzles, and the opportunity to delve into the wonders of natural science and anthropology. This is all done through the use of discovery kits. Each contains items for visitors to look at, feel, and then try to identify. One kit, "Reflections," allows children to dress up in Museum-owned costumes and jewelry to see how people around the world adorn themselves. Open only on weekends, the Discovery Room is located on the first floor of the Museum outside the entrance to the Hall of Ocean Life.

Treasures of Cyprus, a traveling exhibit of nearly 200 priceless artifacts that recently arrived in this country, opened February 16 in Gallery 77 on the Museum’s first floor. In its only New York appearance, the exhibit will remain at the Museum until April 3.

Spanning 8,000 years of the artistic and archeological history of Cyprus, the exhibit includes pottery, figurines, statues, vessels, and jewelry from Neolithic times to the nineteenth century. Culturally, the exhibit is a mirror of the island’s varied past, which included successive periods of Phoenician, Assyrian, Egyptian, Persian, Greek, Roman, Venetian, Turkish, and British influence.

The exhibit, assembled under the auspices of the Cypriot government as a tribute to our country during its Bicentennial, is being circulated here by the Smithsonian Institution Traveling Exhibition Service.

The Alvin Ailey Repertory Ensemble will appear in the Museum Auditorium on March 6 at 2:00 p.m. Formed several years ago to give young dancers and choreographers an opportunity to develop both themselves and their art, the ensemble received wide acclaim for its 1974 television performance of "After Minnie." Most of the dancers are in their early twenties. The ensemble performs frequently in schools, prisons, hospitals, and occasionally with the American Ballet Theatre and the Alvin Ailey City Center Dance Theater, its parent group. Their repertory includes some of Ailey’s best-known pieces, such as "Revelations" and "Night Creature." The performance at the Museum is free to those who have paid the daily admission donation.
Celestial Events
by Thomas D. Nicholson

Sun and Moon  The sun moves into the constellation Pisces about March 12 and remains among its stars until late April. On March 20, it passes the vernal equinox at 12:43 P.M., EST, moving from south to north of the equatorial plane, which marks the end of winter and the beginning of spring in the Northern Hemisphere. The actual date on which our day and night are each twelve hours long, however, is March 17, because of the effect of atmospheric refraction and because we measure the beginning and end of the day by the sun's upper edge.

After bright evening moonlight in early March (full on the 5th), the moon is in the morning sky past mid-month (last-quarter on the 12th, new on the 19th). The slim evening crescent will appear on the 21st or 22nd, growing to first-quarter on the 27th. The moon will be full again on April 3, and it reaches last-quarter phase on April 10.

Stars and Planets  The Star Map for March shows Jupiter and Saturn located prominently among our evening stars, where they have been all winter. But as spring approaches, they will shift slowly westward with each nightly appearance. Both stand out brilliantly, even in comparison with the bright winter stars.

The three evening planets are easy to distinguish. At dusk, Venus will be high and bright in the glow of the setting sun, Jupiter will be higher and to its left, and Saturn will be much farther left and quite high in the eastern sky. Venus sets first, about three hours after the sun on March 15, but much earlier by the end of the month. Jupiter sets several hours before midnight, and Saturn before dawn. Mercury and Mars are not well placed to be seen this month.

March 2–3: Saturn is near the moon both nights.
March 8: The moon is nearest the earth (at perigee).
March 14: Venus begins to move westward (retrograde) as its path takes it between the earth and the sun. This will cause it to leave the evening sky rapidly over the next few weeks.
March 16: Mercury is in superior conjunction, in line with, but beyond, the sun and enters the evening sky.
March 20: Vernal equinox, spring begins.
March 21: The crescent moon is near Venus tonight.
March 23–24: The bright object near the moon on both nights is Jupiter. The moon is farthest from the earth (at apogee) on the 24th.
March 30: The moon is near Saturn tonight; near the bright star Regulus (in Leo) on the 31st.
April 3–4: A partial lunar eclipse is visible from most of North America. At mid-eclipse, 11:18 P.M., EST, on the 3rd, about 20 percent of the moon's diameter is in the earth's shadow.
April 5: The moon is nearest the earth.
April 6: Venus passes between the earth and the sun (inferior conjunction) and becomes a morning star, visible low in the east at dawn in about two weeks.
April 10: Mercury is at its greatest distance to the east (left) of the sun, placing it favorably as an evening star. The planet is in good position for a week preceding and following this day to be seen low in the west after sundown.
April 11: Saturn ends its retrograde motion and begins to move eastward. It has been moving away from Regulus, in Leo, but it now moves left toward the star.

★ Hold the Star Map so the compass direction you face is at the bottom; then match the stars in the lower half of the map with those in the sky near the horizon. The map is for 11:20 P.M. on March 1; 10:25 P.M. on March 15; 9:20 P.M. on March 31; and 8:20 P.M. on April 15; but it can be used for an hour before and after those times.
WHY for Heaven’s sake, put up any longer with the irritation and struggle with wheelbarrows and poorly designed carts as shown in drawings below...

Ladies, Gentlemen:

**WHY for Heaven’s sake, put up any longer with the irritation and struggle with wheelbarrows and poorly designed carts as shown in drawings below...**

---

**Additional Reading**

**Whooping Cranes** (p. 22)

Faith McNulty’s *The Whooping Crane* (New York: E. P. Dutton, 1966) and L.H. Walkinshaw’s *Cranes of the World* (New York: Winchester Press, 1972) cover what little is known of the biology and habitat of this endangered species. David R. Zimmerman’s chapter on whoopers in his book *To Save a Bird in Peril* (New York: Coward, McCann & Geoghegan, 1975, $9.95) and his article for *Natural History*, “Captive Breeding: Boon or Boondoggle” (December 1974, pp. 6–19), describe the initial, and largely unsuccessful, attempts of the U.S. Fish and Wildlife Service to save these cranes from extinction. Zimmerman’s writings present a critical contrast to the currently more fruitful cross-fostering efforts of United States and Canadian biologists. Richard S. Miller’s “The Programmed Extinction of the Sandhill Crane” (*Natural History*, February 1974, pp. 62–69) puts in perspective the status of the foster-parent species that has been pressed into the service of the whooping crane. The June 1976 issue of *Nature Canada* contains many photographs and two informative articles on whooping cranes: Ernie Kuyt’s “Whooping Cranes: The Long Road Back” (pp. 2–9), a well-illustrated, knowledgeable description of their breeding habitat and reproduction in the wild, as well as a detailed account of the Canadian contribution to the various efforts to save the whooper, and R. Dalton Muir’s “Whooping Crane Summer: Filming the Great White Cranes” (pp. 25–30), a narrative of a project aimed at documenting the behavior of adult and newly hatched whoopers on their breeding grounds.

**Howling Monkeys** (p. 34)


**Korean Dance** (p. 42)

Traditional Performing Arts of Korea published by the Korean Commission of UNESCO (Seoul, 1975), provide broad perspective on that country’s music, dance, and drama; see, for example, Yi Tu-Hyon’s “Mask Dance” (pp. 35–80) for details of and characters and dozens of colorful photographs. Anneliese Stucki’s “Aspects of Korean Masks and Masked Dance Drama” (*Asia & Pacific Quarterly of Cultural and Social Affairs*, 1975, vol. 7, no. 2, pp. 12–17) is an useful source of background information. “Korean Folk Music and Dance,” Alan C. Heyman (pp. 90–110), “Korean Folk Play,” by Lee Du-Ne (pp. 112–29), are two of the six essays in *Folk Culture in Korea*, edited by Shin-Yong (Seoul: International Cultural Foundation, 1974). This collection attempt to explore the patterns and habits of Korean culture, the balance and moly between tradition and reality contribute to the Korean nation. Heyman’s Western approach and deep understanding of the essence of Eastern folk cultures are found in his *Dances of the Three-Sand-League Land* (New York: Demon Press/John Reprint, $5.50), an introduction to Korean traditional dance. Write to The Performing Arts Program of the Asia Society, East 58th Street, New York, N.Y. 10022 for a monographs on Music, Drama and Theater in Asia (1976, vol. 3, $42 in an attractive book folder), three monographs on Korean dance, Japanese martial arts, and Indian dance theater.

**Mars** (p. 48)

Radioastronomer Ronald N. Br...
The Galactic Club: Intelligent Life in outer Space (San Francisco: W.H. \nian, 1975, $3.95) is a popular, \native discussion of the evidence for \nsewhere in the universe, including \nsogging on what other living crea-
might look like. Robert Jastrow’s \n Giants and White Dwarfs: Man’s \nemt from the Stars (rev. ed. New \nAmerican Library, 1971) provides a general background on \ntical and astronomical evolution in \nsmos. Rick Gore’s “Sitting for Life \n Sands of Mars” (National Geo-
January 1977, pp. 8–31) de-
t the key Viking lander experiments \ngating the question of life on the \n. Several recent issues of \n, beginning with August 27, 1976 \n9, pp. 759–815), are totally de-
to presentations of some of the data \n by Viking I; data from Viking \n likewise presented, beginning with \nedember 17, 1976, issue (vol. 194, \n77–1353). Gilbert V. Levin and \nna Ann Strait’s “Viking Labeled \se Biology Experiment: Interim Re-
(pp. 1322–29), for example, sums \ne one life detection experiment.

Diomede Island (p. 54) \n Bruemmer’s The Arctic (New \n Quadrangle, 1974) offers an over-
pective on the peoples and places \n far north, while “The Northern- \n People” (Natural History, Febru-
1974, pp. 24–33), a graphically illus-
 description of the lives of Green-
 Eskimos, is an insightful contrast to \nent account of the Diomede Is-
. Alaska, by Bern Keating (Wash-
 National Geographic Society, \n, contains a section dealing specifi-
with the Diomede Islands, William \nunt’s Arctic Passage (New York: \n Scribner’s Sons, 1975, $12.95) \nts the history of the Bering Sea re-
north of the Aleutians, illustrating \rly photographs of ships and crew-
 ing and trading there. The Bering \n Bridge, edited by David M. Hop-
 (Stanford: Stanford University \n, 1967), is a scholarly, wide-ranging \tion of studies of Beringia. Edward \nelson’s classic (1899) monograph \nThe Smithsonian Institution’s Bureau \n American Ethnology, The Eskimo \n Bering Strait, has been recently \nted (New York: Academic \nohnson Reprint, 1971). Con-

Maya Drugs and Enemas (p. 88) \n Peter Furst’s Hallucinogens and Cul-
 (Corte Madera: Chandler & Sharp \nbers, 1976, $4.95) provides a his-
tical overview of the use of hallucino-
gens in a variety of cultural settings, \ncluding those of the Indians of Middle \n South America. Furst has also edited \n popular collection of papers on native \ drugs and their use, Flesh of the Gods \ (New York: Praeger Publishers, 1972, \n.95); and his latest work, “High States \n Culture-Historical Perspective,” will \appear this spring in Alternate States \f Consciousness, edited by psychiatrist \nman E. Zinberg (New York: Free \Press). For background information on \rmon themes in Maya cosmology and \nistry, see these works: J. Eric Thomp-
son’s Maya History and Religion (Nor-
man: University of Oklahoma Press, \n70, $7.95), Elizabeth P. Benson’s The \naya World (New York: Apollo Edi-
1972, $2.95), and Michael D. \n’s The Maya (New York: Praeger \hwers, 1966, $3.95). Coe’s Classic \naya Pottery at Dumbarton Oaks (Wash-
ington: Dumbarton Oaks, 1975, \n20) provides excellent photographs and \hromchroim trolayout drawings of the \nniques and subjects of Maya vase paint-
 Death and the Afterlife in Pre-
 Columbia, edited by Elizabeth P. \n Benson (Washington: Dumbarton \noks, 1975, $10), presents a number of \rprations of Maya funerary prac-
tions and conceptions of death and the \nworld.

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This View of Life Stephen Jay Gould
The 120-year Bamboo Clock

Celestial Events Thomas D. Nicholson

The Unnatural History of Tobacco Erik Eckholm
The smoking habit continues to spread throughout most of the world.

Hot Spots Peter R. Vogt
The volcanic future of Hawaii for millions of years may already be ordained in the "plumbing" beneath those turbulent islands.

The Enigma of Aztec Sacrifice Michael Harner
"Then they ate their flesh with a sauce of peppers and tomatoes."—Bernal Diaz

Vest-pocket Turtle Text and photographs by Jim Cooper
In early spring, mud turtles emerge from sleep, but don't go near the water.

Drums of Calanda Text and photographs by Tor Eigeland
All hell breaks loose at noon on Good Friday in this sleepy Spanish town.

The Pit and the Antlion Howard Topoff
It may seem to spend a lot of time doing silly doodling, but this creature ends up with a first-rate trap.

Besieged Reefs of Florida's Keys Phillip Dustan
Coral reefs have wrecked a lot of ships, but now the tables are turned.

A Matter of Taste Raymond Sokolov
Humble Pie

The Market

Announcements

Sky Reporter Stephen P. Maran
Let There Be Darkness

Book Review Guido Majno
Epidemic!

Additional Reading

Cover

Iceland, which straddles the Mid-Atlantic Ridge, is one of the world's most prominent "hot spots." Its villages thus run the risk of being buried under volcanic ash and showered with molten lava. Photograph by Pete Turner. Story on page 36.
The article on tobacco marks Erik Eckholm's second appearance in these pages. His first was "The Firewood Crisis," in the October 1975 issue. A somewhat revised version of his current article will be part of a book for which the research was sponsored by the U.N. Environment Program. Eckholm writes on environmental subjects for the Worldwatch Institute, a Washington-based, nonprofit research organization concerned with global problems. He has investigated the health situation in Egypt and Southeast Asia and traveled widely in Africa, Asia, Europe, and the Soviet Union. A graduate of Occidental College in Los Angeles, Eckholm got a master's degree in 1974 from the Johns Hopkins University School of Advanced International Studies. Although he eschews cigarettes, he does admit to puffing occasionally on a pipe.

"I began looking at the ocean floor around Iceland in 1971," writes marine geophysicist Peter R. Vogt. During the last ten years he has crisscrossed the oceans many times on research vessels and in specially equipped planes, gathering information on hot spots, continental drift, and plate tectonics. In 1975, he was an exchange scientist for two months aboard a Russian research ship in the South Atlantic and served as cochief scientist on Leg 43 of the Glomar Challenger in the North Atlantic. Vogt is now with the Naval Research Laboratory in Washington, D.C. His hobbies while on dry land include pottery, woodcarving, candlemaking, and collecting and cooking wild fruits and vegetables. He also collects cartoons on his speciality of hot spots in the belief that "scientists should learn to stand back and laugh."

Michael Harner is professor of anthropology and former chairman of the anthropology program at Graduate Faculty of the New School for Social Research in New York City. He has done extensive fieldwork among the Indians of the Amazon region and in recent years has devoted himself to explaining human, social, and cultural evolution from an ecological point of view. Author of numerous articles and monographs, his books include Jivaro: People of the Sacred Waterfalls and Hallucinogens and Shamanism.

Because the threatened Illinois turtle presented an interesting evolutionary problem and its natural history was virtually unknown, Cooper spent two summers in sloughs and on the dunes of Martin Island, Iowa, studying this subspecies. The work became the basis of his master's degree research at Drake University. He has just completed a contract study for the United States Fish-Pesticide Research Laboratory (U.S. Fish and Wildlife Service) in Columbia, Missouri, which involved a test of the usefulness of compartmentalized food chains for evaluating the hazards presently faced by aquatic contaminants. In his spare time, Cooper backpacks and cross-country skis.
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A few years ago, Tor Eigeland happened to meet a cousin of his. The cousin mentioned that Bunuel is a filmmaker from the small town of Cala, which annually celebrates Good Friday with a long and dramatic Easter ceremony. Eigeland, of Norwegian birth, now lives in Spain and has been a free-lance photographer and writer since his student days in Mexico City. He has carried out photographic assignments in the Middle East and is at present doing research on the Arabian Gulf shelf. His other projects include studying Islam and photographing the rebuilding of Lebanon.

Howard Topoff is an associate professor of psychology at Hunter College of the City University of New York (CUNY) and a research associate in animal behavior at The American Museum of Natural History. His field work with ant lions was conducted in conjunction with animal behavior classes at the Museum's Southwestern Research Station in Arizona. The doctoral students and faculty participating in this course are part of a joint CUNY-Museum Ph.D. program in animal behavior. Topoff's present research is on the development and evolution of insect behavior, especially that of ants. He is the author of "Ants on the March," which appeared in the December 1975 issue of Natural History.

Living on an old racing sloop Newport Harbor, California, Ph.Dustan is never far from the water. When he is not on it, he is often on it, having prowled around coral reefs from the Red Sea to the Caribbean. He has been fascinated by their complexity ever since his undergraduate days when he took a biology field course in the Bahamas. In 1974, when he directed a Smithsonian Institution project to assess man-induced damage to the Florida reefs, a sailboat blundered onto a reef and he got firsthand look at its fragility. Dustan, a lecturer in ecology at the University of California at Irvine, is researching the dynamics of coral reef populations and plans to concentrate his future studies on the photosynthetic capacities of certain algae species.
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PUBLISHER'S NOTE: Hans Selye, C.C., M.D., Ph.D., D.Sc., F.R.S. (C) is the world-famous endocrinologist whose concept of stress has been called at the World Congress of Medical Psychology: "breathtaking in its scope; it has permeated medical thinking and influenced medical research in every land, probably more rapidly and more intensely than any other theory of disease ever proposed."

As a long-time member of our Editorial Board we have asked Dr. Selye to outline for you his concept, detailed in his many scientific papers and books, the latest of which "Stress Without Distress"(*) is stated in clear, non-technical language we believe especially helpful to executives.

—Richard Stanton

Everybody knows what stress is and nobody knows what it is. The word stress, like success, failure, or happiness, means different things to different people and, except for a few specialized scientists, no one has really tried to define it although it has become part of our daily vocabulary. Is it effort, fatigue, pain, fear, the need for concentration, the humiliation of censure, loss of blood, or even an unexpected success that requires complete reformulation of one's life? The answer is yes and no. That is what makes the definition of stress so difficult. Every one of these conditions can produce stress, and yet none of them can be singled out as being "it" since the word applies equally to all others as well.

Yet, how are we to cope with the stress of life if we cannot even define it? The executive who is under constant pressure from his customers and employees alike, the air traffic controller who knows that a moment of distraction may mean death to hundreds of people, the athlete who desperately wants to win a race, and the husband who helplessly watches his wife slowly and painfully die of cancer — all suffer from stress. The problems they face are totally different, but medical research has shown that in many respects their bodies respond in a stereotyped manner with

(*) *Stress Without Distress* ... How to achieve a rewarding life style in harmony with the laws of nature, by using stress as a positive force for personal achievement and happiness. J. B. Lippincott Co., Philadelphia and New York. Copyright 1974 by Hans Selye, M.D.
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Ross Ilume Hall, Ph.D.: Beware of those fabricated foods. There is still too much we do not know about all the chemical additives that are hidden away in the fine print on the labels of processed foods.

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Nature usually manages to outdo even the most fanciful of human legends. Sleeping Beauty waited a hundred years for her prince. Bruno Bettelheim argues that her pricked finger represents the first bleeding of menstruation; her long sleep, the adolescent years before full maturity. Since the original Sleeping Beauty was insemminated by a king, rather than merely kissed by a prince, we may interpret her awakening as the beginning of sexual fulfillment.

A bamboo that bears the unpronounceable name Phyllostachys bambusoides flowered in China in the year 919. Since then, with unerring regularity, it has continued to flower and set seed roughly every 120 years. P. bambusoides follows this cycle wherever it lives. In the late 1960s, Japanese stocks of the bamboo (transplanted from China centuries before) set seed simultaneously in Japan, England, Alabama, and Russia. The analogy to Sleeping Beauty is not far fetched, for sexual reproduction follows more than a century of celibacy in these bamboos. But P. bambusoides departs from the brothers Grimm in two important ways. The plants are not inactive during their 120-year vigil—they propagate asexually by producing new shoots from underground rhizomes. Also, they do not live happily ever after, for they die after setting seed.

Ecologist Daniel H. Janzen of the University of Pennsylvania recounts the curious tale of Phyllostachys in a recent article in the Annual Review of Ecology and Systematics (1976). Most species of bamboo have shorter periods of vegetative growth between flowerings, but synchrony of seedling is the rule, and most species wait more than 15 years before flowering (some may wait more than 150 years, but historical records are too sparse to permit firm conclusions).

These flowerings must be set by internal, genetic clocks, not imposed from without by some environmental clue. Our best evidence for this assertion is the unerring regularity of repetition. We do not know any environmental factor that cycles so predictably to yield the variety of clocks followed by more than a hundred species of bamboo. Secondly, plants of the same species flower simultaneously, even when transplanted half a world away from their native habitat. Finally, plants of the same species flower together, even if they have grown in very different environments. Janzen recounts the tale of a Burmese bamboo only half a foot high that had been burned down repeatedly by jungle fires, but flowered at the same time as its unmolested companions standing forty feet tall.

How can a bamboo count the passing years? Janzen argues that the plant cannot be measuring stored food reserves because starved dwarf plants flower at the same time as healthy giants. He speculates that the calendar "must be the annual or daily accumulation or degradation of a temperature-insensitive photosensitive chemical." He finds no basis for guessing whether the cycles of light are diurnal (day-night) or yearly (seasonal). As circumstantial evidence for implicating light as a clock, Janzen points out that no accurately cycling bamboo grows near the equator, where variations in both days and seasons are minimal.

Most of us are better acquainted with another example of strong periodicity—the periodical cicada. The 17-year "locust" (Cicadas are locusts at all, but large-bodied members of the order Homoptera, a group of predominantly small insects, including aphids and their relatives). The story of periodical cicada is even more amazing than most realize: for 17 years the nymphs underground, sucking juices from roots of forest trees all over the eastern half of the United States (except for our southern states, where a smaller group of species emerges every four years). Then within just a few weeks millions of nymphs emerge from ground, become adults, mate, and die. The best counts, from an evolutionary standpoint, will be found in a series of articles by M. Lloyd and H. S. Dyke published in the journals Evolution 1966, and Ecological Monographs 1974.)

The most remarkable fact is not one, but three separate species of periodical cicadas follow the same schedule, emerging together in strict synchrony. Different species may be out of phase—populations around Chicago do not emerge in the same year as forms from New York. But each "brood" follows an unvarying 17-year cycle (13 years in the south)—in the same place three species always emerge together. Janzen recognizes that this phenomenon, despite their logical and geographic distance, is more common than the same evolutionary problem. Recent studies, he writes, "reveal no conspicuous qualitative difference between these insects...bamboo...except perhaps in..."
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way they physiologically can evolve, and why the long period between episodes of sexual reproduction? As I argued in discussing matricidal habits of certain flies (December 1976), the theory of natural selection receives its strongest support when we devise satisfactory explanations for phenomena that seem intuitively as bizarre or senseless.

In this case, we are confronted with a problem beyond the apparent similarity of such wastefulness (for few seeds can sprout upon such fragmented surfaces). The synchronicity of flowering or emergence seems to reflect an ordering and harmony operating upon the species as a whole, but one upon its individual members, the Golden Eagle theory advocates a higher principle beyond individual pursuits—pursuing their own self-interests promoting their own genes in future generations. What advantage do the synchronicity of sex provide the individual cicada or banana plant?

The problem is similar to that faced by Adam Smith when he advocated an unbridled policy of laissez faire as the surest path to a harmonious economy. The ideal economy, Smith argued, might appear orderly and balanced, but it would emerge "... the result of the interplay of individuals following no higher principle than the pursuit of their own best interests. The apparent order toward a higher harmony, Smith argues in his famous metaphor, reflects the operation of an "invisible hand."

As every individual directs his industry in such a manner as its profit may be of greatest value, intends only his own gain, he is in this as in many other cases led by an invisible hand to promoting an end which was no part of his intention. ... By pursuing his own interest he frequently promotes that of society more effectively than when he really intends to promote it.

Since Darwin, via Malthus, grafted Adam Smith upon nature to establish his theory of natural selection, we must seek an explanation of apparent harmony in the advance that it confers upon individuals. What, then, does an individual cicada gain by indulging in such behavior? And, then, at the same time, does all its compatriots?

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In order to appreciate the most likely explanation, we must recognize that human biology often provides a poor model for the struggles of early organisms. Humans are slowly growing animals: we invest a great deal of energy in raising very few, laboriously offspring. Our populations are not controlled by the wholesale death of nearly all juvenile members. Many organisms perform a different strategy in the "struggle for existence": they produce vast numbers of seeds or eggs so that a few will survive the rigors of early life. Early organisms are often controlled by their predators, and their evolutionary defense must be a strategy that minimizes the chances of being eaten. Cicadas and bamboo seeds seem to be particularly tasty to a wide variety of organisms.

Natural history, to a large extent, is a tale of different adaptions, without predation. Some individuals hide, others taste bad, others grow spines or thick shells, still others evolve to look conspicuously like a noxious relative—the list of adaptations is nearly endless, a stunning tribute to nature's variety. Barn swallow seeds and cicadas follow an uncommon strategy: they are eminently conspicuous, available, but so rare and in such great numbers that predators cannot consume the entire bounty. Among evolutionary biologists, this defense goes by the name of "predator saturation." An effective strategy of predator saturation involves two adaptations. First, the synchrony of emergence and reproduction must be very precise, thus assuring that the market is flooded, but only for a short time. Second, this flooding cannot be a very often event; otherwise, the composers simply do not have their own abundant young with an annual bounty. But if the period between episodes of flowering far exceeds the life-span of any predator, the cycle cannot be tracked except by one peculiar primate and records its own history. The advantage of synchronicity to individuals bamboo and cicadas is clear: it reduces the rate of out of step is quickly going up (the cicada "stragglers" do occasionally emerge in off years, but never gain a foothold).

The hypothesis of predator saturation, although unproved, meets...
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primary criterion of a successful plantation. It coordinates a suite of survations that would otherwise main unconnected and, in this case, downright peculiar. We know, for example, that bamboo seeds are shelled by a wide variety of animals including many vertebrates with life-spans; the rarity of flower cycles shorter than fifteen or two years makes sense in this context. Also know that the synchronous ting of seed can inundate an area. Janzen records a mat of six inches deep below the parent plant in one case. Two species Malagasy bamboo produced 50 kilograms (110 pounds) of seed per hectare (2.47 acres) over a large area 100,000 hectares during a single flowering.

The synchrony of three species among cicadas is particularly impressive—especially since years of emergence vary from place to place, with all three species invariably emerge together in any one area. But I am impressed by the timing of the cyclothems. Why do we have 13- to 17-year cicadas, but no cycles of 14, 15, 16, or 18 years? The numbers 13 and 17 share a common proper factor. They are large enough to exceed life cycle of any predator, but they also prime numbers (divisible by integer smaller than themselves). Many potential numbers have 2 and 5-year life cycles. These cycles reflect the availability of periodical cicadas (for they peak too often in years of nonemergence), but cicadas might be eagerly harved when the cycles coincide. Consider a predator with a cycle of five years. If cicadas emerged every fifteen years, each bloom would be hit by the predator. By cycling at a large prime number, cicadas minimize the number of coincidences (every 5 x 17 years, 85 years in this case). Cycles of 13 and 17 years cannot be tracked by smaller number.

Existence is, as Darwin states, struggle for most creatures. Weapons of survival need not be claws or teeth; patterns of reproduction may also serve. Occasional superfluity is one pathway to success. It is sometimes advantageous to all your eggs in one basket, but sure to make enough of them—don't do it too often.

Stephen Jay Gould teaches biology, and the history of science at Harvard University.
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Celestial Events

by Thomas D. Nicholson

Sun and Moon  The sun is moving eastward through the stars of Pisces until April 19, and then moves into Aries, where it remains until mid-May. This motion takes it progressively farther north of the equatorial plane, bringing longer days and shorter nights to the Northern Hemisphere. The moon is full on April 3, then moves into the morning sky to last-quarter on the 10th and new on the 18th. The early evening crescent moon should show up about April 20 or 21, waxing while it remains later in the evening sky through first-quarter on April 26 and full again on May 3. Last-quarter moon occurs again on May 9.

The sun and the moon will combine to produce four eclipses in 1977. The first, on April 3–4, is a partial lunar eclipse visible in the United States and Canada except in the extreme northwest. Later in the month (April 18), a solar eclipse will occur in the Southern Hemisphere, visible as a partial eclipse in a wide area. A penumbral lunar eclipse on September 26–27 and a solar eclipse on October 12 will also be seen from North America.

Stars and Planets  Of our three beautiful evening stars this past winter, only one remains on the evening Star Map for April. Venus is gone from the evening sky, becoming a morning star early in the month and reappearing low in the east at dawn by late April. Jupiter is still in the evening sky, but too low in the west to be shown on the map. It becomes visible at dusk in the southwest, in Taurus, just west of the v-shaped Hyades cluster, and then sets within a few hours. Saturn is still on our map, high in the south as darkness begins. It is in Cancer, about midway between the twin stars (Pollux and Castor) of Gemini and Regulus in Leo. Saturn sets soon after midnight.

Mercury is in favorable position as an evening star in the first half of April, low in the west after sunset. Venus and Mars are morning stars but not well placed for viewing.

April 3–4: Partial lunar eclipse in North America.
April 5: The moon is nearest the earth (perigee).
April 6: Venus, in inferior conjunction with the sun, becomes a morning star.
April 10: Mercury is at greatest easterly elongation.
April 11: Saturn resumes direct (easterly) motion.
April 18: Solar eclipse in the Southern Hemisphere, annular across southern Africa.
April 19: Mercury is in conjunction with the moon and begins its retrograde (westerly) motion.
April 20–21: The bright object near the moon is Jupiter.
April 22: Lyrid meteors (15 per hour) reach maximum.
April 24: Daylight time begins. Venus resumes direct motion.
April 30: Mercury, in inferior conjunction with the sun, becomes a morning star.

May 3–4: Perigee moon occurs 16 hours after full moon, producing tides that are stronger than usual.
May 5: The Eta Aquarid meteor shower reaches maximum. You may see up to 20 meteors per hour in the after-midnight sky.
May 11: Venus is at greatest brilliancy in the morning sky.
May 13–14: Venus and Mars are in conjunction on the 13th, each is in conjunction with the moon on the 14th, and the moon passes in front of Venus (an occultation) over parts of North America.

★ Hold the Star Map so the compass direction you face is at the bottom; then match the stars in the lower half of the map with those in the sky near the horizon. The map is for 11:15 P.M. on April 1; 10:20 P.M. on April 15; 9:25 P.M. on April 30; and 8:25 P.M. on May 15; but it can also be used for an hour before and after those times.
The Unnatural History of Tobacco
by Erik Eckholm

Cigarettes are both a health hazard and a source of revenue. Governments are thus ambivalent in their efforts to discourage smoking.

When accosting a tourist, a street waif in Cairo is as apt to beg for a cigarette as for coins. In the People’s Republic of China, a country renowned for its health-care campaigns, national leaders chain-smoke as they preside over the world’s largest tobacco industry. More than a decade after the United States government declared smoking to be a health hazard, four out of ten American males and three out of ten American females smoke—and the federal Department of Agriculture spends $50 million a year supporting the tobacco industry.

How is it that such a harmful product has become so firmly entrenched in daily life the world over? That tobacco occupies good farmland in India while peasants starve nearby? That the cigarette merchants are allowed to use Madison Avenue’s wiliest marketing techniques to cajole youngsters into a lifetime of smoking? Like a dime novel, the tale of the three-cent cigarette is one of intrigue, corporate power, and governmental hypocrisy; of human pleasure, addiction, and premature death.

“‘This vice will always be condemned and always clung to,’ wrote the perceptive Italian physician Bernardino Ramazzini in 1713 of tobacco use. Trying to figure out why Italian tobacco workers prized their jobs despite the severe head and stomach ailments tobacco dust inflicted upon them, Ramazzini, considered by many to be the father of industrial medicine, made another observation of equal present-day weight when he noted that ‘‘the sweet smell of gain makes the smell of tobacco less perceptible and less offensive to those workers.’”

Although the medical case against smoking has been conclusively established only within the last quarter century, tobacco has had powerful opponents, as well as powerful champions, almost from the moment sixteenth-century explorers gave Europe its first whiff. Yet from the beginning, the lure of profits, social fashions, and the association of tobacco with relaxation have all helped propagate its use. Today, despite the medical community’s consensus and exhortations, the smoking habit continues to spread throughout most of the world. Indeed, many countries are just now entering the era of tobacco-induced disease and death.

Native Americans were the first tobacco smokers, but their European conquerors turned smoking and other forms of tobacco use into global habits. Sir Walter Raleigh, the colorful favorite of Queen Elizabeth, popularized smoking in England during the late sixteenth century. The practice caught on fast and orders for tobacco were filled in Spain’s New World colonies. Upon Elizabeth’s death in 1603, however, British rule fell to James I, who forbade Raleigh’s smoking habit as objectionable as he found the courtier’s politics. (James eventually beheaded Raleigh for political reasons, but a nineteenth-century writer claimed that smokers could consider Raleigh “the first martyr in their cause.”)

James declared that tobacco was unhealthy, unholy, and a gander unbefitting a civilized society. He concluded his famous Counter Blaste to Tobacco, published 1604, by characterizing smoking a custom loathsome to the eye, hateful
bacco soon brought prosperity to the colony. It eventually became the economic backbone of the southeastern colonies despite strong opposition to reliance on this crop by the English king—and even by the founding colonial companies. The "sweet smell of gain" proved a potent force indeed, and although tobacco no longer dominates the economy of that region as totally as it once did, the tobacco industry still wields considerable force there and in other tobacco-producing areas of the world. And today, the tobacco market has a new dimension. On top of traditional public demand for tobacco, scientific image manipulation is used by the industry to try to create an ever larger market.

The popularity of one or another form of tobacco use has varied as standards of fashion have changed. Beginning in eighteenth-century England, for example, and for almost the next hundred years, the practice of sniffing snuff all but replaced the smoking habit. In this century, however, cigarettes have nearly everywhere edged out pipes, cigars, snuff, and chewing tobacco as the medium of choice. Unfortunately, cigarette smoking is probably the most dangerous of all forms of tobacco use.

Skillful marketing by the cigarette companies undoubtedly helped sell the public on cigarettes during the early twentieth century. But the power of advertising alone cannot completely account for the symbolic value with which cigarettes have been invested. Simple tubes of tobacco have come to represent modernity, savoir-faire, and, in the minds of children, who for decades have plunked down nickels for candy cigarettes and bubblegum cigars, adulthood. Hollywood may be one culprit. Humphrey Bogart would not be Humphrey Bogart without a cigarette dropping from his mouth, and the example of Lauren Bacall asking, "Got a match?" helped identify cigarettes as an essential social crutch. Even Bogart's death from cancer of the esophagus cannot dampen the identification of cigarettes with success and glamour that his movies and countless others continue to foster. In contemporary Soviet films, comments the satirical Moscow magazine Krokodil, "when an actor handsome like Apollo... takes a cigarette into his fingers, it isn't accidental. It means the time has come for a director to demonstrate that his character can also think."

Only recently has the compilation of an awesome medical case against cigarettes begun to tarnish the social sheen of smoking. Many thoughtful doctors had long suspected that cigarettes promoted ill health, but proof eluded researchers until the mid-twentieth century. Even in the early 1900s, cigarette advertisers could claim with impunity that their products actually promoted better health.

A startling jump in the number of lung cancer deaths in North America and Europe provided the first widely accepted proof of the hazards of smoking. In the nineteenth century lung cancer was relatively rare, but in the twentieth it rapidly emerged as the leading cause of cancer death in many countries. By 1950, studies in England and the United States showed an exceptionally close correlation between personal smoking habits and the incidence of lung cancer. By 1953, the prestigious New England Journal of Medicine could characterize the evidence linking cigarettes and lung cancer as "so strong as to be considered proof within the everyday meaning of the word."

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researchers independently established that smokers have a markedly higher over-all death rate than non-smokers. Yet the habit continued to spread, especially among adult females and teen-agers, who had lagged far behind adult males in adopting the practice, as well as among the wealthier classes in Africa, Asia, and Latin America.

In the early 1960s, two landmark public documents, which crystallized the evidence on the effects of smoking on health, caused something of a turning point in the social history of tobacco. Both a report released in 1962 by Britain’s Royal College of Physicians and one published in 1964 by the Surgeon General of the United States presented the massive and growing medical case against tobacco. These and other, similar documents prompted some governments to educate people about the hazards of smoking and to place partial restrictions on cigarette advertising. As a result, the word on smoking’s risks has now been fairly effectively disseminated, in the industrial countries at least. Most persons, even most heavy smokers, realize that smoking very possibly shortens their lives.

The most widely recognized health consequence of smoking is probably the heightened risk of lung cancer. The smoking—lung cancer connection is well known simply because avoidable lung cancer takes hundreds of thousands of lives around the world each year. Lung cancer deaths are much more common among males than females, but the gap is narrowing as the rise in female smoking, which began a quarter of a century ago, begins to make itself felt.

Past studies have shown that cigarette smokers are at least ten times more likely to develop lung malignancies than non-smokers. (Those smoking newer, low-tar cigarettes may face a somewhat lower, but still dramatic, rise in lung cancer risk.) Many researchers feel that tobacco is responsible for eight or nine of every ten lung cancers. Combinations of tobacco smoke with air pollution or with toxic substances in workplaces undoubtedly add to the cancer toll; tobacco smoke and certain other pollutants operate together to drastically multiply disease risks. For example, male asbestos workers who smoke have 92 times the lung cancer risk of males who neither smoke nor come into regular contact with asbestos.

But cigarettes alone almost certainly account for most lung cancer cases. Gino B. Gori, deputy director of the Division of Cancer Causes and Prevention of the U.S. National Cancer Institute, estimates that smoking 1 packs of cigarettes a day for a year exposes the lungs to nineteen times more benzopyrene—one of the probable carcinogens in cigarette smoke—than they would receive from breathing the polluted air of Los Angeles a year.

Other organs and tissues, besides the lungs, become especially cancer prone in chronic smokers. The smoking of pipes or cigars, as well as pipe or cigar smoking, raises a person’s odds of developing cancer of the mouth, throat, or voice box, particularly if the smoker is also a heavy drinker. Cigarette smoking also multiplies the smoker’s chances of developing cancer of the esophagus, pancreas, and bladder. But, more frequent and more deadly than the other malignancies, lung cancer poses a greater threat to the smoking life than all the other smoking-induced cancers together. After considering the entire spectrum of cancer and what is known about their cause, the president of the American Cancer Society recently stated: “Don’t smoke and you eliminate some to 20 percent of all cancer deaths. See this and many other countries.”

Despite the publicity that the cigarette—cancer connection has received, far more deaths arising from cigarette smoking involve coronary heart disease—the leading killer in most developed countries—than cancer. Smoking taxes the heart: a middle-aged American male who smokes twice as likely as a nonsmoking male to suffer a heart attack. Female smokers experience a less marked but still significant increase in the odds of having a heart attack. Moreover, smoking combines with other major risk factors, such as high blood cholesterol and high blood pressure, multiply manyfold the heart disease risk for both sexes.

The intense search for carcinoge in tobacco smoke has exposed as the principal agents provocation. Research on the heart and circulatory system, however, suggests that other smoke constituent—name carbon monoxide— influences coronary death rates. When males with heart conditions are experimentally exposed to heavy carbon monoxide
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concentrations, the chest pains of angina pectoris begin after less exercise than usual and persist longer than usual after exertion has stopped. Coronary patients have a limited capacity to supply their hearts with rich blood; exposure to carbon monoxide further reduces this capacity by impeding the transfer of oxygen from the blood to body tissue. Thus, carbon monoxide pollution places an added strain upon the heart and increases the likelihood that those already susceptible to heart attacks will experience them. (Nicotine inhalation seems to have the same effect.) Chronic heavy exposure to carbon monoxide may also promote the initial development of atherosclerosis, nonsmokers to die from chronic bronchitis or emphysema.

Perhaps the most telling of all evidence against cigarettes arises from a simple comparison of annual death rates between smokers and nonsmokers. The famous 1964 U.S. Surgeon General's report noted that the death rate of males smoking ten to nineteen cigarettes daily is 70 percent higher than that of nonsmokers. For those smoking forty or more cigarettes daily, the death rate is 120 percent higher. Nearly half the excess—and presumably avoidable—deaths that occur among smokers in a given year result from coronary heart disease, while more than one-sixth are caused by lung cancer.

which, over time, can lead to heart attacks. Studies show that lifelong smokers tend to have more severe coronary atherosclerosis than nonsmokers do, and animals exposed to carbon monoxide develop higher blood cholesterol counts and more atherosclerosis than unexposed animals.

Not surprisingly, cigarette smokers take on tremendously increased risks of developing long-term respiratory ailments such as chronic bronchitis and emphysema. Charged with causing tens of thousands of deaths and far more disabilities each year in Europe and North America alone, these diseases have emerged as recognized public health problems only during the last century. The twin onslaught on the lungs posed by industrial air pollution and tobacco smoke undoubtedly explains why chronic respiratory diseases are growing in frequency. But cigarettes seem to be the major contributor. Cigarette smokers are five times as likely as nonsmokers to die from chronic bronchitis or emphysema.

Since the major medical indictments of smoking appeared in the 1950s and early 1960s, further evidence that raises questions about human rights has accumulated. Voluntarily inhaling carbon monoxide and carcinogens is one thing; exhaling them into the air that others are forced to breathe is quite another. In a smoky room or car, nonsmokers inhale tar, nicotine, and carbon monoxide just as smokers do, and both groups register at least temporary changes in their bloodstreams. Breathing the exhaust of smokers can strain the heart of a coronary patient who does not smoke.

But the most potentially tragic victims of cigarettes are the infants of mothers who smoke. They are more likely than the babies of nonsmoking mothers to be born underweight and thus to encounter death or disease at birth or during the initial months of life. In an otherwise supportive environment, the infant is usually well equipped to withstand the impact of maternal smoking. But when other factors that imperil the newborn are present, for instance, poverty or maternal nutrition, heavy smoking by the mother nearly doubles the infant's odds of dying within a month of birth. Moreover, whether or not they are born underweight, the infants of smoking mothers suffer more infections, such as bronchitis, pneumonia, than other infants.

Many persons have extinguished their last cigarette after learning of health consequences of smoking. The United States the proportion of cigarette smokers among the population has fallen from 42 percent in 1964, the year in which Surgeon General's report appeared to 39 percent in 1975. Among females, the proportion of smoking fell from a high of 34 percent in 1970 to 29 percent in 1975. In Great Britain and several other countries, smoking have also shrunk in number. As a sound-best response to the perils of smoking, still other new and veteran smokers now buy cigarettes with relatively low amounts of tar and nicotine. The figures, then, show a significant, although hardly revolutionary, reversal of smoking trends in some of the more developed countries. This also shows that the decline in smoking has been especially marked among those with the most education. In the United States, half of all college graduates who have ever smoked regularly have dropped the habit.

The over-all downturn in U.S. smoking rates has been marred, however, by a notable exception—that accounts largely for the slight increase in over-all per capita cigar consumption since it hit its low point in recent history in 1970. Preceded by the continuous effort of tobacco advertisers to identify smoking with women's liberation, young women are narrowing the historic gender gap between male and female smoking rates. In fact, in the 15- to 16-year-old age group, a slightly higher proportion of girls (20 percent) than boys (18 percent) now smoke. Twenty-seven percent of all teen-agers in the United States now smoke regularly and the number is climbing here and in many other countries. But the World Health Organization committee has found especially troubling in light of the evidence finding that smoking during pregnancy has adverse effects on
Disaster is her way of life.

But in the next moment her world can begin to change.

Thanks to you.

Dora Maria's world is a cluster of cardboard shacks and lean-tos, ringed by sanitation ditches where sewage flows openly next to the street. It is built on what used to be a city dump. Everywhere, there is the stench of decomposing garbage. And the air is thick with flies.

Dora Maria plays in the waste as our children play in sandbox. She does not notice stench. Flies light on her face and nestle in her hair. She does not bother to brush them away. She doesn't think of store-bought dolls, new dresses or hot baths. The life she is leading is the only one she knows.

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...fetus." If, as one familiar cigarette advertisement patronizingly chants, women "have come a long way," their equality with men as smokers may lead to nothing more "liberating" than premature death.

Although the percentage of its population that smokes is somewhat smaller than it was a decade ago, the United States retains its long-standing title as the world's premier cigarette-smoking country. This is partly because so many Americans smoke and also because they tend to smoke more cigarettes per day than do most other smokers. About 2,750 cigarettes were smoked in 1974 for every person in the country. Only Japan, with a 1974 per capita consumption of 2,600 cigarettes, came close to the U.S. average. Astonishingly enough, 70 percent of all Japanese males smoke, although only 9 percent of Japanese females do. Annual per capita cigarette consumption in Western European countries ranges from 1,000 to more than 2,000; average consumption in Mexico is more than 700 a year; and per capita consumption in poor African countries, such as Nigeria and Tanzania, is still only a few hundred cigarettes per year.

These national cigarette-consumption averages provide little hint of the present smoking pandemic. While the incidence of cigarette smoking may have peaked in some of the developed Western countries, the practice has entered a dramatic growth phase in most of the less-developed countries. Cigarettes are catching on especially quickly in the cities of the poor countries. A recent Pan-American Health Organization survey in eight urban areas of Latin America revealed that 45 percent of males in those cities smoke; a higher percentage than in the United States. In contrast, only 18 percent of the females in these major Latin American cities are smokers. To capitalize on this new growth, the major cigarette companies are now as never before aiming their promotion at markets in the developing countries.

Cigarette smoking is not yet the national pastime in most of Africa and Asia that it is in Latin America, partly because average personal incomes in Africa and Asia are generally much lower than those in Latin America. Ironically, however, just when the smoking habit is being dropped by record numbers of the better-educated and better-off individuals in North America and Western Europe, the educational and economic growth of the world's poorer countries is leading their countrymen in taking the practice. Data from In Uganda, and elsewhere show that cigarette smoking is especially prevalent among university students.

Perhaps the chief constraint on cigarette use in poor countries is moral: only the rich can afford to enjoy them as an occasional smoke. As comes in Africa, Asia, and Latin America rise, however, both number of smokers and their smoking frequency climb as well. Rapid growth usually affects smoking rates perceptibly; oil-rich Middle Eastern countries are providing cigarette merchants with a hot new market. In Nigeria, lung cancer is rare, but a medical professor at La University warns that "lung cancer will emerge with the affluence generated by our country's oil economy; there will definitely be more smoking for cigarettes."

Smoking in poor countries is totally confined to urban areas. The practice still has long been entrenched in some rural regions. For example, shredded tobacco for hand-rolled cigarettes or pipes is a stock item in every Indonesian marketplace.

In China, the amount of tobacco grown in backyard plots for personal consumption probably rivals the output of the vast state-run tobacco industry. Contemplating the dim nutritional prospects of the Gurung, a hill tribe of Nepal, an anthropologist recently wrote that, faced with a finan pinch, the tribespeople would probably let themselves become "nourished rather than give up their cheap luxury goods such as cigarettes."

Who profits from the tobacco business? The list of those with a financial stake in the cigarette trade includes private and governmental tobacco farmers, huge transnational private cigarette companies and state-owned cigarette monopolies, local and national governments that depend in part upon tobacco-generated taxes and foreign exchange to survive, and the thousands of newspapers and magazines whose profits derive in part from the cigarette advertisements they carry.

The two leading tobacco-grow countries are the People's Republic of China and the United States; In the Soviet Union, and Brazil co-
but lag way behind. The world’s cigarette producers are, in part, the Chinese government monopoly, the British-American Tobacco Company, the Soviet government monopoly, the Japanese government monopoly, and Philip Morris Inc. Hence three of the top cigarette producers are public, rather than private, enterprises.

The nearly free functioning of cigarette companies in capitalist countries is predictable. But the seemingly unchecked power of tobacco interests the governments of controlled-market economies, such as China and the Soviet Union, is puzzling, particularly since both of those governments so strongly emphasize preventive medicine. While the Soviet government is at least trying to discourage smoking through public education, the Chinese government has done nothing to uproot the habit. Hunger and unsanitary living conditions were the overriding health challenges in China, an anticigarette campaign probably would have been a luxury. But now, following China’s dramatic success in reducing undernutrition and infectious disease, cigarette-induced ailments are on the increase. Admittedly, antismoking campaigns would probably strike the Chinese as hypocritical, since many powerful national leaders—including the late Chairman Mao—are heavy smokers. But upon his recent return from a visit to China, a U.S. Senate staff member offered a second explanation: the large tax on cigarette sales “serves as a major source of investment capital for the central government—a source not easily replaced and therefore not lightly abandoned.”

Many governments must view the tobacco trade with mixed emotions. As they boost cigarette and tobacco taxes and import duties—often ostensibly to discourage smoking—governments simultaneously create a major source of revenue that is far easier to justify, politically, than increases in other kinds of taxes. In many countries, the tax revenue from tobacco products exceeds the amount received by the farmers for the original tobacco crop. In 1974 in the United States, federal, state, and local governments took in about $6 billion in taxes on tobacco products, while the $4 billion in tobacco taxes received by the British government in that year constituted 70 percent of consumer expenditures on cigarettes. Even in Nigeria, where smoking’s grip is less well established, tobacco taxes provided 2.2 percent of all the tax income in 1969/70.

Held hostage to the political power of the tobacco and cigarette producers or lured by self-interest in the tobacco business or both, many governments actively subsidize tobacco production. Samuel Epstein, a physician whose specialty is environmental health, calculates that the U.S. Department of Agriculture spends about $50 million annually on price supports, tobacco research, export promotion, and other programs that support the tobacco industry. The nation’s Agricultural Research Service, he notes, “assigns more space to research on tobacco than to research on food distribution. What’s more, the ARS’s concern is to produce a more marketable product, not a safer product.”

Governmental hypocrisy in the treatment of tobacco becomes especially easy when tobacco and cigarette exports are involved. Foreign exchange is always welcomed by economic planners, and in this case, the negative health results are someone else’s concern. To help keep Italy’s tobacco exports competitive outside the European Economic Community, the EEC provides a subsidy of about ten cents for each pound of tobacco sold. The U.S. government ended its direct export payments in 1973, and terminated its practice of sharing equally with producers the costs of export promotion in 1975. But the federal government still finances tobacco booths at foreign trade fairs and trips of tobacco experts to and from the United States.

Perhaps the oddest and most questionable use of tobacco by the United States has been the inclusion of tobacco in the Public Law 480 “Food for Peace” program of concessional agricultural sales to needy countries. This supposedly humanitarian aid program has been manipulated to meet several goals at once: to get rid
of domestic tobacco surpluses, to introduce foreigners to U.S. tobacco in the hope of nurturing a future commercial market, and to provide economic aid to politically favored governments. The amount of tobacco shipped on easy terms under P.L. 480 has ranged in value from $17 to $35 million a year over the last decade, with the bulk going to areas of "national security" concern, such as South Vietnam, Cambodia, and, most recently, Egypt.

Those who design, print, or broadcast cigarette advertisements also benefit from the tobacco business. Far from reducing promotional fever, the ban on advertising cigarettes over television and radio in the United States and several other countries merely provided a windfall for the print media. The entire $250-million advertising budget of the American cigarette companies now goes totally to magazines and newspapers. Only a few major U.S. periodicals have refused to share in this money.

The mainstay of the tobacco business are, of course, the hundreds of millions of tobacco consumers—those who pay for both the pleasures and the lethal consequences of tobacco use. Social forces encourage people to start smoking and to cling to the habit, but the $85 to $100 billion that consumers spend each year on cigarettes is what sustains global cigarette production and trade.

In the ambiguity-plagued universe of environmental health studies, only rarely does proof emerge of an unequivocal link between a particular environmental agent and a particular disease. The air tight medical case against cigarettes stands out sharply as an exception. Cigarettes, therefore, explicitly challenge the capacity of societies to use the conclusions of health research to improve daily life. The selective vision of cigarette company executives and the smoke screen of cigarette advertising notwithstanding, today's meaningful debate is not over the possibility that cigarettes might be a public hazard—the only question concerns eliminating a proven hazard.

But decreasing the hold of cigarettes is no simple task. Pollution from cigarette smoke, unlike impure water or industrial wastes in the air, results primarily from personal decisions. Smoking, overnutrition, dangerous driving, and other forms of self-destruction are all health problems rooted in personal behavior, problems that often leave health officials perplexed and frustrated. Many persons with knowledge of the risks involved still persist in unhealthy behavior. How can public health officials influence them? Draconian interventions into people's lives might reduce smoking to a minimum, but at a social price few are willing to pay.

From childhood onward, people are constantly bombarded with subtle and not-so-subtle enticements to smoke; advertisements that associate cigarettes with sexual success are reinforced by what is probably a far stronger influence—the example set by countless smoking adults. Once they become smokers, individuals grow both psychologically and physiologically dependent on cigarettes. Although teen-agers may start smoking out of a desire to appear sophisticated and mature, they may continue long after that motive has lost its relevance because they are hooked on nicotine, an addictive drug.

The full social cost of cigarette smoking has never been calculated, but the purchase price of cigarettes, the extra medical expenses incurred by smokers, and the income that smokers sacrifice to unnecessary disease and premature death constitute only a portion of the total cost. A 1975 report to the Massachusetts Public Health Association estimated that Massachusetts smokers alone cost the state's general public more than half a billion dollars a year. If no one in the state smoked, fire protection costs would fall by at least $18 million and fire damage by at least $24 million a year. State medical costs provided from public funds or health insurance to treat smoking-induced diseases are $220 million a year. Production losses in the state totaling $260 million a year result from the working time missed because of smoking-related disease.

The cost of cigarettes includes, in addition to the above factors, the many hundreds of millions of dollars in public funds spent around the world each year on research on smoking-related cancer, heart, and respiratory diseases. Moreover, nonsmokers generally pay higher life insurance rates than they would if smokers were not included in the actuarial tables. The health hazard inflicted upon innocent bystanders provides another critical justification for government intervention to deter tobacco use.

Over the last few years many local and national governments have, in fact, restricted public smoking. Mow recently banned smoking in city's restaurants, while smoking public buildings and transport has been limited or prohibited many parts of the United States and Europe. Such laws are often laxly enforced, however. Interestingly, more than half of all current smokers poll in the United States in 1975 agree that cigarette smoking "should be lowered in fewer places than it is now.

Governments can weed out major contradictions from their present policies by ending subsidies to the tobacco industry. But in the end, only way to solve the smoking problem is to steer young people away from the habit and to help older smokers kick it. The vigorous, systemic use of all possible educational channels, advertising restrictions, prominent warnings on cigarette packages, tax disincentives, and so on might radically alter the smoking scene.

A different approach to the problem is to press ahead with the search for cigarettes that are lower in tar, carbon monoxide, and other toxics. Both the cigarette companies and the U.S. government are now involved in research toward that end. While opinions differ as to whether public funds ought to be diverted from antismoking campaigns in such research or whether all such expenses ought to be borne by the private companies, safer cigarettes undoubtedly reduce the health cost of smoking. The two goals, a non-smoking society and less harmful cigarettes, need not be viewed as contradictory; both can be pursued at once.

In the world's more developed countries, personal behavior has emerged as the dominant influence on health. The relevant personal choice is, in turn, influenced by the prevailing social and political environment. Societies cannot and, most won't agree, should not try to dictate mentally rational behavior to each individual. But neither should they encourage self-destructive behavior. U.S. psychologist Daniel Horn, one of the pioneers in the study of smoking and health, says, today's challenge is "to identify the means whereby we can help people whether children or adults—to develop the capability of understanding the issues in personal-choice head behavior, and the capacity to make choices both in their own self-interest and in the interest of society large.'"
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That’s me, my wife Britt, and my son Rick at Matagorda Beach. We come here so often as we can.”

Gulf Oil Corporation
Hot Spots

Peter R. Vogt

Most volcanic activity can be explained by plate tectonics. But some volcanic locations, such as Iceland and Hawaii, are still puzzling.

General acceptance of the idea of continental drift by geologists in the United States dates only from the late 1960s. The continents are now known to lie embedded like rafts in a floating oceanic crust, or "lithosphere," composed of the earth's upper mantle and the uppermost part of the outer core. The lithospheric plates move slowly about relative to each other (an inch or two per year). The motion of the 50- to 100-mile-thick plates causes earthquakes, volcanic action, and mountain building at the plates' edges. Plate motion and its consequences, including continental drift, are the result of a unifying tectonic concept known as "plate tectonics." Although now taken as virtual fact, tectonics is still being explained as a force, a mechanism that moves the plates. Most investigators agree that some sort of thermal convection in the earth's mantle drives the plates being relative to the frozen skin on top of this gushingly convulsing system. Plate tectonics explains the regular creation of new oceanic crust along the axis of the mid-oceanic ridge, where molten material wells up from within the mantle. It also explains the existence of curved festoons of volcanic islands like the Aleutians or the Marianas with their nearby deep-sea trenches and associated belts of intensive earthquake activity. These volcanic islands are surface expressions of oceanic plates descending into the mantle from which they were created tens or hundreds of millions of years before.

What plate tectonics by itself has not been able to explain is a collection of some dozens of relatively localized centers of intense volcanic activity, many of which are within the interiors of plates instead of at their margins. In this article, I refer to such localized volcanic areas as "hot spots." By that term I mean not only volcanoes of this type on the earth's surface but also the regions below them where the melting of volcanic material takes place. Although there appear to be more than 100 hot spots active at present on our planet, these spots do not expel equal amounts of material. Some discharge an average of more than one cubic mile of lava per century—most of it a dark, fine-grained rock called basalt—others less than one-thousandth as much. (Of course, centuries or even millennia may pass without any volcanic eruption at all.)

The most prominent hot spots currently active in the continental United States are in the area of Yellowstone National Park and the northeastern corner of New Mexico. Both are dwarfed by the hot spot at Hawaii. A map of the globe shows that the worldwide distribution of hot spots is not random. There are large "spotless areas" such as the western Atlantic and eastern North America. The distribution of hot spots does not correlate strongly with the continents or ocean basins but many prominent hot spots tend to be close to the mid-oceanic ridge.

The two most familiar and most spectacular examples of hot spots are Hawaii and Iceland. A detailed look at them may thus be the best way to approach the problem of what causes hot spots. It might at first seem outrageous to lump together two such seemingly diverse places: one, a necklace of green specks floating in the vast blue Pacific, which trails off in a westwardly direction from the towering volcanoes of the island of Hawaii—the "Big Island"—to deeply eroded smaller islands and finally to coral atolls and entirely submerged volcanic cones called seamounts; the other, a cold and stony hulk in the stormy North Atlantic, the emergent summit of a vast bulge of the Mid-Atlantic Ridge. But for all their differences, Hawaii and Iceland have several properties in common—both represent unusual and long-lived volcanic activity that dates back tens of millions of years and seems to migrate over the lithospheric plates with time. The volcanic activity of Iceland is unusual because it is several times greater than that occurring elsewhere along the Mid-Atlantic Ridge. And the copious volcanism of Hawaii is unusual because it occurs in the midst of a million square miles of volcanic quiescence, far from the nearest mid-oceanic ridge.

Iceland contains numerous volcanoes of various kinds and is one of the most active volcanic regions on earth. Most of its recent volcanic activity is restricted to a few belts that
extend northwest through the middle of the island. Rocks at the center of the island are new and young, but as one moves either westward or eastward away from the center, the rocks get progressively older, dating back fifteen million or more years at the eastern and western coasts. Massive submarine extensions form a transverse ridge, perpendicular to the axis of the Mid-Atlantic Ridge. Where the transverse ridge emerges above sea level in Greenland and the Faeroes, volcanic rocks that erupted about sixty million years ago cap the ridge edges. Thus, whatever is causing the profuse volcanic activity on Iceland today has existed more or less continuously for sixty million years.

In the case of Hawaii, the islands west of the volcanically active Big Island get progressively older and volcanically deader. Whatever produced the Hawaiian segment and its continuation as the Emperor seamounts must have existed for at least the last seventy million years, since that is the age of the oldest surviving seamounts at the northern end of the chain. These seamounts will disappear when the leading edge of the Pacific plate that carries them descends into the deeper mantle below the Aleutian arc.

The progressive aging of volcanic rocks the farther away they lie from the area of recent activity is not a new discovery. The nineteenth-century American geologist James Dwight Dana deduced the effect in 1838 from his observation that the Hawaiian Islands are more eroded and less active volcanically the farther west one goes. It was not, however, until radiometric dating methods were applied to the Hawaiian Islands a century later, that Dana was proved correct. But the systematic aging in a certain direction could not itself be understood until plate tectonics came along in the mid-1960s. It was then that the Canadian geophysicist J. Tuzo Wilson conceived the basic explanation of the hot spot.

There must be a relatively fixed region of persistent mantle melting below the lithospheric plates, Wilson reasoned. This region, the hot spot,

The earth’s crust is a thin outer shell, 10 to 40 kilometers deep. The lithosphere, which includes both the crust and the uppermost part of the mantle, is the 50- to 200-km-thick rigid material of which the earth’s drifting plates are composed. The next layer, about 500 km thick, is the semimolten asthenosphere over which the plates move. Below that are some 2,200 km of rocky mantle. Next is the 2,100-km liquid outer core and then the 1,370-km solid inner core.
ting to the last five to ten million years indicate that hot spots have not moved, although information from earlier times suggests that they may have. In my view, hot spots apparently do not move—or if they do, they generally move more slowly than lithospheric plates. This relative fixity of hot spots was shown in 1971 by W. Jason Morgan, a geophysicist at Princeton University, by means of paleomagnetic data.

The magnetism in certain rocks records the direction toward which the magnetic poles as well as the latitude at which the rocks were originally formed. If the area in which the rocks are currently found is part of a moving lithospheric plate, the magnetism in the rocks can provide information about the motion of the plate. Morgan showed that hot spot traces in data on rock magnetism yield a consistent picture of plate motion if a cause of the hot spots is geographically fixed.

Hot spot tracks have thus proved useful in reconstructing the actual motion of the plates over the past with respect to the deep mantle. The tectonics only describes the relative motions between plates. For example, two plates might be moving apart eastward and westward, but if they are moving in this way relative to each other, both could be moving northward over the deeper mantle.

The relative fixity of hot spots had other and perhaps deeper significance. It was one of the observations that led Morgan to make the mental leap from Wilson's hot spots to the idea of thin columns of relatively hot mantle rising in the earth's mantle. Such columns, or "convection lanes," express itself as a hot spot. Plumes possibly extending as far as 1,800 miles to the bottom of the earth's mantle would not be expected to shift rapidly about. Morgan's hypothesis likened the plumes to "thunderheads" in the atmosphere. They were postulated as rising at rates of rapid (2 meters, or 6 1/2 feet, per year), narrow upward convection lanes of hot mantle material that spreads out in the upper mantle and then sinks slowly in regions distant from the site of origin to complete the convection circuit. This was a novel approach to the old idea of mantle convection, according to which convection is not restricted to narrow zones but consists of wide cylindrical cells.

Alternative theories try to explain linear volcanic chains, like the Hawaiian Islands, in terms of gradually advancing fractures in the lithospheric plate, magma being thought to be potentially available everywhere at sufficient depth. In the Pacific, such fractures would have to extend southeastward and close up at the rear as they progress, otherwise there would be volcanic activity all along the chain. The hot but rigid rock of the lower lithosphere would be induced to melt when the fracture temporarily released some of the pressure of the overlying material.

Is there any way to prove that hot spots are really evidence of rising convection plumes? In Morgan's model, the top of the plume is in the soft, semimolten earth layer just below the lithospheric plates. This mushy zone is commonly referred to as the "asthenosphere." Plumes bring material up vertically out of the deeper mantle; at depths of about a hundred miles, the first tiny melt pockets develop in the hard but plastic rock. This partially molten "crystal mush" then moves radially outward into the asthenosphere, much as a glacier moves away from a mountain. The greatest amount of melting would occur directly above the rising plume, thus causing the observed volcanic activity at the hot spot. Although other theories about hot spots could also account for the volcanism, the outflow of molten material into the asthenosphere is a specific prediction unique to the plume model. The theory would receive support if such a flow below the plates could be measured.

In 1971, the same year Morgan introduced his mantle plume ideas, a research team from Columbia University published the results of a 1966 geophysical research cruise to the Reykjanes Ridge off the coast of Iceland. Their measurements suggested to the possibility that flow below the plates—specifically, flow away from the Iceland hot spot—could be measured and used to demonstrate that Morgan's mantle plume theory is valid.

Projecting southwest from Iceland, the Reykjanes Ridge forms a northern extension of the Mid-Atlantic Ridge. The Reykjanes Ridge has a crestal zone of elevated volcanic topography close to the line where new magma is coming up. This "line" is a narrow zone, no more than a few miles wide, where new crust is being added to the steadily diverging American and Eurasian plates, to the accompaniment of frequent earthquakes and submarine volcanism. The crestal zone of the Reykjanes Ridge shoals gradually northeastward and then emerges in Iceland as Reykjanes, a peninsula. The capital city of Reykjavik, on the peninsula, is on the very edge of the American plate, on ocean crust so young and hot that geothermal waters can be tapped only a few hundred to a few thousand feet below the surface. Reykjavik is heated by these waters. A few miles to the

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The World's Active Hot Spots
southeast one can walk along the lava flows of the newly born "ocean crust" of Reykjanes and across to the Eurasian plate, of which eastern Iceland is a part. In addition to the Reykjanes Ridge crest, there is a second young volcanic belt—one that includes such famous volcanoes as Hekla, Katla, Surtsey, and Heimaey—still farther east. It appears that the line demarcating sea-floor separation is in the process of shifting to the eastern zone of volcanoes. If so, the volcanic fires of Reykjanes may someday—perhaps in a million years—be shifted. Shifts such as the above are not too common in the world ocean; the fact that many of the known shifts have occurred near hot spots tends to lend credence to the plume theory. Outward flow from plumes could help break plates apart or weaken them so much that other forces could separate them.

If there is a flow below the plates, does it spread out evenly in all directions? Probably not. Since plates get thicker with age—at the expense of the underlying soft layer—a natural conduit is formed below the mid-oceanic ridge. Much of the plume flow would be channeled into this "pipe"; irregularities in the flux leave a record of flow speed imprinted like frozen waves on the ocean crust. The mid-oceanic ridge and the pipe below it are displaced at major fracture zones. Such displacements would block or interrupt the flow in the mid-oceanic pipe to various degrees. The result of these new discoveries is a complex plumbing system wherever plumes exist below the mid-oceanic ridge, for example, near Iceland, the Azores, or the Galápagos Islands in the Pacific.

Independent verification of flow below the crest of the Mid-Atlantic Ridge and even of damming at transform faults—fractures in the earth's crust that tend to run at right angles to the ocean ridges—has emerged from the geochemical studies at the University of Rhode Island, which found Icelandic volcanic rocks derive from a distinct plume-type mantle. As the mantle flows under the Reykjanes Ridge, it becomes mixed with "normal" mantle, that is, mantle distant from plumes, with the result that basalts dredged along the Reykjanes Ridge become progressively less "Icelandic" in their chemistry as distance from the hot spot increases. North of Iceland the Icelandic chemistry disappears abruptly across a major fracture that is displaced from the axis of sea-floor spreading. This abrupt cutoff of rock of Icelandic type composition can be explained if northward flow from the Icelandic plume has been dammed at the fracture.

Are there any other measurements we can make of what is going on below the plate in the deep mantle, other than of the particular topography found near Iceland, that might help us understand the cause of hot spots? If hot spots are mantle plumes that extend upward from their origin at great depth, one might expect the rising material to differ somewhat in its physical properties from that in the surrounding mantle. If so, seismic waves generated by earthquakes or atomic explosions might be slowed or bent as they passed through different materials in the rising plume. Since a plume is very narrow on the scale of the earth, an earthquake would have to occur at just the right location, with respect to the seismograph, for the waves it generates to intercept the plume. To date, there have been some reports that seismic waves generated in the western Pacific island arcs and recorded in western Canada have been affected by anomalous conditions as they passed above the earth's core-mantle boundary directly under Hawaii. But several investigators have disputed these interpretations, and the question of whether the physical properties of the mantle are distinctive at great depths in the mantle below the area of current hot spot volcanism is an open one.

Seismology can only indicate the present state of the earth. What we should really have is a historical index of activity that shows, for example, how many cubic miles of mantle the plume brings upward per year over periods of geologic time. Needless to say, there is no direct way to measure the upward flow in a mantle plume. However, the average annual rate of lava and ash poured out by a hot spot's volcanoes can be measured. To compute from this measurement the volume of mantle brought up, we would have to know what fraction of mantle actually melts and escapes to the earth's surface. The chemistry of the basalts involved indicates that the rate of volcanic discharge needs to be multiplied by an average from 10 to 100 to give the volume of mantle that produced the lavas.

There are two possibilities for estimating volcanic discharge rate. First, the volcanoes can be monitored as the volume of erupted rocks measured directly after each eruption. Since volcanoes are notoriously erratic—many years may elapse between eruptions—a long historic observation record may be necessary to establish a geologically meaningful, long-term average eruption rate. Accurate records of measured erupted rocks are a recent development. On Hawaii, where the volcanoes discharge copiously, accurate lava flow measurements extend back only to the last century. The currently most active volcano is Kilauea on the island of Hawaii: over the period from 1952 to 1971, Kilauea discharged an average of 60 million cubic yards of lava per year. Since the early nineteenth century, the average combined annual discharge of Kilauea and Mauna Loa has been about 1 million cubic yards, but this must be considered a lower limit since little is known about nineteenth-century submarine eruptions. During actual eruptions, the discharge rate of lava may be hundreds of times higher, course, just as rainfall rates may be much higher during a storm than an averaged over a year.

The second way to estimate volcanic discharge rate—one I have made use of—involves estimates of the Hawaiian chain into fifteen-mile-wide strips running across the chain from the southwest to the northeast. The volume of volcanic topography—that is, islands, submerged island bases, and seamounts—above the abyssal sea floor was calculated by subtracting the volume under the sea floor.

When the Helgafell volcano on the Icelandic island of Heimaey erupted in January 1971, houses in the fishing village of Vestmannashejar were almost buried in volcanic ash.
tions of the million-year average.

But when we examine the output of the Hawaii hot spot over still longer time periods—say, ten million years—it is no longer true that productivity can have remained constant. Since there are now numerous rock age dates along the Hawaii-Emperor chain, the massive portions of the chain around Gardner Pinnacles, west of Ni‘ihau, and, likewise, between Oahu and Hawaii seem to represent a higher than average lava discharge rather than slowdowns of the Pacific plate. (If a plate slows down while discharge remains constant, we should also expect the volcanic chain to become more massive.) The topography of the Hawaiian Islands clearly shows a progressively increasing discharge that began about six million years ago—the time when Kauai and Ni‘ihau islands were formed at the geographic site currently occupied by the Big Island, namely, over the Hawaii hot spot. The Big Island is aptly named—I cannot think of a larger, purely volcanic island, either visible or sunk below the sea, with the single exception of Iceland. And Iceland is largely a bulge in the ocean floor itself, not a volcanic edifice constructed, lava flow by lava flow, from the abyssal depths. In terms of the surviving seventy-million-year volcanic trail left on the Pacific plate by the Hawaii hot spot, the “geologic present”—that is, the last one or two million years—has been truly exceptional.

What about the discharge rates of other hot spots around the world? Most are less well known than Hawaii and less plentiful in their volcanic output. I have compiled discharge histories of a number of hot spots, with the following surprising result: There seems to be a globally synchronized waxing and waning of volcanic discharge rates at widely spaced hot spots. For example, the twelve- to eighteen-million-year-old peak in discharge rate that produced the massive part of the Hawaiian Ridge near Gardner Pinnacles and French Frigate Shoal corresponds in time to the extrusion of the vast Columbia basalts in Oregon by a hot spot at present...
Iceland's Hekla Volcano had been quiescent for about 5,000 years before it suddenly exploded in 1973 to the surprise of local residents.
under Yellowstone National Park. That peak discharge rate marked the beginning of strong volcanic activity in the Canary and Cape Verde islands and other hot spots. The increasingly abundant volcanism of the last six million years also affected various other hot spots in addition to Hawaii.

If a seeming correlation between the ups and downs of volcanic activity at different hot spots was unexpected, so was the finding that ash layers in oceanic drill cores revealed discharge highs for the same periods—from twelve to eighteen million years ago and from six million years to the present. Most of this ash does not come from hot spot volcanoes. It comes instead primarily from the notoriously explosive volcanoes situated along such island arcs as the Aleutians, Kuriles, Japan, and the West Indies, where oceanic plates descend into the mantle. The available evidence suggests to me that the world’s volcanoes belch simultaneously in a global chorus, a result as surprising as it is unexplained. (By “simultaneously” I am, of course, referring to million-year averages, not annual averages.) Why should hot spot volcanoes and island arc volcanoes vary their output concurrently? One possibility might be that plume convection, responding to episodic instabilities deep in the mantle, accelerates the plates, which in turn cause more island arc volcanism as they are forced into the mantle at a higher rate.

Whatever the cause of hot spots may be, there is still much that we have yet to learn about them. For example, are they truly fixed or do they possibly move with respect to each other? Do they contribute in a manner not now understood to the process of continental drift? More specifically, will the Big Island of Hawaii grow bigger still or be succeeded by an even more spectacular massif of overlapping volcanoes to the southeast? Alternatively, will the volcanic hot spot trails of the Hawaiian chain dwindle once again, as they did after the previous high, twelve to eighteen million years ago?

W. Jason Morgan, who originated the mantle plume idea, has suggested a rise speed of about 2 meters (6½ feet) a year for mantle material in an ascending plume. At that rate it would take one or two million years for an increase or decrease in plume activity to take effect on the earth surface after originating at depths great as the core—mantle boundary. Our volcanic future a few million years hence—with all its possible consequences—may therefore already be preordained deep in the mantle.

The Hawaii hot spot, whose surface expression is marked today by Mauna Loa, above and Kilauea, right, has been astonishingly vigorous during the last few million years and continues to remain so. Since the early nineteenth century, for example, an average combined annual discharge rate of these two volcanoes has been about 35 million cubic yards.
human sacrifice was meant to appease the appetites of the gods—and of the Aztecs themselves.

On the morning of November 8, 1519, a small band of bearded, dirty, exhausted Spanish adventurers stood on the edge of a great inland lake in central Mexico, staring in disbelief at the sight before them. Rising from the interior of the lake was a magnificent land city, shining chalk white in the early sun. Stretching over the lake were long causeways teeming with travelers to and from the metropolis, Tenochtitlan, the capital of the Aztec empire, now known as Mexico City.

The Spaniards, under the command of Hernán Cortés, were fresh from the wars of the Mediterranean and the conquest of the Caribbean. Tough and ruthless men, numbering fewer than four hundred, they had fought their way up from the eastern tropical coast of Mexico. Many had been wounded or killed in battles with hostile Indians on the long march. Possibly all would have died but for their minuscule cavalry of fifteen horses—which terrified the Indians, who thought the animals were gods—and the aid of a small army of Indian allies, enemies of the Aztecs.

The panorama of the Aztec citadel across the water seemed to promise the Spaniards the riches that had eluded them all their lives. One of them, Bernal Díaz del Castillo, later wrote: “To many of us it appeared doubtful whether we were asleep or awake... never yet did man see, hear, or dream of anything equal to our eyes this day.” For the Spaniards, it was a vision of heaven.

Slightly more than a year and half later, in the early summer of 1521, it was a glimpse of hell. Again the two sixteenth-century drawings from the Florentine Codex of Bernardino Sahagún. At left, the victim’s heart is offered to the sun. At right, priests sacrifice a youth who had been chosen to personify the Aztec deity Tezcatlipoca for a year. Accompanied by a retinue, the future victim often strolled as a god on earth, playing one of his clay flutes. When he finally ascended to the temple-pyramid altar, he broke his flutes, one by one, on the steps. The vast majority of victims did not enjoy such presacrificial status.
Spaniards found themselves on the lakeshore, looking toward the great capital. But this time they had just been driven back from the city by the Aztec army. Sixty-two of their companions had been captured, and Cortés and the other survivors helplessly watched a pageant being enacted a mile away across the water on one of the major temple-pyramids of the city. As Bernal Díaz later described it,

The dismal drum of Huichilobos sounded again, accompanied by conches, horns, and trumpetlike instruments. It was a terrifying sound, and when we looked at the tall cué [temple-pyramid] from which it came we saw our comrades who had been captured in Cortés’ defeat being dragged up the steps to be sacrificed. When they had hauled them up to a small platform in front of the shrine where they kept their accursed idols we saw them put plumes on the heads of many of them; and then they made them dance with a sort of fan in front of Huichilobos. Then after they had danced the papás [Aztec priests] laid them down on their backs on some narrow stones of sacrifice and, cutting open their chests, drew out their palpitating hearts which they offered to the idols before them.

Cortés and his men were the only Europeans to see the human sacrifices of the Aztecs, for the practice ended shortly after the successful Spanish conquest of the Aztec empire. But since the sixteenth century, Aztec sacrifice has persisted in puzzling scholars. No human society known to history approached that of the Aztecs in the quantities of people offered as religious sacrifices: 20,000 a year is a common estimate.

A typical anthropological explanation is that the religion of the Aztecs required human sacrifices; that their gods demanded these extravagant, frequent offerings. This explanation fails to suggest why that particular form of religion should have evolved when and where it did. I suggest that the Aztec sacrifices, and the cultural patterns surrounding them, were a natural result of distinctive ecological circumstances.

Some of the Aztecs’ ecological circumstances were common to ancient civilizations in general. Recent theoretical work in anthropology indicates that the rise of early civilizations was a consequence of the pressures that growing populations brought to bear on natural resources.

As human populations slowly multiplied, even before the development of plant and animal domestication, they gradually reduced the wild flora and fauna available for food and disrupted the ecological equilibriums of their environments. The earliest strong evidence of humans causing environmental damage was the extinction of many big game species in Europe about 10,000 B.C., and in Amer- north of Mexico by about 9,000 B.C. Simultaneously, human population in broad regions of the Old and New Worlds had to shift increasingly from marine food resources and small game hunting. Finally, declining quantities of wild game and food plants made domestication of plants and animals essential in most regions of the planet.

In the Old World, domestication herbivorous mammals, such as cattle, sheep, and pigs, proceeded at that of food plants. By about 7,200 B.C. in the New World, however, ancient hunters had completely eliminated herbivores suitable for domestication from the area anthropologists call Mesoamerica, the
on of the future high civilizations of Mexico and Guatemala. Only in the Andean region and southern South America did some camel-related species, especially the llama and the alpaca, manage to survive hunters’ onslaughts, and thus could be domesticated later, along with another important local herbivore, the guinea pig. In Mesoamerica, the guinea pig was unavailable, and the Camelidae species became extinct several thousand years before domesticated food production had to be seriously undertaken. Dogs, such as the Mexican hairless, and wildfowl, such as the turkey, had to be bred for protein. The dog, however, was a far from satisfactory solution because, as a carnivore, it competed with its feeders for animal protein. The need for intensified domesticated food production was felt early, anthropologist Robert Carneiro has pointed out, by growing populations of fertile localities circumscribed by rain poorly suited to farming. In such cases, plants always became domesticated, climate and environment permitting, but herbivorous mammals apparently could not, unless appropriate species existed. In Mesoamerica, the Valley of Mexico, with its fertile and well-watered bottoms surrounded by mountains, fits well Carneiro’s environmental model. In this confined area, population was increasing up to the time of the Spanish conquest, and the supply of wild game was declining. Deer were nearly gone from the Valley by the time of Aztec rule.

The Aztecs responded to their increasing problems of food supply by intensifying agricultural production with a variety of ingenious techniques, including the reclamation of land from marsh and lake bottoms in the chinampa, or floating garden, method. Unfortunately, their ingenuity could not correct their lack of suitable domesticable herbivores to provide animal protein and milk. Hence, the ecological situation of the Aztecs and their Mesoamerican neighbors was unique among the world’s major civilizations. I have recently proposed the theory that large-scale cannibalism, disguised as sacrifice, was the natural consequence of these ecological circumstances. The contrast between Mesoamerica and the Andes, in terms of the existence of domesticated herbivores, was also reflected in the numbers of human victims sacrificed in the two areas. In the huge Andean Inca empire, the other major political entity in the New World at the time of the conquest, annual human sacrifices apparently amounted to a few hundred at most. Among the Aztecs, the numbers were incomparably greater. The commonly mentioned figure of 20,000, however, is unreliable. For example, one sixteenth-century account states that 20,000 were sacrificed yearly in the capital city alone, another reports this as 20,000 infants, and a third claims the same number as being slaughtered throughout the Aztec empire on a single particular day. The most famous specific sacrifice took place in 1487 at the dedication of the main pyramid in Tenochtitlan. Here, too, figures vary: one source states 20,000, another 72,344, and several give 80,400.

In 1946 Sherburne Cook, a demographer specializing in American Indian populations, estimated an overall annual average of 15,000 victims in a central Mexican population reckoned at two million. Later, however, he and his colleague Woodrow Borah revised his estimate of the total central Mexican population upward to 25 million. Recently, Borah, possibly the leading authority on the demography of Mexico at the time of the conquest, has also revised the estimated number of persons sacrificed in central Mexico in the fifteenth century to 250,000 per year, equivalent to one percent of the total population. According to Borah, this figure is consistent with the sacrifice of an estimated 1,000 to 3,000 persons yearly at the largest of the thousands of temples scattered throughout the Aztec Triple Alliance. The numbers, of course, were fewer at the lesser temples, and may have shaded down to zero at the smallest.

These enormous numbers call for consideration of what the Aztecs did with the bodies after the sacrifices. Evidence of Aztec cannibalism has been largely ignored or consciously or unconsciously covered up. For example, the major twentieth-century books on the Aztecs barely mention it; others bypass the subject completely. Probably some modern Mexicans and anthropologists have been embarrassed by the topic: the former partly for nationalistic reasons; the latter partly out of a desire to portray native peoples in the best possible light. Ironically, both these attitudes may represent European ethnocentrism regarding cannibalism—a viewpoint to be expected from a culture that has had relatively abundant livestock for meat and milk.

A search of the sixteenth-century literature, however, leaves no doubt as to the prevalence of cannibalism among the central Mexicans. The Spanish conquistadores wrote amply about it, as did several Spanish priests who engaged in ethnological research on Aztec culture shortly after the conquest. Among the latter, Bernardino de Sahagún is of particular interest because his informants were former Aztec nobles, who supplied dictated or written information in the Aztec language, Nahua.

According to these early accounts, some sacrificial victims were not eaten, such as children offered by drowning to the rain god, Tlaloc, or persons suffering skin diseases. But the overwhelming majority of the sacrificed captives apparently were consumed. A principal—and sometimes only—objective of Aztec war expeditions was to capture prisoners for sacrifice. While some might be sacrificed and eaten on the field of battle, most were taken to home communities or to the capital, where they were kept in wooden cages to be fattened until sacrificed by the priests at the temple-pyramids. Most of the sacrifices involved tearing out the heart, offering it to the sun and, with some blood, also to the idols. The corpse was then tumbling down the steps of the pyramid and carried off to be butchered. The head went on the local skull rack, displayed in central plazas alongside the temple-pyramids. At least three of the limbs were the property of the captor if he had seized the prisoner without assistance in battle. Later, at a feast given at the captor’s quarters, the central dish was a stew of tomatoes, peppers, and the limbs of his victim. The remaining torso, in Tenochtitlan at least, went to the royal zoo where it was used to feed carnivorous mammals, birds, and snakes.

Recent archeological research
lends support to conquistadores’ and informants’ vivid and detailed accounts of Aztec cannibalism. Mexican archeologists excavating at an Aztec sacrificial site in the Tlatelolco section of Mexico City between 1960 and 1969 uncovered headless human rib cages completely lacking the limb bones. Associated with these remains were some razorlike obsidian blades, which the archeologists believe were used in the butchering. Nearby they also discovered piles of human skulls, which apparently had been broken open to obtain the brains, possibly a choice delicacy reserved for the priesthood, and to mount the skulls on a ceremonial rack.

Through cannibalism, the Aztecs appear to have been attempting to reduce very particular nutritional deficiencies. Under the conditions of high population pressure and class stratification that characterized the Aztec state, commoners or lower-class persons rarely had the opportunity to eat any game, even the domesticated turkey, except on great occasions. They often had to content themselves with such creatures as worms and snakes and an edible lake-surface scum called “stone dung,” which may have been algae fostered by pollution from Tenochtitlán. Preliminary research seems to indicate that although fish and fowl were taken from the lakes, most of the Aztec poor did not have significant access to this protein source and were forced to be near-vegetarians, subsisting mainly on domesticated plant foods such as maize and beans.

The commoners theoretically could get the eight essential amino acids necessary for building body tissues from maize and beans. (A combination of the two foods complement each other in their essential amino acid components.) However, recent nutritional research indicates that in order to assure that their bodies would use the eight essential amino acids to rebuild body tissues, and not simply siphon off the dietary protein as energy, the Aztec commoners would have had to consume large quantities of maize and beans simultaneously or nearly simultaneously year-round. But crop failures and famines were common. According to Durán, a sixteenth-century chronicler, poor people often could not obtain maize and beans in the same season, and hence could not rely upon these plants as a source of the essential amino acids. How did the Aztecs know they needed the essential amino acids? Like other organisms perfected under natural selection, the human body is a homeostatic system that, under conditions of nutritional stress, tends to seek out the dietary elements in which it is deficient. Without this innate capacity, living organisms could not survive.

Another Aztec dietary problem was the paucity of fats, which were so scarce in central Mexico that the Spaniards resorted to boiling down the bodies of Indians killed in battle in order to obtain fat for dressing wounds and tallow for caulking boats. While the exact amount of fatty acids required by the human body remains a subject of uncertainty among nutritionists, they agree that fats, due to their slower rate of metabolism, provide a longer-lasting energy source than carbohydrates. Fatty meat, by providing not only fat, which the body will use as energy, but also essential proteins, assures the utilization of the essential amino acids for tissue building. Interestingly, prisoners confined by the Aztecs in wooden cages prior to sacrifice could be fed purely on carbohydrates to build up fat.

In contrast to the commoners, the Aztec elite normally had a diet enriched by wild game imported from the far reaches of the empire where species had not been so depleted. But even nobles could suffer from famines and sometimes had to sell their children into slavery in order to survive. Not surprisingly, the Aztec elite apparently reserved for themselves the right to eat human flesh, and conveniently, times of famine meant that the gods demanded appeasement through many human sacrifices.

At first glance, this prohibitive against commoners eating human flesh casts doubt on cannibalism’s potential to mobilize the masses of Aztec society to engage in wars for prisoners. Actually, the prohibitive was, if anything, a goad to the lower class to participate in these wars since those who single-handedly took captives several times gained the right to eat human flesh. Successful warriors became members of the Aztec elite and their descendants shared the privileges. Through the reward of flesh-eating rights to the group in need of them, the Aztecs assured themselves an aggressive war machine and were able to motivate the bulk of the population, the poor, to contribute to state and upper-class maintenance through active participation in offensive military operations. Underlying the war machine, victories, and the resultant sacrifice were the ecological extremities of the Valley of Mexico.

With an understanding of the importance of cannibalism in Aztec culture, and of the ecological reasons for its existence, some of the Aztec more distinctive institutions begin to make anthropological sense. For example, the old question of whether the Aztecs’ political structure was not an “empire” can be reexamined. One part of this problem is that the Aztecs frequently withdrew from conquered territories without establishing...
ing administrative centers or garrisons. This “failure” to consolidate request in the Old World fashion puzzled Cortés, who asked Moctezuma to explain why he allowed the surrounded Tlaxcalans to maintain their independence. Moctezuma reportedly replied that his people could thus obtain captives for sacrifice. Since the Aztecs did not normally eat people of their own polity, which would have been socially and politically disruptive, they needed nearby “enemy” populations on whom they could prey for captives. His behavior makes sense in terms of Aztec cannibalism: from the Aztec point of view, the Tlaxcalan state was reserved as a stockyard. The Aztecs were unique among the world’s states having a cannibal empire. Understandably, they did not conform to Old World concepts of empire, based economies with domesticated herds providing meat or milk. The ecological situation of the Aztecs was probably an extreme case problems general to the high population pressure societies of Mesoamerica. Cannibalism encouraged the definition of the gods as eaters of human flesh and led almost inevitably emphasis on fierce, ravenous, and carnivorous deities, such as the jaguar and the serpent, which are characteristic of Mesoamerican pantheons. Pre-Columbian populations could, in turn, rationalize the more grisly aspects of large-scale cannibalism as consequences of the gods’ demands. Mesoamerican cannibalism, disguised as propitiation of the gods, bequeathed to the world some of its most distinctive art and architecture. The temple-pyramids of the Maya and the Toltecs, and of the pre-Aztec site at Teotihuacán in the valley of Mexico, resemble those of the Aztecs in appearance and probably had similar uses. Even small touches, such as the steepness of the steps on pyramids in Aztec and other Mesoamerican ruins, become understandable given the need for efficiently tumbling the bodies from the sacrificial altars to the multitudes below. Perhaps those prehistoric scenes were not too dissimilar from that which Bernal Díaz described when his companions were sacrificed before his eyes in Tenochtitlán:

Then they kicked the bodies down the steps, and the Indian butchers who were waiting below cut off their arms and legs and flayed their faces, which they afterwards prepared like glove leather, with their beards on, and kept for their drunken festivals. Then they ate their flesh with a sauce of peppers and tomatoes.

Gruesome as these practices may seem, an ecological perspective and population pressure theory render the Aztec emphasis on human sacrifice acceptable as a natural and rational response to the material conditions of their existence. In *Tristes Tropiques*, the French anthropologist Claude Levi-Strauss described the Aztecs as suffering from “a maniacal obsession with blood and torture.” A materialist ecological approach reveals the Aztecs to be neither irrational nor mentally ill, but merely human beings who, faced with unusual survival problems, responded with unusual behavior.

Skulls of sacrificial victims at the Aztec site of Tlatelolco, Mexico City. Mexican archeologists believe that the holes were made both to remove the brains and to mount the skulls on a rack.
Confined to a few midwestern localities, the Illinois mud turtle faces a demanding environment and extinction.

The empty shell lay in the scrubby vegetation beneath a canopy of cedar boughs. Close examination revealed it was the shell of an Illinois mud turtle, but the surroundings offered no clue to what caused the turtle’s demise or to how the shell came to be atop this sand dune. I had come to Big Sand Mound in eastern Iowa, to study this turtle, so I noted my exact location and a few details of the find in my journal and dropped the fist-sized shell into my field bag.

This was not my first encounter with the Illinois mud turtle under what seemed, to my untrained eyes, to be unusual circumstances. Once, while rounding a bend in a tractor road, I had come upon a dead female, her shell crushed by the recent passage of a vehicle. The nearest body of water was almost a half mile away, and the animal appeared to have been going in the opposite direction.

Such incidents had sparked my interest in the Illinois mud turtle, a plain creature whose nearest relative has a range with a center almost a thousand miles south in the arid southwestern United States. What I learned in two years of study was the probable role of a rigorous and changing environment in the evolution of a geographically isolated turtle.

*Kinosternon flavescens spooneri* is not nearly as imposing a creature as its scientific name. It is rarely more than five inches long, and its domed shell is a dingy olive or brown with no ornamentation. The turtle’s distinguishing features are its bright yellow chin, a plastron with two well-developed transverse hinges, and a disagreeable odor that issues from musk glands when the animal senses a threat.

Despite its generally unremarkable physical appearance, the Illinois mud turtle does have several characteristics to attract the student of natural history: its distribution is sharply limited, the area it inhabits is a remnant prairie, and it appears to have adaptations to a drier environment than that in which it is found. In addition, the Illinois mud turtle is a member of a largely unstudied group of turtles—the mud and musk turtle family.

In eastern Muscatine County, Iowa, bordered by the Mississippi River, is Big Sand Mound. Occupying about 1,500 acres, this formation is one of the outstanding features of Muscatine Island, a vaguely defined region delineated by an old channel of the river. From the highway that skirts its western edge, Big Sand Mound appears as a large hump, roughly two miles long, rising fifty to sixty feet above the river flood plain. The mound had its origin in the wind-blown sediments of a prehistoric lake, located about twenty miles to the west, and its ecological characteristics are anomalous to the sur-

Recently emerged from hibernation, an Illinois mud turtle moves slowly over a barren stretch of Big Sand Mound in eastern Iowa, possibly in search of a pond in which to begin feeding.
rounding countryside. Topographically, it is similar to Nebraska’s Sand Hills or the dune country around Lake Michigan.

Parts of the mound’s slopes are covered with prairie grasses and heavily forested in oak, hickory, red cedar, and ash, while the top is mostly cultivated. The mound’s eastern edge is a sparsely vegetated region of shifting sands—small dunes that form and re-form, sometimes burying tree trunks ten to twenty feet up. However, three distinct types of aquatic habitats occur there. A large, shallow oxbow lake winds around the northern and eastern edges of the mound. This lake, almost completely ringed in willow growth, is separated from the Mississippi by a large dike. Several permanent ponds lie just south of the oxbow, while in the surrounding sandy lowlands, scattered temporary ponds hold water usually until midsummer. These three habitats and the adjacent sands support the largest known population of Illinois mud turtles. Western hognose snakes, ornate box turtles, and other relict Plains animals also inhabit the dunes, and scattered among the grasses are prickly pear cacti.

April is the month of awakening for the hibernating denizens of the mound. Dazed and sluggish, they emerge to begin another year. Among them is the Illinois mud turtle.

For several weeks after emerging from hibernation, mud turtles rarely enter water. Temperatures in the ponds are usually too low to permit activity and so the turtles undertake overland journeys of considerable length. These apparently random movements may be related to the turtles seeking water warm enough to begin activity.

As seasonal temperatures moderate, the turtles begin entering water in search of food. In early May, they sometimes move into shallow water in the early morning and remain still for several hours before advancing into deeper water to feed. Such activity is a form of temperature regulation: the sun-warmed shallows elevate the turtle’s body temperature from 18° to 32°C, preparing it for activity in the cooler depths. Also, such behavior may serve to concentrate the turtles in groups, facilitating courtship and mating, both of which occur in water. By mid-May, the turtles begin to bask. Small groups of isolated individuals rest watchfully on floating debris or exposed shorelines while the sun is high.

Once the waters have warmed enough to permit extended immersion, mud turtles are rarely seen on land unless they are venturing between ponds. Terrestrial excursions are usually restricted to the morning or late evening.

Rising temperatures in June bring further alterations to the Illinois mud turtle’s daily routine. Basking now shifts from exposed to shaded sites and the turtles begin spending less time at the surface of the water. Some turtles, instead of basking, just float motionless at the surface, submerging to the depths at the slightest disturbance.

In the water, mud turtles forage over the bottom in search of fish, crustaceans, and insects. Aquatic vegetation and decayed animal matter are eaten, but aquatic beetles, dragonfly larvae, and other larval insects are the major items in their diet. By early summer, mud turtles feed heavily on the fairy shrimp that teem in the warm, shallow waters of seasonal ponds. As the summer progresses they shift to foraging in the mud ooze that bottoms the larger bodies of water. A favored source of invertebrate prey is the flooded woodland that surrounds a large lake after extended periods of heavy rain.

Middle to late June is the beginning of Illinois mud turtle nesting on the Mound. Shallow excavations in the sand, some surrounded by crushed and dried remnants of turtle eggs left behind by marauding skunks and raccoons, are visual evidence that nesting has begun.

Predation pressure is highest during a period of several days following egg laying, because the female scent is still strong and the disturbed sand marks the nest site. Female mud turtles construct more elaborate nests than many other species, sometimes even constructing false nests that are identical in configuration to the real ones. The female may remain in the false nest for several days before moving to a new site. This behavior is possibly a mechanism to thwart predators by increasing the effort involved in finding turtle eggs.

The female mud turtle seeks a site among scattered clumps of grass,
ually on an east-facing slope and ways within a few hundred feet of water. She begins to burrow with her forelegs, vigorously tossing the sand behind her. When only the rear margin of her shell is exposed, the turtle verses herself in the burrow. She then pushes sand upward, covering the entrance above her. The female lays from two to six hard-shelled, elliptical eggs, then uncovers herself and replaces the sand. The characteristic of enclosing herself within the nest distinguishes the Illinois mud turtle from the majority of turtle species. Most turtles simply scoop a depression in the sand with their hind legs, deposit the eggs, and scrape debris and earth over them before returning to water.

How long a female mud turtle remains in the nest is as yet unknown. Early July, I came across a circle of moist sand about six inches in diameter; its moistness indicated it was freshly dug nest. Digging into it, I attracted a female mud turtle, blinking at the brilliance of the sunlight. Beneath her in the excavation were still moist eggs. I returned the turtle to her nest, covered it, and left. Turning an hour later, I found the surface of the nest as I had left it. But examination disclosed that the female had departed. How long she would have remained had I not disturbed her, I cannot guess. This is not to imply that the turtle was tending the nest; more likely her actions were related to temperature regulation. In July, surface sand temperatures can become inhospitably high. Mud turtles traveling overland at this time sometimes deal with the extreme temperature by spending the hottest part of the day in a burrow, emerging at sunset to resume activity. Such was probably the case with this female.

Young Illinois mud turtles hatch in September and are approximately the diameter of a quarter. They resemble adults in marking and coloration except for the presence of a series of black spots on the upper shell and an irregular black blotch on the underside. Attached to the lower shell is the bright yellow yolk sac that provides nourishment to the young turtle through the first weeks of its life. I was not able to determine the time of emergence from the nest, but data from other mud turtle species suggest that the young might remain in the nest after hatching, live off the yolk sac, and hibernate until the following spring.

One might expect that exposure to Iowa's withering July and August heat would cause the mud turtles to become even less terrestrial than they are in June. Instead, a reversal in behavior takes place at this time. As temperatures soar into the nineties, basking in water ceases and mud turtles begin to appear more frequently on land, sometimes even at midday. By late July the turtles begin leaving the ponds in the early morning and moving into the sand where they bury themselves during the heat of the day, emerging at night to return to the ponds.

This behavior appears to be an adaptation to a grassland environment of high summer temperature and an intermittent water supply. As the smaller ponds begin to dry up, daytime water temperatures reach potentially lethal levels, forcing the turtles out. In the moist sand beneath the vegetated slopes, temperatures remain tolerable. While pond and surface temperatures exceed 40°C, subsurface sand temperatures remain a tolerable 25° to 27°C. The turtles move back and forth at first, burying themselves in the daytime and emerging to

Young turtles bask in the rays of the midday sun. At this stage of their lives, they are vulnerable to such predators as skunks and raccoons.
return to the ponds late at night. This appears to be a relict behavioral pattern. Alterations of the aquatic habitats on the mound have resulted in some areas that are deep enough and large enough to remain habitable throughout the hot days of summer.

Such behavior increases into early August when activity abruptly ceases. Suddenly the sand surface is devoid of mud turtles, as are the ponds. Other turtle species continue their activities, sometimes even basking; but at this time, no amount of trapping, netting, or tramping through the sand produces even a glimpse of an Illinois mud turtle.

August is the month of aestivation for Illinois mud turtles on Big Sand Mound. A behavioral mechanism that aids certain animals in surviving periods of extreme heat, aestivation is particularly important to animals that inhabit arid and desert regions. As temperatures rise to unfavorable levels, the animal selects a cool place, usually beneath the soil surface or in the damp ooze at the bottom of a drying pond. Here it remains in a state of dormancy until more tolerable conditions prevail.

So, after a period of movement to and from the ponds, the mud turtles simply settle into a sandy burrow near the overheated waters. The water table at the mound is very high; and the root systems of the plant cover help to retain some of the thirty-three inches of annual precipitation. The ponds along the eastern edge of the mound are not much higher than the Mississippi River. Some of these ponds, where most Illinois mud turtle activity occurs, actually rise and fall with the river. On the higher slopes, where burrowing takes place, moist sand is seldom more than a foot beneath the surface. In the cool sand, the turtles await the return of more moderate weather.

The turtles sometimes go directly from aestivation to hibernation, remaining inactive from August until the following spring. During such years the Illinois mud turtle might have the shortest annual activity period of any turtle—fewer than one hundred days.

Much Illinois mud turtle behavior centers around its thermoregulatory demands. A cold-blooded vertebrate inhabiting areas of temperature extremes beyond those it can physiologically tolerate must evolve behavioral adaptations to regulate its temperature.

During late Tertiary and Pleistocene times, the Southern Great Plains Corridor, a broad belt of land extending from southwestern North America northward along the eastern slope of the Rocky Mountains into Canada, played an important role in reptile dispersal. From population centers in the Southwest and the Mexican Plateau, subtropical species advanced northward with favorable climatic changes and retreated south when adverse conditions prevailed. Among the reptiles that used this dispersal route were the ornate box turtle, western hognose snake, and the yellow mud turtle (Kinosternon flavescens). Responding to increasing aridity in the Southwest and Great Plains, the yellow mud turtle evolved specialized traits. Conditions demanded that the turtles move about in the early spring to find water warm enough to begin such activities as feeding and mating. In summer, it became necessary to locate waters cool enough to continue such activities. Predominantly aquatic, the turtles still had to develop a tolerance for extended terrestrial activity. When no suitable aquatic habitat was available, as during late-summer drought, aestivation was necessary to enable the turtle to survive until more tolerable conditions returned, while hibernation provided a means of withstanding the bitter prairie winters. In areas where environmental conditions moderated, these extreme behaviors lingered on as relics, remnants of the species’ ancestry.

Today, three subspecies of the yellow mud turtle are recognized. Kinosternon flavescens flavescens occurs widely throughout the southwestern United States, ranging from Nebraska to Mexico. Adapted to the arid conditions of the Plains, it can be found in temporary ponds and potholes, and more recently, in cattle troughs. K. f. stejnegeri, the Mexican yellow mud turtle, is found in Mexico. The Illinois mud turtle has the most limited distribution. It now occurs in only a few localities in eastern Iowa and Illinois—areas characterized as remnant sand prairie.

This pattern of distribution suggests that the ancestral yellow mud turtle was once found over a large area of North America. Changes in conditions, brought about by the advance and retreat of glacial ice and more recently, by the arrival of man, might have resulted in the turtle’s disappearance over some of that area with only a few populations remaining in ecological pockets that retain some favorable characteristics. Such separation would eventually lead to the formation of subspecies and probably accounts for the presence of the Illinois mud turtle.

As with any animal that occupies an extremely limited range, the Illinois mud turtle’s future is far from assured. The dwindling of the prairies has resulted in the loss of much potential mud turtle habitat. Man’s activities, such as draining sloughs and potholes and cultivating grassland, have also aggravated conditions. Indeed the Illinois mud turtle seems to be declining in numbers. Population have decreased in Illinois in recent years and disappeared in Missouri where the subspecies formerly existed; in Iowa the turtle is almost exclusively confined to the tiny area Muscatine Island, near an area of rapid industrialization. Such population declines may be a result of natural trends or of the encroachments of man; most likely they are a combination of the two. Whatever the cause it is unlikely that the trend will be reversed.

Eggshells scattered around a Illinois mud turtle’s nest a evidence of a raid by a skunk raccoon. Nest mortality is high during the period when the female scent is still strong on the nest.

Illinois mud turtles prey aquatic organisms, ranging from small fish to fairy shrimp, scavenging for decaying fish flesh. This adult is feeding on a young bluegill it has just captured.
Drums of Calanda

Text and photographs by Tor Eigeland

Each Good Friday this sleepy town awakens with a sudden clamor before resuming its repose for another year.

As the church bells struck noon on Good Friday, the best drumsticks of the best drummer hit the best drum in Calanda. Gently but firmly, an intricate rhythm began to shape patterns of beats and syncopated, staccato sounds. The thousands of other drums in the little town were silent. Tomás Gascón, tall, dark, and strong, drummed on. An enchanted anticipation filled the air. Suddenly, Tomás Gascón stopped and, in the dead silence that followed, half smiled.

Then all hell broke loose. Twelve hundred small sticks struck six hundred small drums, and four hundred big sticks pounded upon four hundred bombos—large bass drums. The noise hit one in the guts like the fist of a heavyweight boxer. It was ear-splitting, shattering, frightening. People who do not venture into Calanda on this day claim that the drums can be heard seven miles away.
At any other time of year Calanda is a quiet town of some 4,000 souls and many animals located in the middle of farming country in lower Aragón—about 200 miles east and slightly to the north of Madrid. To outsiders, Calanda—with its ageless, clustered houses—is unremarkable, typical of thousands of other towns that dot the Spanish countryside. To the townspeople, however, it is remarkable not only for its annual drumming ceremony but also as the birthplace of filmmaker Luis Buñuel.

Neither rich nor poor, the town is very old—nobody knows for certain how old. Its narrow streets are lined with two- or three-story, ocher-gray buildings, whose ground floors hold several bars and many small and simple shops. The town's heart, the Plaza de la Iglesia, is dominated by a cathedral. Anyone who is not at home or out of town can generally be found in the plaza. Even so, the hot midday sun usually empties it of people until dusk, when it fills with groups talking and strolling. But at noon on Good Friday, it churns with an expectant crowd.

A lull follows the first frantic drumming while religious processions form. A statue of Jesus bearing his cross is carried out of the cathedral on a float. Statues of the Virgin Mary and other religious figures follow. "Roman" soldiers, looking as if they had always been here, accompany the floats, as do long rows of drummers in purple tunics and pointed Ku Klux Klan-like peaked hoods. The drums return to a steady beat: "Da-rramm-da-rramm-da-rramm, da-rrammarrarrarrarrarr-rarrmm." Jesus and the Virgin Mary rock back and forth as the people carrying
the floats follow the rhythm of the drums. Solemnly, the procession winds its way through the streets of Calanda, then returns to the cathedral for the Mass.

A free-for-all of drumming follows the Mass. Bands of from ten to thirty drummers swarm through the town, stopping outside the homes of friends and families, where according to tradition, they are served cookies and wine. Other drummers stay in the plaza—alone or in constantly moving groups, fragmenting and re-forming with new people. When overcome by thirst or fatigue or both, the drummers stroll into one of the bars for wine or beer. Although the drinking is constant, there is no drunkenness; the Calandinos imbibe just enough to keep going. And with the clamoring of the drums, there is no room for shouting or yelling or even for the crying of babies. The few tourists present are treated with friendly indifference. The big occasion to them is an enormous drum that they can bang on.

After a few hours, the relentless pounding on the bombos begins to break the skin of the drummers' hands and blood colors the big drums. Some seem not to mind or notice; others put on gloves when the pain becomes too great. Perhaps the flowing blood represents a religious purification.

In the late afternoon, another mass followed by a rest period provides a hiatus from the din. But at about 10:00 P.M. the drumming starts up again. It does not stop until 2:00 A.M. the next day. During this sixteen-hour period, the constant, thunderous drumming becomes hypnotic, the drummers hypnotized. Religious fervor, country wine, and more blood on the bombos are some of the ingredients of this annual scene. During the night, people have been known to stroll straight into the country oblivious, drumming, and muttering to themselves.

The year that I observed the drumming ritual, a blow woman in a light blue blouse provided a stark, some Buñuel-esque sight as her strong right arm slammed drumstick on the pale tan bombo-skin. Caught up in steady surge of the rhythm, she was indifferent to lacerations on her hand and fingers caused by hitting edge of the big drum; the patch of red blood sloshed spreading over it, provided a startling contrast in color. The woman later put on a glove but kept on drumming till the end.

The bars stayed busy and were open all night. In relative quiet behind the closed doors, I asked several people about the origin of this curious custom. To Gascon's reply was typical: "I've played since my mother carried me in her arms. And my father played since I was a baby. I think we have always played the drums here." A priest said that drums were probably first be played in Calanda in 1643 when Roman soldiers appeared and presented a full coat of torm from the Roman authorities to a Calanda notable by the name of Miguel Pellicer.

At 2:00 P.M., on Saturday, the drumming stops at once after a brief ceremony. The silence is almost deafening as the beginning of the drumming on Granada. Half-stunned, the people stroll off alone or in threes and threes. Half an hour later Calanda is just a quiet, little town again.
The Pit and the Antlion

Howard Topoff

A larva that stumbles into this pit is on a one-way slide to waiting jaws of death.

An insect larva is a transient con- cern inside of which are developing the important evolutionary adaptations of the adult organism. But a larva can lead an existence every bit fascinating and complex as the adult. Even without such structures as legs and copulatory organs, an insect larva is a mature animal in many respects, often possessing specialized structures that endow it with a life markedly different from its adult forms.

One of the best examples of a developmental dichotomy is antlion, which together with the antlions, lacewings, and lacewings belongs to the order Neuroptera. The adult antlion, with its long, slender body and delicate outstretched wings, resembles a damselfly. The larva, by contrast, is a tiny wedge-shaped creature that looks almost all of its time hidden in the soil. Because their specialized structural and behavioral adaptations make them efficient and draculipe predators, antlion larvae are among the few nonpest insects to have generated more behavioral study than the adult forms.

What has made larval antlions a favorite study subject for more than 200 years is their behavior of constructing funnel-shaped pits in dry sand and waiting upon small terrestrial animals that accidentally fall into it. As its common name implies, the antlion larva feeds predominantly upon the many species of ants that forage in its environment, not because of any unique feeding specialization, but simply because ants are usually the most abundant wingless arthropods wherever antlions are found. The larva will, in fact, just as readily consume a wide variety of arthropods, including spiders, sowbugs, caterpillars, and beetles.

An antlion excavates its pit by moving backward in a circle, using its oval-shaped abdomen as a plow and its flat head as a shovel for flicking sand upward. When the pit is completed, the larva lies motionless on the bottom, concealed beneath the sand, with only its long, piercing mandibles exposed. When a foraging ant or other suitably small prey accidentally steps over the rim of a pit, the sand particles making up that portion of the sloping wall roll downward, carrying the victim to the skewerlike mandibles of the waiting antlion.

Frequently, the antlion does not successfully impale its prey on the first attempt, and the prey tries to escape up the angled wall and out of the pit. But as the potential victim scurries upward, it dislodges the tiny dry sand particles beneath it and finds itself on a treadmill—moving its legs as fast as it can but making no upward progress. To make matters worse for the prey, the antlion responds to the mechanical stimulation of the miniature sand avalanche resulting from this activity by flicking its head upward and showering the prey with sand. As this storm of loose sand falls on the slope of the pit it speeds up the treadmill effect. The prey loses ground and eventually tumbles back toward the waiting antlion.

As soon as it has trapped the prey with its mandibles, the antlion moves backward, dragging the victim deeper into the sand and sucking out its protein-rich body fluids. Holding on to its prey is no simple task, especially when an antlion snare an animal considerably larger than itself. Here it is aided by a morphological adaptation consisting of numerous hair tufts that project anteriorly. Anyone who has ever used a toggle bolt will appreciate how these hairs function. When the antlion moves backward, the hairs bend and offer little resistance. But when a struggling prey organism attempts to pull the antlion forward, the hairs flare outward and anchor into the substrate.

For several springs, I have led an animal behavior class at The American Museum of Natural History's Southwestern Research Station in Arizona. We worked exclusively with Myrmeleon immaculatus, a species extremely abundant in the fine silt deposited along the banks of a creek near the research station. Many of our observations focused on the actual process of pit construction. We noted that before a pit is excavated, the larva moves just beneath the substrate, flicking sand continuously as it plows backward across the terrain. When a larva moves backward in this fashion, it leaves a narrow furrow in front of it, much as would be created by dragging the tip of your finger lightly across the sand. Because the path of the larva can seem tortuous, these movements are called doodles, hence another popular name for the antlion: doodlebug.

The success of both doodling and pit construction requires the antlion to overcome several formidable problems. Digging through sand with efficiency is one. The antlion accomplishes this by utilizing a variety of
morphological specializations. Foremost among these is the shape of the larva’s abdomen, with its relatively blunt anterior end gradually tapering toward the posterior—the direction of movement. This shape enables the antlion to slide easily backward through the dense substrate when the hind legs move forward on their power stroke. The animal is also aided by its hair tufts, which bend forward when the animal moves backward, but which fan outward and anchor it when the legs move back on their return stroke. (This prevents the animal from simply oscillating back and forth in the sand.) In addition to functioning as anchors, one particular group of tufts on the ventral surface of the abdomen seems to have an additional function. These tufts occur along two longitudinal ridges and the hairs growing from them are longer than those on most other parts of the body. This arrangement actually creates two furrows relatively devoid of sand. As a result, when the larva’s hind legs move backward on the return stroke, they move within these air pockets, thus encountering far less resistance than when moving through the sand on the power stroke.

Because pit construction is almost invariably preceded by some amount of doodling, biologists have always assumed that doodling is important in enabling the antlion to sample the environment and locate a suitable site for its pit. It has never been made clear, however, exactly which parameters of the environment provided the selection pressure for the evolution of doodling. For example, it is doubtful that substrate type is the key parameter, because antlions are not terribly fussy about the medium in which they dig. The published literature shows that pits have been found in quartz sand, red sandstone, dust, humus, rotted wood, gypsum, and even coal ashes. The only consistent requirement seems to be that the substrate be composed of small, dry, loose particles. Furthermore, because these variables are properties of the substrate itself, the larva is undoubtedly capable of responding to them without ever raising its head above the sand. But this is precisely the outstanding feature of doodling. As the antlion pushes its way backward through the sand, it repeatedly flicks sand upward, thus raising its head above the soil surface. It would make sense, therefore, if the primary adaptive function of doodling enabled the antlion to respond to environmental cues whose energy source was capable of stimulating receptors located on its head. The obvious candidates for this job are the well-developed eyes, which are situated on both sides of the head, close to the base of the mandibles. But what does the perception of light have to do with locating a site for a pit?

One indirect clue, pointed out in practically every field study of antlions, is that pits are seldom found in greatly exposed areas. They tend to be concentrated instead beneath overhangs or other natural overhangs. The advantage of such locations is good protection from the sun, large animals, traffic, wind, and rain. Although we cannot be certain at this early stage of the project, our studies have provided some circumstantial evidence that the larvae actively locate sheltered sites by means of a visual orientation process that takes place during doodling.

When we released captured antlions within our experimental pits on the edge of sand, much of the sand surface was covered with patches of shade produced by surrounding trees and the early morning sun. The larvae doodled in many directions during early morning, but all activity ceased throughout the day—late morning to early afternoon. Late in the afternoon, however, a second burst of doodling occurred. As the sun set westward toward the horizon, shaded areas on the sand surface gradually receded eastward. By late afternoon, all the antlions were doodling in an easterly direction, with some minor scattering, so that by late afternoon, the experimental plot was cove with a series of relatively straight parallel doodles. Some of the antlions were actually keeping pace with moving shadows. Although it was clear whether the antlions were responding directly to the darker areas of shaded sand, to some aspect of the leaf and branch pattern from trees, or to temperature variation...
were all clearly moving toward shaded locations.

Sometime between 5:00 and 7:00 o'clock, each antlion abruptly ceased moving in a straight line and began to move in an almost perfect circle. Construction had begun. As each larva circled backward, it continued to flick sand up over its body and onto the circular furrow. When it completed the first circle, it moved forward and continued along another circle of slightly smaller diameter. The larva continued this pattern of movement until an inverted cone was formed, then it took up a predatory position and ceased activity.

An antlion often finds its backward movement during pit excavation aided by small stones, pieces of insects, and other debris. One response to this situation is for the antlion to turn its course slightly and simply pass the obstacle. Unless the stone is exceedingly massive, however, there are several reasons why this is the most effective adjustment. If the antlion shifts its circling pattern upward, around the pebble, it will likely encounter the pebble again while excavating the interior of the pit. On the other hand, if the antlion bypasses the stone by moving inward, the obstacle winds up perched near the rim of the crater. Unfortunately, this proves to be only a temporary solution because the action of wind and rain could easily cause the pebble to fall back into the pit. In addition, obstacles around the rim of the pit may cause potential prey organisms to alter their direction away from the pit.

In order to study the antlion's response to obstacles, we collected several dozen larvae, ranging in weight from 14 to 54 mg, and placed them in coffee cans filled with fine sand from their field environment. Each evening when the animals were engaged in pit construction, we carefully placed pebbles of varying weight directly in their paths. We found that the strategy of altering the direction of circling is indeed used by the antlion, but only when the obstacle is so massive that it cannot be budged. When this occurs, however, the antlion doesn't merely move around the pebble. Instead, it actually stops circling, dozes to another area of several centimeters away, and excavates an entirely new pit. If the obstacle is at all movable, however, the antlion promptly removes it. We discovered that the *Myrmeleon* larva possesses at least four different mechanisms for removing pebbles from its pit, depending upon how heavy the pebble is in relation to its own weight.

Very small pebbles, weighing from a fraction to approximately five times the weight of the antlion, are treated like ordinary grains of sand. The antlion moves backward under the pebble until its head is positioned directly beneath and then flicks the obstacle out of the pit by catapulting it upward and back over the long axis of its body. Because the path traveled by the pebble is along a tangent to the circular groove in which the antlion is digging, we have termed this mechanism of pebble removal a "lateral flick."

A slightly heavier object, between five and eight times more massive than the antlion, elicits a noticeably different response. Although the antlion assumes the same position as for a tangential flick, it now heaves the pebble laterally, perpendicular to its body axis, away from the center of the pit. The adaptive value of this "lateral flick" is that the pebble now has to travel a shorter distance in order to clear the outer wall of the pit. If the pebble is approximately ten times the weight of the larva, the insect switches to a third mechanism, one that we call a "radial flick." The name of this procedure stems from the fact that the antlion now rotates its body 90 degrees, lining itself up along the radius of the circle, with its head facing toward the center. In this position, as in the previous lateral flick, the pebble is thrown out along the shortest path possible. The advantage to the antlion of taking this position for heavier pebbles is that by heaving the stone backward along its body axis, the animal is using its most powerful stroke.

The radial flick is the last mechanism available to the antlion for catapulting objects out of the pit. When it encounters an obstacle that is heavier than ten times its own weight, it initially makes several at-
A wandering ant has stumbled into an antlion's pit. Alerted by cascading grains of silt loosed by the ant, the antlion awaits its prey with poised mandibles (1). Having eluded its predator's first attack, the ant scrambles up the 38- to 42-degree slope of the pit in an attempt to escape. The antlion furiously flicks silt upward, preventing the ant from gaining purchase (2). After the ant is finally trapped, the antlion sucks out its body fluids (3). Finished with its meal, the antlion flings the prey carcass out of the pit (4).

Attempts to toss it into the air. But the animal's musculature cannot provide the necessary power, the pebble merely jiggles slightly on the surface of the sand. After several futile attempts at flicking, the antlion emerges from the sand, places the end of its abdomen against the stone, and slowly pushes it radially up the side of the crater and out of the pit, stopping only after the pebble is seven centimeters from the rim. Then the antlion does and about-face, moves back down the slope, reenters the sand, and resumes excavating.

Observing an antlion remove a pebble by means of this radial push is reminiscent of the legend of Sisyphus, king of Corinth. In Greek mythology, Sisyphus was the cleverest of men. When Death came for him, he instructed his wife not to offer the traditional sacrifice to the dead. Upon arriving in the underworld, however, Sisyphus complained that his wife was not doing her duty. He even managed to convince Hades, god of the underworld, to permit him to return to the upper world to punish his wife. It was a trick, of course, and when Sisyphus returned he and his wife lived together for many more years. After traveling the underworld for the second time when he died of old age, Sisyphus was handed a most unusual punishment. His task consisted of rolling a huge rock up and out of a deep crater. Each time the boulder neared the rim, however, it rolled back down to the center of the crater and he
Sisyphus

an antlion is not usually con-
ted with precisely the same prob-
Sisyphus had. Because most nat-
y occurring stones are irregularly
ed and have somewhat flattened
aces, they do not automatically
down into the pit if the animal
entarilly loses contact. The ant-
s task is also simplified in that the
push need not be executed in
uous movement. Instead, an-
imal might push the stone part-
up the slope, stop for several sec-
s, and then resume pushing.
decided to put the antlion to the
ate Sisyphus test by repeating
stacle experiment, this time
perfectly spherical ball bearing.
The result was an exhibition of
ancing that would be the envy of
cus seal. Once again, the ant-
emerced on the surface of the
ber several unsuccessful at-
 flicking a heavy steel ball.
ced its abdomen against the ball
arted pushing slowly up the
 of the crater. Almost immedi-
, however, the smooth ball
in to shift position so that the tip
larva's abdomen was no longer
applying force through the center of
the ball. The antlion responded with
series of compensatory movements,
similar to those one would make
while balancing a broomstick verti-
cally on the tip of an outstretched
finger. Whenever the ball slipped ei-
er toward the right or left, the ant-
ion reacted by shifting its abdomen
in the same direction just far enough
so that it was properly recentered
on the ball.

When we repeated this experiment
eral times, it became obvious that
we had just about approached the
it of the antlion's capability for be-
havioral adjustment. As the animal
ushed the sphere up the slope, its
bdomen was in an almost constant
ate of movement. More times than
ot, however, the larva lost control,
the ball rolled down to the center of
the pit, and the larva, like Sisyphus,
had to start again.

Although placing pebbles and ball
bearings in the paths of antlions dur-
ing pit construction may at first glance
seem to be little more than clever
icks designed by scientists to amuse
hemselves, these experiments can
swer questions of fundamental im-
portance. Animal behaviorists often
use the term "stereotyped" when re-
erring to the behavior of an organism
ose capacity for adjusting is rela-
tively limited. A serious problem
rises, however, when this conclu-
sion is reached as a result of studies
ducted only in the species' natural
vironment. On the one hand, it may
be true that the organism sim-
ly does not possess the neural com-
plexity necessary for a wide range of
havioral flexibility. On the other
and, it is also possible that novel sit-
ations arise infrequently, so that the
rganism only occasionally has the
portunity to demonstrate its com-
range of behavioral patterns. This
one of the principal rationales
conducting carefully controlled
periments in a laboratory setting.
By testing the organism under a vari-
y of experimental conditions, the

The hairs on an antlion are adaptive
in prey capture. When a victim
ting to escape tugs at
the predator, the hairs flare
ward and anchor the antlion.
investigator can often elucidate, in a short time, a range of behavioral processes that might take many months of field study to uncover. Although our class experiments represent only the very first stages of a thorough research program, we have already demonstrated that the antlion *Mymelone immaculatus* possesses a far greater potential for behavioral adjustments than had previously been reported.

Although the excavation of pits by antlions has often been compared with the building activities of other arthropods, such as spiders, caddisflies, and honeybees, our findings concerning the antlion’s behavioral plasticity suggest that the analogy is a poor one. Consider, for example, the beautiful cartwheel pattern of the orb web built by *Araneus diadematus*, one of the master weavers of the spider world. If the spider merely moved from one support to another, haphazardly depositing threads of silk along the framework, the result would undoubtedly be little more than a silty mass (and probably a silty mess). The formation of an optimal snare requires *Araneus* to utilize a precise sequence of its own intrinsic behavioral patterns and not rely on being helped by factors in its external environment.

In the case of the antlion, by contrast, the evolutionary process has taken a very different direction. The success of the antlion’s behavior is guaranteed precisely because the organism is adapted for taking maximum advantage of the physical properties of the substrate in which it is excavating. As a result, its behavior can be quite variable, yet still produce an inverted conical pit with ideal trapping properties.

To understand how this works, consider the following simple exercise, one that anyone can perform at a sandy beach. A cylindrical pail is filled with the dry sand found far from the water’s edge and carefully inverted on a flat surface. The resultant mound of sand will not have the cylindrical geometry of the pail. Because the sand is dry, particles slide past each other as soon as the pail is lifted, so that the mound will be relatively cone shaped. The angle by which the wall of the cone slopes upward from the base will always be similar as long as the same substrate is used. In earth science, this angle is termed the “natural slope” and represents the steepest angle under which an unbraced wall of material will remain in stable equilibrium.

Although this example is for the formation of a cone whose apex rises above the substrate, the same geologic principles are operative when sand is removed during the formation of a funnel-shaped pit. To demonstrate this, we collected several buckets of silt from the antlion’s habitat, and with a small vacuum cleaner sucked up particles until we created a pit with a diameter comparable to that of a larva’s pit in the field. We then measured the slopes of the walls of our artificial pits and found that they ranged between 39 and 43 degrees. When we measured the slopes of antlion pits in the field, the calculated range was 38 to 42 degrees. Our conclusion is that many of the features of an antlion’s pit result as much from the action of physical forces operating on the silt particles as from the behavior of the antlion itself. Thus, it is not surprising that the antlion exhibits no rigid sequence of movements during pit construction. The antlion may excavate the initial circle by moving either clockwise or counterclockwise, and the direction of circling may change several times before the pit is completed. Another common variation is for the antlion to stop circling altogether and cut straight back and forth across the center of the depression, only to resume circling after an unpredictable number of such crossings. Finally, the antlion may simply spend varying periods of time in the center of the depression and flick handfuls of sand without changing the position of its body. As long as the antlion remains within the area delineated by its initial circle and spends enough time tossing out sand, the result will always be a first-rate trap.

---

*Having encountered a stone during pit construction that is more than ten times its body weight, an antlion pushes the obstacle up and over the rim.*

Howard Toddill
esiged Reefs of Florida’s Keys

Phillip Dustan

Tons of sun- and water-shippers inadvertently, mercilessly, assault the delicate refuges of marine life.

More than one hundred known wrecks lie along the mangrove-fringed coastline of the Florida Keys, and coral reefs having claimed victims here since the sixteenth century.

The best-known wrecks are those of the Spanish plate fleets. Laden with treasure from the conquered Aztec and Inca empires, these ships assembled in convoys near Cuba before sailing across the Atlantic with their cargo to Spain. Upon leaving Cuba, usually sailed north, riding the Stream through the narrow keys of Florida. In 1733 a particularly savage hurricane trapped the fleet in the Straits and drove twenty ships onto the reefs. During the five-year period following the disaster, the Spanish government succeeded in salvaging twelve million dollars worth of treasure. Success, however, was only partial for some of the ships lay in water too deep for divers. For the next 200 years, the wrecks remained buried beneath the sand; then in the late 1950s and early 1960s, a few adventurous divers recovered an additional four million dollars worth of silver and gold.

Like those of the 1733 plate fleet, the fragile hulls of many other ships have been split open by the sharp corals. Common to all these cataclysms has been the understandable lack of concern of captains and crews for the damage their vessels inflicted upon the reefs.

The Keys, a narrow, 166-mile-long band of islands, stretch southwestward from the east coast of southern Florida to the Dry Tortugas. At their northern end are fossil reefs formed during the Pleistocene when sea levels were higher. The lower keys—from Big Pine to Key West—are composed of oolitic sediments and bear a close resemblance to the geologic structure of the Bahama Banks. The keys support an assemblage of vegetation related to that of the West Indies. Although logging operations in the 1800s erased most of the large lignum vitae and mahogany trees in the area, second and third growth trees are now common.

Today these islands are a haven for vacationers seeking the warm sun during winter months. Tarpon, bonefish, and sailfish lure fishermen; osprey, roseate spoonbill, white ibis, and many other bird species bring bird watchers; and the beautiful offshore reefs attract divers. In addition, the keys support a multimillion-dollar commercial fishing industry.

In the early 1960s environmentalists, concerned that the richness and beauty of the reefs were disappearing under the demands of coral and fish collectors and treasure seekers, began a campaign to preserve the reefs. Their efforts, led by John Pennekamp, an editor of the Miami Herald, and Gilbert Voss, a marine biologist at the University of Miami, resulted in the establishment of the nation’s first underwater park—John Pennekamp Coral Reef State Park. In conjunction with the newly formed federal marine sanctuary, the park encompasses more than a hundred square miles of sea floor off Key Largo, an area possessing some of the most prolific reefs in the Keys. Within its boundaries are 35 species of coral and more than 500 species of fish. The collecting of corals and fish is forbidden within the park, but line fishing, lobstering, and commercial fishing are permitted.

Coral reefs, one of the richest and most productive ecosystems on earth today, are rapidly becoming imperiled. Man is directly responsible for their decline. In Hawaii, the once pristine Kaneohe Bay reefs are covered with layers of sediment as a result of land clearing. Sheets of green algae, nourished by sewage, have encrusted much of the sea floor near the reefs. In Sri Lanka, coral is mined as a building material. In the Philippines, divers collect coral and ship it to the United States where it is sold in curio and aquarium shops. And in Palau, plans are in the making to construct an oil refinery and superport in the midst of the reefs.

Although the reefs in John Pennekamp Coral Reef State Park have not suffered this kind of massive damage, they are threatened in another way—by the skyrocketing upsurge in scuba diving, snorkeling, and leisure boat-
boats and associated equipment primarily responsible for physical damage. Divers damage corals by inadvertently scraping off the animal tissue. The corals replace this tissue much the same way our own bodies heal a scraped knee. Divers and snorkelers also break branches of more delicate corals with fin kicks by standing on the sessile creature. As well adapted as they are to forces of the sea, branching corals have no match for a 150-pound human pharmacist.

Probably the most widespread damage to reefs in the park results from the anchoring of small boats. Larger commercial diving boats disperse too much water to anchor directly over the reefs, and out of respect they usually anchor in sandy areas. Small privately owned boats, however, often glide into the shallows and anchor directly on the reef. Most anchors weigh more than five pounds and, like humans, can easily dam the corals by stopping off branches gouging surfaces. The damage can not cease with the settling of the anchor. While the boat swings in the sea, anchor chains and ropes often cause more damage than the anchors themselves. And as the anchor is weighed, it often bounces over the bottom, causing damage again.

The damage caused by a single anchor is restricted to a small area, and some reefs are heavily trafficked. On a busy day, up to two hundred boats visit Molasses Reef, only two acres in area; on most other days, an average is twenty to fifty boats. Anchors are dropped on the reef some 15,000 times each year. If each anchor damages an area of only six square inches, the cumulative damage over a year’s time is approximately one-tenth of an acre.

Each wound inflicted on a coral organism disfigures the growth of the entire reef. The natural living routine of an organism stops while it expends energy to repair the wound—energy normally used to capture food, to reproduce, to grow and add to the bulk of the reef. Coral reefs exist because the rate of deposition exceeds the rate

The Keys, a 166-mile-long island chain, curve southwesterly around the tip of Florida. Coral reefs and mangrove thickets, habitats of abundant marine life, once surrounded all the islands.

The park's popularity has provided us with a natural laboratory to probe the question of coral-reef survival under heavy recreational pressure. In 1974, more than 300,000 people paid admission to use the park. In 1975, paid attendance was estimated at 400,000. Most of these people entered the park on commercial diving boats. Coral reefs are one of the few ecosystems that construct their own geomorphology. Covered by a veneer of countless fragile corals, algae, and other organisms, all attached to a limestone framework, each reef is gradually formed by the accumulation of carbonate sediments. As the organisms on the reef surface die, their skeletons provide an anchor for additional living corals. Each coral lives according to the laws of natural selection. Most species have specific habitat requirements and thrive only in environments that fulfill their needs. The result is the growth of asymmetrical reefs with distinct patterns.

The main direction of reef growth is into the prevailing seas, a community adjustment to wave conditions. The geometrics of coral species reflect the intensity of wave motion in their individual habitats. Round, massive forms are able to resist the power of waves. Elkhorn corals, Acropora palmata, with their major axis growing parallel to the swell direction, distribute the power of a wave. Many species of gorgonians, the flexible sea fans, grow perpendicularly to the average direction of the surge, presumably to maximize feeding efficiency. All coral forms seem to allow the organisms to catch particulate food while dissipating hydrodynamic energy most efficiently.

Researchers can use these species' responses to changes in their positions to study the effects of man on coral reefs. When corals are overturned, for instance, they grow new branches, or edges, oriented to the direction of the prevailing seas. Much can be learned about the survival ability of reefs by studying their rate of regeneration.

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We tried to ascertain the vitality of the reefs in John Pennekamp Coral Reef State Park between October 1974 and December 1975. Damage to the reefs there is being caused not only by physical but also by chemical interference. In 1975, the greater Miami area produced 84 million gallons of sewage per day, which was pumped into the ocean. Some of this enters the inshore currents, which flow south past a portion of the reefs. The resultant damage to reefs is difficult to detect over short periods of time. A 10 percent decrease in growth rate, for example, would have a profound effect on a reef but would not be apparent for about twenty-five years. Our studies on Carysfort Reef in the park, however, revealed some species suffering mortality rates as high as 22 percent over a six-month period. Chemical pollution also affects reproductive rates and the ability of larvae to settle.

Physical damage, far more direct and localized than chemical damage, is easier to assess. On the Pennekamp reefs, divers, snorkelers, and their
growth rates of the corals are re-
duced due to damage, rates of net acre-
age may be similarly reduced. Only a
small change in the growth rate is
necessary for a drastic decrease in net
growth over the long run. To the
initiated eye the change would be
in well-formed reef to coral-entan-
gled rubble (a type of reef structure)
within decades.

probably the most dramatic immi-
dence damage suffered by reefs is that
caused by boat wrecks. Although this
does not happen with great fre-
quency, the resultant damage clearly
displays the fragility of reefs. On No-
ember 2, 1974, the 38-foot trimaran
was blundered onto Key Largo Dry
Reefs Reef, having just set out from
Everglades bound for Los An-
geles. She was reaching before a fif-
ty to twenty-knot wind, with seas
described as six to nine feet high, in
a navigational error put her in
line of the reef. The hull
headed on a shallow patch of a
ral spur, then smashed head-on
her full sail into the reef flat, a
ve of delicately branching elkhorn
Maya’s rudder gave way first, bowed by the belly of her main
which, once ripped open,
disabled the entire contents of the en-
room and cabin into the sea.
Diss
and heavy in the water, she
rendered as her crew tried desper-
ty to save her. But the sea had
led Maya’s fate and she pounded
death on the reef. A day later all
remained aloft was one sponson
a few bits of wood. Like that of
plate fleet of 1733, Maya’s re-
sains lie scattered on the ocean floor.
Maya’s wreck site covered some
square feet. The impact
ished the branching corals to rub-

Massive corals were abraded or
torn, and many living sessile
structures were killed or exposed
to erosion. Fish populations were
porarily disrupted; their terri-
tories and coral cave refuges de-
voided. Many of the small pomacen-
fishes were scarred in battles over
redistribution of new territories.
her fishes hunted the area for
anges and other invertebrates ex-
posed when the corals were over-
turned. Although the fish adjusted to
the new conditions quickly, recovery
of the coral populations will take
many years.

In an attempt to ascertain the extent
damage to the reef, we had the
largest colonies dated by carbon 14
analysis. The results showed that the
skeletons had absorbed carbon 14
from atomic weapons testing held in
the last thirty years. By correlating
reef-growth rate with the location of
carbon 14, we determined that the
largest reefs overturned at Key Largo
Dry Rocks were somewhere between
fifteen and forty years old. Although
new coral has begun to grow on the
upset structures, the growth of the en-
tire reef was set back a considerable
amount of time. During the year fol-
lowing the wreck, we monitored the
changes in the reef and the regrowth
damaged corals.

Many of the pieces scattered on the
bottom had died, their deaths ap-
parently being related to their posi-
tions and sizes. Large pieces fared
much better than small ones and
pieces in semiprotected spots sur-
vived longer than those in exposed or
highly protected places (the former
were tossed about by swells and the
latter did not receive sufficient sun-
light). In some areas where corals had
collapsed onto other parts of the same
colony, their tissues had fused and the
two parts grew together. Those pieces
still living had begun to regrow and
reorient their skeletons to prevailing
sea and light conditions.

Corals first respond to damage by
growing a thin layer of new skeleton
and tissue. This takes from weeks
to months, depending on the size of
the wound and the species of coral.
Elk-
horn coral grows new tissue and skele-
tal material at a rate of about half an
inch per month. Before the coral can
cover a wound, however, other orga-

nisms colonize the bare skeleton in an
ecological succession starting with
diatoms, then blue-green and red
algae. In the process of healing, the
coral must overgrow this algal jungle.

New polyps then form on the sur-
face and branches begin to grow.
Local environmental conditions af-
cct their direction and shape. In-
terestingly enough, we found that the
rate of growth of new branches was
slightly greater than that of undam-
aged ones. The former, however,
were thinner; thus, the net amount of
skeletal material deposited may be
the same. Because the wreck changed

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Humble Pie

Unjustly maligned, English food is a gutsy old cuisine, but hard to find

Gastronomes in search of a scape-goat to roast invariably turn toward England. Take Talleyrand, the leading French epicure—and statesman—of the Napoleonic period. “England,” he pronounced, “has an infinitude of religions, but only one sauce.” Talleyrand was wrong, of course. England then, as today, had one established religion and several sauces of its own, roughly as many, indeed, as Italy. But, facts to the contrary notwithstanding, Talleyrand’s gist—that England is a place of great moral tolerance for plain food—is an article of faith for many well-traveled Americans even at this late date.

“London,” they will concede, “is a great city—civilized, hospitable to eccentrics, and filled with parks, but...the food is unspeakable.” You may have met people like this. I know one extremely well. I was...

Then, last fall, on a day stereotypical British dampness and gloom, in the plushly remodeled home of the novelist Frederick Marryat (now a first-class hotel) on the south coast at New Milton, Hampshire, I fell, open-mouthed and to a barely stifled cry of pleased surprise, upon that rara avis, a magnificent English meal.

The main course was, literally, a rare bird, a lightly roasted goose with high and bloody flesh. Finished with homemade “gitchips” (small, crinkled potato chips and English bread sauce (see recipe below), this dish had the structure, logic, and uniqueness that imply...
Susturary world view. And so, deserted from culinary bigotry, I am ready to eat humble pie.

Humble pie is, in fact, a case in t. It is a real English dish, but like any real English dishes, you will y, every, see it in British restaura-

They serve French food, Italian , featureless convenience foods, hog but English food. As a re-

If you want to find humble pie, look in a book and see that it has ing to do with humility. It is a pie posed of all manner of meats, re to bacon, and sometimes . Originally, it was made from hams, or numbles, of deer. ow just as "nipple" became "an fel, so numble turned into "an le," which, since a dropped ch" was at some point assumed, we into "humble" and sounded poor food. If it had been called *not des abats de chevreuil en te* you and 1 and the inspectors e Guide Michelin would long ago beaten a path to the brilliantly ace Burgundian inn that served it spécialité.

As it happens, numbles does have French or, at least, an Anglo-Nor-

ancestry. It goes back ultimately e Latin *lumbus*, for "loin." The

connection with inards is obvious, and the etymology also illustrates the common Roman background of French and English food.

Medieval menus in both countries derive directly from the Mediter-

ranean heritage of the Roman Empire. The oldest French cookbook, the *Vianier of Taillevent*, dates from the fourteenth century and lists sauces of the same sweet-and-sour type we know from recipes in Apicius and from other ancient descriptions in Latin. What we think of today as French cuisine does not begin to show up in cookbooks until the eighteenth century.

Roughly speaking, the same kind of Romanesque diet seems to have dominated the English table well into the modern period. Much evidence for this exists. Madge Lorwin has collected some representative recipes and modernized them for home use in her recently published *Dining with William Shakespeare* (Athenaeum). Here you will find the roast birds, meat pies, pickled and salted fish, and homely grain puddings and breads that fed Falstaff and Rabelais and anyone else above the poverty line in Europe before 1700 and even later.

From this perspective, beef-and-

kidney pie can be properly viewed, not as a specifically British concoction, but as a survival from pre-

modern European cooking. The grouse I ate is a comparable an-

achronism that harks back to a time when game birds dominated banquet tables in France and England. Not only pheasants, grouse, and par-

tridge, but such abandoned delicacies as stork, heron, crane, and swan were avidly consumed by British and French royalty.

Organ meats of every kind also fed the gentry on both sides of the Channel. But vestiges of this more diverse, preindustrial diet persisted in England longer and more visibly because no other native cuisine developed to supplant it. Lyttton Strachey wrote in this century of country meals that included "for breakfast the inside of a she-goat, at lunch sow's udder trimmed with tripe and parsley smothered in thick white sauce."

You and I will probably never face such fare, no matter how deeply we penetrate the English countryside, but there is no understanding British food without taking into account this gutsy, old-fashioned background. Salted fish—kippers or smoked haddock—for breakfast is not an Anglo-

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**To Be an Invalid**

The Illness of Charles Darwin • Ralph Colp, Jr., M.D.

What was the mysterious illness that plagued Darwin throughout his adult life? His contemporaries did not know and, in the ninety years since his death, the search for solutions has continued. Did he have allergies, arsenic poisoning, gout? Was he a hypochondriac, unduly coddled by his wife? Was his illness neurotic? Colp presents a detailed medical history of Darwin, with information on his heredity, discussion of various theories about the illness, and the first transcription of Darwin's family medical book. Using his insights as a practicing psychiatrist, Colp advances the well-considered opinion that the illness can only be understood by realizing the conflict between Darwin's anxiety to prove his theory of evolution and his equal anxiety about that theory's ideological consequences. Illustrated $15.00 until 6/30/77; thereafter $17.50

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Saxon quirk. It is an edible remnant of an era before refrigeration. Like porridge, it gives us a taste of plain food of the past.

This plainness, which pervades authentic British cooking, can be saline, as with my grouse, whose flesh had been carefully hung, exposed to the open air, so that it would deco- pose, turn tender, and develop a flavor of powerful sophistication.

The question remains: Why this plainness or, rather, this fidelity to antique methods and tastes prevalent in a country that otherwise led Europe into the modern age? Perhaps the answer lies buried in some imperceptible recess of the English character. If there are at least two good reasons, one can point to, the Puritan revolution and the Napoleonic Wars. When French chefs were inventing modern French food in the seventeenth century, England tightened its belt and restrained its gastronomic impulses under the skinflint gaze of Cromwell and his lieutenants. When Tuleyard’s chef, Careme, arrived in France in the early nineteenth century, he brought a dazzling new style of food, but he also bore the hallmark of Bonaparte’s France.

Since Napoleon, down to the present day, French “kickshaw (from quelque chose) have offended English national pride. Elaborate dining was, in sense, equivalent to French supremacy. Yet even at 100 percent Englishman defensive, claimed plain food—roast beef and overcooked vegetables—as his national heritage, he, conversely, ced

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This was an outstanding but not isolated instance. To eat well in London or elsewhere in England, you find yourself going to a French or at least a foreign restaurant nine times out of ten.

Good British food is a chore to cate outside private homes. Some exceptions prove this rule, however. Usually luxury items—oysters, double cream, strawberries, and salmons. Then, too, there are certain spin remnants of empire, notably curried Anglo-Indian com- nation of rice, haddock, chowder, egg, and curried called “kedgeree.” But the true spirit of British cookery is still kept alive, here and there, despite the depredations of the
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dom in palm and pine,“ and plummeting pounds. You have to

look and ask. And if you are very

good, a nannylke waitress will some
day serve you a slab of silverside (the
corned top round of beef) and then

some meltingly delicious fresh figs or

a slice of Christmas Stilton. “Oh, to

be in England. . . .”

Bread Sauce

1. Bring milk to a boil in a large saucepan. As soon as it starts to

foam up, reduce heat so that the milk simmers gently.

2. Take the onion, stick the cloves into it, and add it to the milk. Then

stir in the breadcrumbs.

3. Continue simmering until the breadcrumbs have thickened the

sauce, about 5 minutes. Stir continuously.

4. Stir cream into the sauce and season to taste with white pepper,
salt, and nutmeg.

5. Remove onion and discard (with cloves) before serving sauce with

feathered game or poultry.

Yield: About 2 cups

Plain Scones

2 cups flour

1/2 teaspoon salt

3 tablespoons shortening

1 teaspoon sugar

1/4 cup milk, approximately

1/4 cup yellow raisins

1. Preheat oven to 450 degrees.

2. Sift the flour and salt together.

3. Cut in the shortening and sugar.

4. Moisten with milk gradually, until you produce soft dough.

5. Grease a baking sheet.

6. On a lightly floured surface, roll out the dough to a thickness of

roughly 1/4 inch. Cut the dough into squares or circles.

7. Bake on the greased baking sheet for 10 minutes.

Yield: 6 servings

Raymond Sokolov’s most recent cookbook is The Saucier’s Apprentice, a guide to French sauces.
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Announcements

From April 4 to May 1, the Museum will feel the influence of R. Buckminster Fuller—architect, engineer, philosopher, educator, and writer, but probably best known as designer of the geodesic dome. On May Day, at 3:00 P.M. in the Museum auditorium, Fuller will discuss his ideas about design, learning, youth, history—any number of topics. He never lectures on a specific subject; rather, he communicates in a stream of consciousness, presenting his thoughts—usually focused on common sense and efficiency—with humor, charm, and enormous imagination. If Fuller’s appearance follows the precedent set last year, his audience will leave the auditorium inspired by the infinite possibilities he presents.

To introduce Museum visitors to some of his concepts, a retrospective exhibit of photographs of Fuller’s designs and structures will go on display on April 4 in the Center Gallery, near the People Center.

Tickets to the May 1 lecture are available by mail or at the lobby information desk. Admission for Participating and Donor Members will be $4.50 with a limit of two; $5.50 for Associate Members and public.

The Education Department’s Spring Series of Workshops for Children will begin the third weekend in April and continue through the third weekend in May. Each workshop is taught either by a departmental staff member or by a professional from the particular study area. The following sessions will be available: exploring Earth’s Past, The Natural History of London, Ecological Life of a Park, Nature Photography, and exploring with the Microscope. Workshops meet on either Saturdays or Sundays and most include field trips to Central Park or other parks in New York City. The cost of each workshop is $20. For further information call (212) 873-7507.

The Education Department is sponsoring appearances by two dance companies in the Museum auditorium. Both performances will be for those who have paid the daily Museum entrance fee. On April 2 at 2:00 P.M., members of the Philippine Dance Company, directed by Reynaldo G. Alejandro, will exhibit some of their repertory of 40 dances representing the different cultures of the Philippines. On the following day, April 3, at 2 P.M., the Allnations Dance Company will present “Joy in Every Land.” This company of young professionals of many nationalities performs dances representative of their respective cultures.
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Let There Be Darkness

Optical observatories around the world need protection from increasing light pollution

In recent years, astronomers have become more and more concerned over the growth in light pollution—the presence in the environment of unnecessary artificial light that interferes with astronomical research. Light pollution has damaged the viewing conditions at some important observatory sites in the United States and abroad and has forced the relocation of others. National and international astronomy organizations have formed committees and task forces to investigate the problem. But until lately, few persons other than astronomers have worried about this effect, which the New York Times called "light blight" and "a new and insidious form of environmental contamination." Since 1972, however, a growing awareness among community leaders and environmentalists, as well as concerned scientists, has stimulated the adoption of legal protection for several observatories, through ordinances that place limits on the design and operation of outdoor lighting equipment in urban areas. Recent evidence now suggests that such controls are actually working.

In the United States, the principal observatories with large telescopes are concentrated in the western states, which have experienced intensive economic development and population growth in the near past. The increase in light pollution around western cities has thus had a particularly serious effect on astronomy. At Lick Observatory, on Mount Hamilton near San Jose, California, a place that was described in 1887 as offering "advantages superior to those found at any point where a permanent observatory has been established," lights and smog from the Bay Area are menacing the research program. Light and smog combine synergistically—smog particles reflect light in all directions, increasing the undesirable illumination of the night sky. In this way, air pollution also contributes to light pollution. A leading astronomer at Lick, Robert Kraft, has warned that by the 1980s, scientists will no longer be able to observe extremely faint objects, such as the more distant galaxies and quasars.

In the mid-1960s, the problem at Lick was recognized, and a staff astronomer ran a two-year survey of California south of San Francisco in a search for a new and darker observatory location. (Locations farther north are considered less desirable for astronomical research because of more frequent spells of cloudy weather and diminished capability for viewing southern stars.) Charting California cities and their estimated sky glows, he found that much of southern California was already contaminated by light pollution. He projected an even worse situation for 1985, but by the early 1970s some astronomers had already concluded that this projection had erred on the optimistic side.

The problem is not confined to California, although that state, with Lick imperiled, Mount Wilson Observatory seriously disturbed by the lights of Los Angeles, and Mount Palomar Observatory menaced by the glow from both San Diego and Los Angeles, clearly is a leader in this unhappy trend. Throughout the country and, indeed, the world, astronomers are upset by the increased interference of outdoor lighting with delicate observations. In Mexico, city lights and pollution have twice forced the relocation of the principal research activities of the Observatorio Astronomico Nacional since 1951. The first move was from Tacubaya, where skies were ruined by the growth of the city of Puebla, and the second to Tonanzintla as a result of the growth of the city of Puebla. In 1965, the Mexican astronomers began developing a new observatory in the Sierra de San Pedro Mártir, in Baja California. According to satellite photos of sky cover conditions around the world, this is one of the three clearest regions on earth. It is hoped that surrounding large forest and protected legislation will retard light pollution at this ideal spot. If they don't, may be no place left for astrophysics.

Amateur astronomers reported similar problems. One amateur in Bedford, Cheshire, in England, wrote in the Journal of the British Astronomical Association to complain about new streetlights near his home and the installation of floodlighting for a nearby soccer stadium. He urged the local members of the association to protest to their respective members of Parliament and noted that streetlights had previously been turned off at midnight, now they are in short supply they have been left on all night and sometimes during the daytime hours as well.
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Worsening of the problem of light pollution can be seen in these two photographs of Greater Los Angeles. The top picture was taken from Mount Wilson in 1911; the bottom one in 1965. In view of the region's population growth, there is no reason to believe the situation has recently improved.

Prompted by the Japan Association to Protect the Starry Sky, asked building owners to turn off lights in order to permit sky watchers to view a meteor shower associated with the breakup of Comet Giacobini-Zinner.

Jesuit astronomers at Castel Gandolfo, Italy, where the Vatican Observatory is located, built a portable "night sky photometer," calibrated by the dim light of a radioactive source. With this, they measured light pollution at various places in the country. One of the most affected locations turned out to be that of the observatory itself, where the Jesuits found that the sky brightness at an altitude of 45° above the horizon
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In the battle against light pollution, astronomers have, at times, despised that things might only get worse. For example, at Wesleyan University in Middletown, Connecticut, the school administration installed four 100,- 000-candlepower mercury lamps adjacent to a protesting astronomy professor’s 24-inch telescope. Bart J. Bok, an astronomer for more than 40 years, has told how, as director of the Mount Stromlo Observatory in Australia, he was forced by increased street lighting in Canberra to transfer much of the observatory’s research program to a remote post in the outback. Bok had been present at Tonantzintla, when lights spoiled the sky over that part of Mexico. Now living in Tucson, where he has been director of Steward Observatory and is currently professor emeritus at the University of Arizona, he has watched outdoor lighting grow to the point where it threatened the world’s finest collection of “big eyes.”

The total investment in the astronomical laboratories of the Tucson area has been estimated at sixty million dollars, and more equipment is under construction. Within sixty miles of Tucson are the telescopes of the Steward Observatory, Kitt Peak National Observatory, the Lunar and Planetary Laboratory, the Mount Hopkins Observatory of the Smithsonian Institution, and the new McGraw-Hill Observatory. These are major installations. It was at Steward that the flashing light pulses from the Crab Nebula were discovered, and where astronomers identified several of the most distant quasars in the known universe. At McGraw-Hill, observers detected the optical outburst of nova A0620-00 (see “Exploding Stars,” Natural History, May 1976). Kitt Peak was established in the late 1950s by the National Science Foundation to provide scientists and students from universities lacking modern instruments with access to such facilities at a good viewing location. By the early 1970s, however, Bok and other local scientists reported that growth in the number and intensity of outdoor lights in Tucson and Phoenix, as well as in outlying trailer parks and small towns on the desert, threatened Kitt Peak and the other nearby observatories. Even the vehicular headlights from the increased flow of traffic on Interstate 10 between Tucson and Phoenix contributed to the problem.

In June 1972, the astronomers persuaded Tucson authorities to adopt ordinance No. 3840, dealing with outdoor lighting, a landmark in the fight against light pollution in major urban areas. This ordinance directed that future lighting installations be fully shielded so the lights would shine down, not up, and that they be filtered, if necessary, to remove the bluer shades that interfere most with astronomy. Relatively inoffensive home-lighting installations were not affected. Advertising searchlights were to be turned off between midnight and sunrise and outdoor illumination of buildings “by floodlight projected above the horizontal” was banned when the purpose was purely architectural or esthetic. Some types of advertising lights were also restricted. At both Kitt Peak and the University of Arizona, astronomers promoted compliance with the new rule by counseling local businessmen on acceptable lighting designs and by writing to national manufacturers to encourage the design of less offensive streetlight reflectors.

Heartened by the Tucson ordinance, astronomers in Richland, Washington, the site of the Battelle Institute’s observatory, persuaded the city fathers to enact a similar law. But not all astronomers are optimistic. One outspoken activist in San Diego contributed an editorial to the astronomical journal Mercury entitled “Can We Save What’s Left of the Dark?” warning that the end of optical astronomy in the United States may be inevitable.

In a society already concerned about energy conservation, light pollution is a cause of dismay not only to astronomers. Light that streams out into the sky is wasted, performing no useful purpose. It represents a substantial loss of electrical energy, much of which is generated by burning precious reserves of fossil fuels. Surely commonsense approaches can be found to this problem. When Smithsonian astronomers at Mount Hopkins, for instance, complained about bright new lights at the dog track in Amado, Arizona, the management installed better reflectors on the lamps, resulting in both a brighter track and less stray light in the neighborhood.

The latter was appreciated by astronomy researchers and the formers welcomed by local students of the greyhound breed.

Much of the lighting in major urban areas, notably that using new bright mercury and sodium lamps, has been justified on the ground that it will discourage crime. Bright streetlights may provide additional reassurance to apprehensive pedestrians, but there is little that they actually prevent crime. According to a published study, UCLA astronomer who compiled FBI crime figures with data on door lighting.

Fortunately, a happy ending is in sight. A principal authority on light-pollution measurements, J. A. Hoag of Kitt Peak, reported in April 1976 that his data (as recent as Kitt since 1970) show that Tucson ordinance No. 3840 adopted in 1972, the rate of increase in light pollution dropped off dramatically. Further, at the University of Hawaii, which has a major observatory under development at Mauna Kea, the director of the Institute for Astronomy told me of success in obtaining legal protection on a countywide basis even before the pollution reached threatening proportions. There, light pollution was received as an environmental issue of general concern, rather than as a nuisance only to cloistered scientists. Civic leaders got together to form protective measures suggested by Mauna Kea astronomers and the Oahu Advertiser lent editorial support, which concluded that “light along the Big Island would keep the mountaintop valuable economically to the benefit of Hawaiians the rest of the world.”

In addition to interfering with astronomical research, light pollution creates a more subtle, less quantifiable loss that affects everyone: it prives urban dwellers of the opportunity to witness and enjoy the beauty of the night sky. The work of Hoag, who shows that light-pollution ordinance can achieve its purpose, and the increased interest by municipal governments in this issue suggest that we may yet see “dark at the end of the tunnel.”

Stephen P. Maran is an astronomer at NASA’s Goddard Space Center in Greenbelt, Maryland.
Sharon Puddester is one of a thriving group of Newfoundland potters and handicraft artisans. She lives in picturesque Portugal Cove with her husband and a lively menagerie of goats, geese, pigs, chickens and cats.

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Epidemic!


Three books on epidemics have appeared in short succession. If their authors had previously agreed to avoid competition, they could scarcely have done better, for they have attacked their subject in radically different ways. William H. McNeill, of this country's most noted historians, professor of history at the University of Chicago, and author of the much acclaimed The Rise of the West: A History of the Human Community, has given us another masterpiece. His Plagues and Peoples was followed by a vast amount of research; it deals with the origins of epidemic disease and traces its role in human affairs throughout the ages. Alfred W. Crosby, Jr., associate professor of history at Washington State University, is also not a newcomer. He has earlier dealt with the biological consequences of Christopher Columbus's adventures in The Columbian Exchange, and his new book, Epidemic and Peace, 1918, takes a single, recent epidemic and studies it in depth, with emphasis on its human impact. The third book, Epidemics, is essentially a short sourcebook with selected quotations from original texts. Geoffrey Marks is a medical writer and William K. Beatty is professor of medical bibliography.

The most ambitious design is obviously McNeill's. Only a seasoned historian would have dared take such a long view of life on this planet. How did infectious disease come about? How did it affect the early hunters? What did civilization and infectious disease do to each other in different parts of the world? What is the impact of climate on local parasites and thereby on local culture? What was the role of travel? And of medicine? Others have tackled such questions, notably Hans Zinsser in his memorable Rats, Lice and History, but McNeill's book will remain the landmark for years to come.

I had long waited for someone who would tell me what people, plants, and microbes came into each other over the ages; this is the closest I can hope to get. McNeill works at the giant puzzle with a broad grasp of matters historical, as one would expect, but he has also done his scientific homework exceptionally well (witness the fifty-four pages of notes)
and uses medical lingo so accurately that I suspected him of having a couple of years in medical school. But he modestly credits nine readers and a few other experts who combed through the manuscript.

I cannot convey the sweep of a book in a few lines, but I can you an example of McNeill’s speculative. He deals with our parallel inhabitants of the world with impartiality that mankind sounds like a minority group (he it humankind). In fact he makes me think that a Martian visitor, locat at our planet with keen eyes, will conclude that its real inhabitants are bacteria (which are obvious more numerous and more widespread) and interpret the people of the disease that tends to destroy greenery, pollute the air and water and cause the growth of man. It is a book called cities. If you ever thought of yourself as a race, let me give you this food. Thought in McNeill’s own words: “Looked at from the point of view of other organisms, humankind therefore resembles a race of disease whose occasional lapses less virulent forms of behavior [it mine] have never yet sufficed to mit any really stable, chronic relationship to establish itself.” In other words, the world is still acutely suffering from us.

Among the many themes developed by McNeill, I will choose a to stimulate your appetite for more. Civilization, as we know it, crowded people into cities, and provided big game for bacteria. Known is that many epidemic plagues of civilization began their reign among “cattle–where—then transferred from country to town. On the American continent, animals domesticable on a large scale were not available (remember there were no horses, no cow, sheep before the Europeans came). This may help us understand how Aztecs could pile up in cities like Tenochtitlán (Mexico City), and remain free of the diseases of civilization that ravaged the Old World. On the long run, of course, this was to their advantage: it deprived them of the chance to develop bac strains with which to mount down invading Spaniards.

That America was conquered by bacteria and viruses rather than by woods is too well known to repeat. McNeill chooses examples that
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Michael Rauhether Conducting
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give you the chills (and make you feel even more guilty toward your American Indian friends). Such as the tale of the Cayapo, a South American tribe, which numbered 6,000 to 8,000 in 1903. That year the tribe accepted one single missionary who made every effort to preserve the Cayapo from the dangers of civilization. Result: In 1918 they had dropped to 500; in 1950, only two or three were left. The tribe disappeared. And this time the intentions had been the best.

Three-way interactions (plants—people—parasites) show even more clearly how man the manipulator can be manipulated by his own doings. In Europe, during the 1600s, improved agricultural methods provided turnips and alfalfa as feed for cattle on a scale previously impossible. This meant more cattle for food, thus more healthy people; but it also meant a better target for the malaria-carrying mosquito, which prefers cattle to people. Now it so happens that the malarial parasite does not find cattle a suitable host; so the chain of infection was broken, and malaria withdrew to the Mediterranean lands, where summer droughts prevented the production of the new fodder crops.

The effects of world travel provide McNeill with more nuggets. In the days of sailing ships, for instance, the plague had time to burn itself out during long trips: an automatic quarantine, in a way. When ships became bigger and faster and could carry larger populations of rats, the plague bacilli managed to cross the oceans successfully. What better illustration of the two-edged sword of progress. But the most fascinating tale about the plague is the step-by-step expansion of Pasteurella pestis, hitching rides as it could from the Himalayan foothills until centuries later it found a perfect microclimate in rodent burrows of the New World all the way from Mexico to Canada. Get bitten today by a ground squirrel in the western United States and you stand a fair chance of coming down with as good old-fashioned bubonic plague. We are now armed against it with streptomycin and other magic bullets, but the bugs have not given up since the Middle Ages—they have just gone underground.

Now be prepared for a shock. Did it ever occur to you that bugs and taxes might have something in common? This is one of McNeill’s most original thoughts. He brings it up discussing the situation of fate whose energies—historically—have been drained either by diaz (“microparasitism”) or by zoonosis (“macroparasitism”). It took a little while to accept this notion, but it both interesting and awakens.

Also, I have a hunch that some professional historian will try to turn to shreds. It is certainly true that microparasitism and macroparasitism can sap your blood, but time will tell whether the idea of considering the horse in the same plane is a stroke of genius or a play on words. And talking in words: infectious diseases (microparasitism) make you immune to the Latin word "immunitas" meant to exempt from taxes (macroparasitism). So there is a true bridge of lands between microbial and fiscal sites. McNeill does not use this argument, but I think it adds power to cause.

In a book dealing with epidemiology it is somewhat sobering for a physician to find that medicine is first mentioned on page 235. The reason obvious. Before Pasteur (and until late 1800s) there was no effective way to deal with infectious diseases, except for smallpox vaccination, which was launched about 1800, and smallpox inoculation, which was practiced sporadically on a smaller scale fewer centuries.

In summary, a great book. (To its publishers we would read it, to its notes included. Perhaps next time they would make it a little easier for the reader to find the notes. Book signers seem to forget that when once they are sold, also have read.)

Crosby’s The Epidemics and P. 1918 is, a fine, galloping account of the influenza pandemic that killed some 25 million people in less than a year. In some ways it was a prelude out of the Middle Ages bound in the twentieth century. No plague had killed so many people in so short a time. And there was no treatment available, except TLC (tender loving care). Nurses were better at it than doctors. Crosby chooses some ghastly episodes that you will never forget. He tells the tale of whole Alaskan villages wiped out, except for the dogs, dogs dying at the dead with live children huddled against them. Or the hulk trip of the Leviathan bound for Europe packed with troops—an explosion of influenza on board. Other episodes are gripping be...
remind us that the survival of
on sense under stress, in our
edly rational society, is not to
en for granted. San Francisco,
ance, became bitterly divided
he issue of wearing prophylac
to masks. Eventually the po
came involved. In retrospect,
sense seems almost hilarious,
t that the sensible messages
towned out. It could all happen

final chapter, on the discovery
of a virus, reads like science fic
And in the end, having told the
25 million deaths, Crosby is
ed by a problem of human mem
his enormous, worldwide dis
made very little impact on the
ors. There is practically no
if it in literature (compared with
ificent plagues that killed fewer
and it is scarcely remembered

as, I am sure, this was an effect
World War II, which blurred the
episode (although the war it
tilled less people). But this is
ot the main reason. A dis
hat affects everybody but kills
2 or 3 percent is not terribly
ening. People tend to accept it
ambling, almost as a challenge.
ague is quite another story: its
ility can approach 100 percent.
flu could not produce a lasting
But it did produce a sensitive,
ugh, well-written book.
third book, *Epidemics*, by
and Beatty, does not aspire to
the same league as the other
It is essentially a short textbook
a short bibliography; its basic
is to provide you with excerpts
ature from all times. An eye
account is more impressive
statistics, as when a survivor of
ack Death complains that the
l has become a lonely place.
y three books about epidemics,
ay wonder? Why all at once?
be coincidence, but I prefer to
it as a sign of renewed interest
physical world around us. S
little creatures could do us in
any time—or they could help us
ve on this planet. History, as
science, can teach us how to

o Majno is chairman of the
ment of Pathology at the Uni
ity of Massachusetts Medical
. He is also the author of The
ing Hand: Man and Wound in

I commanded a Danube steamer

The captain didn't know I
took over his story-book steamer
on the trip from Linz to Vienna,
but I stood on the bridge giving
my own orders to the wind. At
Melk, we sailed through the
incredible Wachau valley where
taneous castles crown jutting
slopes. At the wine-growing town
of Duernstein, the fortress where
Richard The Lionheart was held
prisoner in 1193 soared above us.
Naturally, I took the time to
rescue his ghost for old times' sake.

After glorious days in Vienna
I followed the Danube to
Carnuntum with its museum of
Roman Art and splendid ruins,
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Haydn spent his boyhood.
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**Additional Reading**

**Hot Spots (p. 36)**

**Aztec Cannibalism (p. 46)**
For details of the evidence upon which his theory is based, see Michael Harner’s lengthy paper in the February 1977 issue of American Ethnologist: “The Ecological Basis for Aztec Sacrifice.” In his account for Natural History, Harner quotes from The Conquest of New Spain, by Bernal Díaz del Castillo (trans. by John M. Cohen, New York: Penguin Books, 1963, $2.50). Bernal Díaz, the most famous participant–chronicler of the conquest of Mexico, provided comprehensive accounts of Aztec sacrifices and their aftermath. Two of the more popular accounts of Aztec life-styles at the time of the conquest stand in stark contrast to Díaz’s, each devoting a single sentence of text to the issue of cannibalism. One is William H. Prescott’s The Conquest of Mexico, a volume written in the nineteenth century and now available together with his The Quest of Peru (New York: Modern Library, $5.95). The other is from 1940s, George C. Vaillant’s Aztec of Mexico: Origin, Rise, and Fall (Pueblo Books, $2.95). Jacques Soussan’s Daily Life of the Aztecs on the Eve of the Spanish Conquest (Stanford University Press, $2.95), although written in a poetic style, is generally authoritative and informative.

**Mud Turtles (p. 52)**
Archie Carr’s So Excell Fishe: A Natural History of Turtles (New York: Doubleday, 1973, $2.95) provides a thorough, comprehensive study of turtle behavior and ecology—patterns of movement and reproduction, nest construction, diets, predation, and the implications for conservation. Mud Turtles of the United States, by petrologists Carl H. Ernst and W. Barbour (Lexington: University of Kentucky Press, 1972), is a comprehensive, detailed (3 to 4 pages per species) volume providing color photographs and general information on habitat, range, behavior, and diet of turtles. John Goode’s Turtles to Ises, and Terrapins (New Charleston Scribner’s Sons, $4.95) is a good general reference for the layman. More precise information on the ecology and activity of yellow mud turtles can be found in I.Y. Mahmoud’s studies: “Coy Behavior and Sexual Maturity in Species of Kinosternid Turtles” (Copeia, 1967, pp. 314–19) and “The Comparative Ecology of Kinosternid Turtles of Oklah (Southwestern Naturalist, 1965, pp. 31–66).
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Coral Reefs (p. 72)

Douglas Faulkner's The Living Reef (New York: Quadrangle, 1974) and Jacques Couteau and Philippe Diole's Life and Death in a Coral Sea (Garden City: Doubleday, 1971) are beautifully illustrated introductions to the world's coral reefs. F. G. Smith's Atlantic Reef Corals (rev. ed. Miami: University of Miami Press, 1971, $6.95) and T. F. Goreau's "Ecology of Jamaican Coral Reefs" (Ecology, 1959, vol. 40, pp. 67-89) introduce reefs of the Atlantic Ocean. "Life and Death of the Reef," by Robert E. Johannes, with stunning photographs by Douglas Faulkner (Audubon, September 1976, pp. 36-55), is a graphic account of the impact of man's activities on coral biology. This article is followed by Kenneth Brower and Douglas Faulkner's "To Tempt a Pacific Eden, One Large Oily Apple" (pp. 56-91), spelling out plans to turn a group of Pacific coral reefs into a super-port-oil refinery complex. The responses of coral organisms to damage and pollution are described in two earlier Natural History articles: Gilbert L. Voss's "Sickness and Death in Florida's Coral Reefs" (August-September 1973, pp. 40-47) and Ralph Mitchell and Hugh Ducklow's "Slow Death of Coral Reefs" (October 1976, pp. 106-110).

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In the photograph on page 66 of the February 1977 issue, the fish labeled a rosisside dace is actually a redline darter.
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BY CADILLAC
4 Authors

12 This View of Life Stephen Jay Gould
Evolution's Erratic Pace

20 Letters

24 A Naturalist at Large A. Myra Keen
Paleontological Hoaxes

32 Farming the Edge of the Andes Stephen B. Brush
Photographs by Victor Englebert
In remote valleys, agriculturists are preserving a genetic base that may help feed all humankind in the future.

42 How Mussels Get Attached Arnold Tamarin
These creatures, battered by waves, hold on with real mussel power.

48 Shelters on the Plains Roger Welsh
Living in Nebraska is like being hunged: "Once you hang there for awhile you sort of get used to it."

54 Confessions of an Animal Trafficker Jean-Yves Domalain
What expalins the passion for collecting, which leads to such suffering and death?

68 Fabulous Timbuktu Klaus-Friedrich Koch
At the edge of the Sahara, the remnants of a once-great city.

76 The Market

78 Celestial Events Thomas D. Nicholson

80 A Matter of Taste Raymond Sokolov
Bananamania

84 Sky Reporter Stephen P. Maran
The Cygnus A Conundrum

88 Book Review John S. Marr
Uninvited Guests

92 Announcements

94 Additional Reading

Cover: African civets are captured in large numbers by natives who remove and sell the mask. The industry is part of the enormous worldwide traffic in wild animals and their by-products. Photograph by Bruce Coleman. Story on page 54.
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Roger L. Welsch first learned about folk architecture ten years ago at graduate school and says he has preoccupied with its varieties, especially on the Great Plains, ever since. Currently a professor of folk architecture at the University of Nebraska, Welsch would like to spend less time laying traditional buildings and more time "thinking about them, feeling them, building them, tearing them down, driving nails, and cussing." In this effort, he is reconstructing two log cabins on his Nebraska farm. So attuned to nineteenth-century life on the plains is Welsch that he says he would like to look like C. N. Dunlap, a ranch foreman during the 1880s, whose photograph appears here.

While still in high school, Klaus-Friedrich Koch walked across Sar- dinia and Montenegro and his later travels have taken him to unexplored parts of New Guinea (where he lived for nearly two years in a remote valley in the Central Mountains), to the Himalayan kingdom of Bhutan before the Lindblads got there, and through Burma and Afghanistan. He has also been to Tahiti, Samoa, Fiji, and Tuvalu (formerly Ellice Islands). In 1974, he made a pilgrimage to Mecca and in 1976 he felt a sudden need to visit Timbuktu. Koch camouflages his addiction to traveling by conducting ethnographic research. He taught anthropology at Harvard for several years before joining the faculty of Northwestern University. His many publications include two previous articles in Natural History.
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On November 23, 1859, the day before his revolutionary book hit the stands, Charles Darwin received an extraordinary letter from his friend Thomas Henry Huxley. It offered warm support in the coming conflict, even the supreme sacrifice: "I am prepared to go to the stake, if requisite...I am sharpening up my claws and beak in readiness." But it also contained a warning: "You have loaded yourself with an unnecessary difficulty in adopting Natura non facit saltum so unreservedly."

The Latin phrase, usually attributed to Linnaeus, states that "nature does not make leaps." Darwin was a strict adherent to this ancient motto. As a disciple of Charles Lyell, the apostle of gradualism in geology, Darwin portrayed evolution as a stately and orderly process, working at a speed so slow that no person could hope to observe it in a lifetime. Ancestors and descendants, Darwin argued, must be connected by "infinitely numerous transitional links" forming "the finest graduated steps." Only an immense span of time had permitted such a sluggish process to achieve so much.

Huxley felt that Darwin was digging a ditch for his own theory. Natural selection required no postulate about rates; it could operate just as well if evolution proceeded at a rapid pace. The road ahead was rocky enough; why harness the theory of natural selection to an assumption both unnecessary and probably false? The fossil record offered no support for gradual change: whole faunas had been wiped out during disarming short intervals (see my column of October 1974). New species almost always appeared suddenly in the fossil record with no intermediate links to ancestors in older rocks of the same region. Evolution, Huxley believed, could proceed so rapidly that the slow and imperfect process of sedimentation rarely caught it in the act.

The conflict between adherents of rapid and those of gradual change had been particularly intense in geologic circles during the years of Darwin's apprenticeship in science. I do not know why Darwin chose to follow Lyell and the gradualists so strictly, but I am certain of one thing: preference for one view or the other had nothing to do with superior perception of empirical information. On this question, nature spoke (and continues to speak) ambiguously and multifariously. Cultural and methodological preferences had as much influence upon any decision as the actual data.

On issues so fundamental as a general philosophy of change, science and society usually work hand in hand. The static systems of European monarchies won support from legions of scholars as the embodiment of natural law. Alexander Pope wrote:

Order is Heaven's first law;
and this confessed,
Some are, and must be,
greater than the rest.

As monarchies fell and as the eighteenth century became embroiled in an age of revolution, science began to see change as a normal part of universal order, not as aberrant or exceptional. Scholars then transferred to nature the liberal program of slow and orderly change that they vocated for social transformation: human society. Karl Marx recognized the primary path of influe when he wrote to Engels in 1862:

It is remarkable how Darwin recognized among beasts and plants his English society with its division of labor, competition, opening up of new market, "invention," and the Malthusian "struggle for existence."

To many scientists, natural cyclicalism seemed as threatening as reign of terror that had taken great colleague Lavoisier.

Yet the geologic record seems to provide as much evidence for cyclicalism as for gradual change. The gradualism of a nearly universal tempo, Darwin, to use Lyell's most characteri method of argument—he had to replace literal appearance and commonplace for an underlying "reality." Contrary to popular myths, Darwin and Lyell were not the heros of science, defending objective against the theological fantasies of "catastrophists" as Cuvier and Buckland. Catastrophists were committed to science as any gradist; in fact, they adopted the metaphor "objective" view that one should believe what one sees and not inter
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If gradualism is more a product of Western thought than a fact of nature, then we should consider alternate philosophies of change to enlarge the realm of constraining prejudices. The Soviet Union, for example, scientists are trained with a very difler philosophy of change—the so-called dialectical laws, formulated by Engels from Hegel’s philosophy. Dialectical laws are explicitly punctual. They speak, for example, the “transformation of quantity into quality.” This may sound fanciful, but it suggests that change occurs in large leaps following a slow accumulation of stress that a system resists until it reaches the breaking point. Heat water and eventually reaches a boiling point. Oppress the workers more and more, and they suddenly break their chains.

Eldredge and I were fascinated to learn that most Russian paleontologists support a model very similar to our punctuated equilibrium. The connection cannot be accidental.

I emphatically do not assert general “truth” of this philosophy, punctuational change. Any attempt to support the exclusive validity of a grandiose notion would border on the nonsensical. Gradualism sometimes works well. (I flew over folded Appalachians this morning and saw the striking parallel ridges left standing by gradual erosion of softer rocks surrounding them.) make a simple plea for pluralism, guiding philosophies, and for recognition that such philosophies however hidden and unarticulated constrain all our thought. The dialectical laws express an ideology QF openly; our Western preference for gradualism does the same thing more subtly.

Nonetheless, I will confess to a personal belief that a punctuational view may prove to map temps biological and geologic change more accurately and more often than any of its competitors—if only because complex systems in steady state are both common and highly resistant to change. As my colleague British ologist Derek V. Ager writes in a forthcoming edition of his book, “Geologic change . . . “The history of one part of the earth, like the life of a soldier, consists of long periods of boredom and short periods of terror.”

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Letters

Aztec Enigma

Michael Harner’s picture of the supposed contrast between the Old World and the New, and between Mexico and the Andes, is simply wrong (“The Enigma of Aztec Sacrifice,” April 1977). Herbivores suitable for domestication were never eliminated from Mesoamerica, either by the “ancient hunters” or by environmental changes following the last glaciation. Deer, big horn sheep, pronghorn antelope, tapirs, and pecarí, to mention only the larger herbivores of Mexico, could all have been successfully domesticated to assure a steady supply of animal protein. Any animal on the long list of Mexican relatives of the South American guinea pig would have done the job just as nicely for the ancient Mesoamericans as the guinea pig did for the Andean peoples. Sahagún refers to gopher meat tamales and to rats in a long inventory of high-status food for the well-nourished Aztec aristocracy. And what about the rabbit—like the guinea pig, a rodent—with its near-legendary fecundity and its soft hair that was so highly prized for warriors’ costumes?

What makes the Mesoamericans unique is that they did not choose to domesticate animals that were available. They did domesticate the turkey, the dog, the honey bee (whose protein-rich larvae were also eaten), and possibly the duck. Harner is wrong to call the dog a “carnivore” and hence, not only an inefficient converter of protein but one that “competed with its breeders for animal protein.” Dogs are omnivorous, the Mexican hairless especially so, fattening readily on an almost wholly carbohydrate diet. Its average weight is 30 to 35 pounds.

Woodrow Borah’s unpublished population estimate, cited by Harner, of 25 million for central Mexico, finds few takers among Mesoamericanists. We agree with Edward Calnek and H. B. Nicholson that the actual figure probably lies between 10 and 15 million at most. Nor have we been able to find anyone who would agree with the astonishing figure of 250,000 sacrificial victims per annum, which Harner, without citing any evidence, chooses to equate with 250,000 human bodies for the Aztec dinner table.

Harner did not mention the Aztec empire’s tribute system, thanks to which enormous amounts of goods—including foodstuffs—and services flowed into the three cities of the Triple Alliance from conquered provinces. Sahagún claimed that thanks to annual tribute in maize, beans, and chia seeds, there were enough basic staples in the royal granaries to sustain Tenochtitlan for twenty years.

Harner’s “materialist,” or economic determinant, interpretation, has in effect reduced the Indian ancestors of most Mexicans and millions of Mexican Americans to the level of creatures subject to their stomachs, too undiscerning to recognize that there were other, far more efficient and economical ways of getting protein than eating their fellows. Harner and the editors of Natural History considered the social and political institutions of disseminating such a mea- 

PetE T. F.

JILL LESLIE FR.

State University of New York, All.

One might object to many of the deductions adduced by Michael Harner in “The Secret of Aztec Sacrifice.” But he has advanced a hypothesis that fits what we know about human nutrition and the Mesoamerican society of the late fifteenth and early sixteenth centuries. His theory complements the two other hypotheses of population (and a deliberate policy of terror on the Aztecs’) part that have been advanced to explain the remarkable population explosion of human sacrifice and associated ingestion of parts of the victim after the middle of the sixteenth century. Accordingly, Harner’s ideas must be taken seriously and tested by much further research.

Harner’s critics seem to place Sahagún and Durán in opposition to Bernal Diaz. I do not think that these sources really opposed. Bernal Diaz agrees with other Spaniards who were among the early Europeans to arrive in central Mexico. For an elucidation of Sahagún and Durán we should look to the Relaciones de las gráficas, a lengthy series of reports prepared for Philip II a half century after the conquest, which used Indian elders and informants and included description of their customs and rites. These reports were roughly contemporaneous with those of Sahagún and Durán but cover the entire country. Their testimony is generally unanimous that in aboriginal times the human cleared was an abundance of meat for sale; the upper classes ate relatively well and the lower classes poorly. According to the reports, the diet of the lower classes had improved substantiably under Spanish rule.

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The Author Replies: The point of articles in Natural History and American Ethnologist (February 1977) is to propose an explanation of why the Aztecs, among all known human societies, sacrificed unparalleled numbers of human victims. If the Fursts have an alternative explanation, they are not to be trusted. They speculate with an undeniable certitude that the Mesoamericans could have successfully bred a variety of wild herbivorous mammals for food. Happens such domestication, however difficult, might have occurred eventually. Mesoamerica remained the only major region of civilization that lacked domesticated herbivores for meat or milk. Despite its zoological classification as a carnivore, the dog can indeed be fed with food. But unlike most major domesticated herbivores, it still competes with its owners for essentially the same kinds of food, animal or vegetable. As the Fursts' dissatisfaction with Borhegner's numerical estimates, the Aztecs and their neighbors held the world's record, whatever the actual numbers, for human sacrifice. There were repeated famines, shortages of food despite the tribute and the granaries. In my explanation, the human sacrifices were neither work of madmen nor slavish response gods with unaccountable tastes, rather an adaptive solution to ecologic problems that changed with the introduction of New World livestock in the tenth century. Aztec cannibalism is long gone, and modern Mexican-Mexican Americans cannot be held responsible.

The Editor Replies: The Fursts' implication that Natural History should suppress new theories and protect readers because they are naïve goes completely against our scientific philosophy and our basic respect for our readers.
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**A Naturalist at Large**

by A. Myra K

## Paleontological Hoaxes

P. T. Barnum would applaud the success that wily hoaxers have enjoyed at paleontologists’ expense

Competition between scientists has meant that the pursuit of knowledge is occasionally sidetracked by hoaxes—deliberate attempts to pass off fake discoveries as genuine. Recent hoaxes, perpetrated by scientific workers under extreme pressure to obtain grants or admission to prestigious institutions, can be considered cries for help. Older incidents have ranged from good-humored pranks to attempts to destroy rivals’ careers.

A number of paleontological hoaxes have been so successful that they took years to expose, and some have never been completely unraveled. Vertebrate paleontologists have been favorite dupes, perhaps because bones appeal more to hoaxers’ imaginations than do other types of fossils. Two fakes that hoodwinked the paleontological community for long periods were the Calaveras skull, discovered in 1886 in a mining site northwest of Yosemite in central California, and Piltdown man, whose presumed remains were unearthed in 1912 in Sussex in southeast England.

The Calaveras skull caused considerable excitement when it was reported in 1886. It seemed to indicate that man had lived in California during late Tertiary time—more than seven million years ago—far earlier than anywhere else on earth. J. D. Whitney, a geologist who had been chief of the California Geological Survey, had accepted the skull as genuine on the testimony of a friend, a physician. In his turn, the good doctor had taken the word of the young miners from whom he had acquired the skull. They claimed to have dug it out of a new mine shaft.

Skeptics, however, pointed out that the matrix, or dirt, inside skull did not resemble the Sien gravels of the mining pit in which it was supposed to have been buried. By 1911, both Whitney and his friend had died, and a U.S. Geological Survey report could tell the true story of the Calaveras skull without embarrassing anyone involved.

The Calaveras gravels actually contained some genuine fossil stumps of palm trees. About the time of the discovery, floodwaters from a nearby stream had washed a number of skeletons out of an Indian burial place. These two events inspired an avid practical joker to trick the respected physician, who was an avid collector of fossils and similar curiosities. With the help of some accomplices, the joker convinced the doctor to accept a contemporary Digger Indian skull as a Tertiary fossil several million years old. But the pranks were not expected to concerning the physician to submit the skull as genuine. Whitney. Hoping to save face for the Calaveras skull was eventually unmasked, it became embedded in the litera
ta of prehistoric man as falsely as it had been embedded in the gravel shaft and it is still sometimes mentioned as a possible fossil of pre-Pleistocene man, more than a million years old.

The story of Piltdown man involved many individuals, including some of the most eminent specialists of their time. Although the find was proved a hoax in the 1920s, several mysterious aspects of the case, including the perpetrator’s identity and motives, remain unsolved. The discovery was first announced in 1912, when the highly respected English amateur paleontologist Charles Dawson, who had ready been responsible for some remarkable finds, sent some fragments...
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of a human brain case and jaw to Sir Arthur Smith-Woodward, paleontologist and keeper (curator) of the Department of Geology at the British Museum. Dawson, who later gave several vague and confusing accounts of his original find, claimed that he first noticed the bone fragments in a road workers’ gravel pit on Piltdown Common, near Fletching, Sussex. The skull he sent Smith-Woodward was anomalous: the jaw was remarkably primitive; the brain case quite advanced. Yet the two seemed to fit together, partly because the scientific community, on the lookout for tangible evidence of Darwin’s theory, wanted to see a match. Smith-Woodward gave Dawson’s Piltdown man the scientific name *Eoanthropus dawsoni* and tried to illustrate what he must have looked like.

Dawson led Smith-Woodward to his site, and a number of other paleontologists followed, including Teilhard de Chardin, who was just beginning his scientific career, and an interested amateur named Sir Arthur Conan Doyle, who was then writing about Professor Challenger’s discoveries in *The Lost World*. Dawson located another site at Piltdown and he and his visiting colleagues turned up additional fragments—some crude tools, parts of a second skull, and remains of associated fauna, including elephants, rhinoceroses, and beavers. All these finds seemed incontestable proof that man was living in England in pre-Pleistocene time or not later than early Pleistocene (a million years ago), before the Ice Age.

As in the Calaveras case, a few skeptics carped about small discrepancies and complained that the Piltdown skull did not fit into any logical sequence of fossil man’s history. Piltdown man was classified as an enigma and usually drawn on in charts of human evolution as a side branch that led nowhere.

Then, in the early 1950s, technical advances in chemical and physical analyses permitted a restudy of the actual material of the Piltdown skull and its associated artifacts. Results immediately showed that the brain case was that of a Neanderthal man whereas the jaw was that of a modern ape. The two parts of the skull had been made to match by staining and breaking down the jaw and filing the teeth. The analysts proved that a second Piltdown jaw could have been manufactured from an ape jaw, but not from the very differently shaped jaw of a genuine early man, such as Heidelberg man. The Piltdown hoaxer foisted his clever deception on the gullible scientific community so carefully and patiently, that to this day no one can positively name him. In his 1955 book, *The Piltdown Forgery*, J. S. Weiner, whose colleagues worked on the chemical reexamination of the fossils, stated that the available evidence points to Dawson, who died in 1916. Dawson’s motives are difficult to fathom: he had a well-established reputation, which would have been irreparably tarnished if his trickery had failed. Weiner believes that if Dawson was not the culprit, he was the tool of a blackmailer.

Dr. Johannes Beringer, an eighteenth-century German amateur, was the victim of a third palaeontological hoax, an attempted character assassination centered on his *Lithographiae Wirceburgensis*, published in 1726. Beringer successfully combated his persecutors, but his triumph is not part of the apocryphal version of this hoax, which crops up periodically in textbooks and popular scientific literature. The usual version is that Beringer, a German university professor, was so excited by some fossils he had found and took his students on so many field trips to his site that they tired of helping him and began fabricating material for him to discover. This harmless student prank is supposed to have continued unabated until the professor decided to publish figures of all the stones. His students tried to disillusion him by making more and more improbable fossils, such as butterflies sipping nectar at flowers, spiders with their webs, letters of the Hebrew alphabet—all of which Beringer joyously accepted as genuine. His book was off the presses before he found the stone that finally disenchanted him: it had his name on it. Beringer ruined himself financially by buying up the unsold copies of his book and died heartbroken. To recoup the family fortune, his heirs rebound the books and sold them as collectors’ items.

But Beringer’s story is rather different from this tragic account. In 1963, the University of California Press issued a translation of Beringer’s original work, with supplementary notes and some documentary evidence proving that the professor was the subject of something far more serious than a student prank. Dr. Beringer was indeed a professor, in that he was dean of the faculty of medicine at the University of Würzburg in Germany, but he was a court physician and had a lucrative private practice as well. In addition he had established such a reputation as a learned amateur collector of curios that he incurred the envy of two university colleagues, a librarian and a professor of geography and mathematics. They plotted to use Beringer by casting him in the role of a forger of fossils. After fabricating the figured stones, the plotters hid one of the three young men who had been helping Beringer dig and instructed him to sell Beringer the *lithographies* (lying stones) or to plant them where he would find them. May 1725, Beringer saw the first of these “fossils”: one stone show the sun and its rays and two depict some wormlike objects.

The “discoveries” continued nearly a year. Beringer then judged that he had enough stones to justify publication. In the spring of 1726, he issued 21 plates, showing some 2 stones. Most of Beringer’s text is interesting discussion of theories previously advanced to account for fossilization. In the academic style of his time, Beringer examined these theories one by one and refuted each. Even mentioned the rumors that figured stones were fake plants enemies, but he discounted the idea as unthinkable. Beringer did not permit to settle the question of how such stones had been formed. He published his illustrations to show the wonders of “this new stone collection” and continue the “search for truth” about them.

No sooner was the book in print than the evidence of trickery became overwhelming that Beringer, disillusioned at last, felt obliged to defend his honor by judicial proceeding. Würzburg court records show that the hearing was held in the cathedral April 1726, and two municipal trials in April and June. The two principal witnesses were exposed and declared that the man and other shadowy figures in the plot had sought revenge because they had found Beringer overweeningly arrogant and conceited.

The schemers were duly punished the librarian, who had been writhe and history of the duchy of Würzburg was forbidden further access to university archives. His manuscript remained unfinished and he died five years later. The other professor vanished from the duchy, but was later allowed to return after he asked...
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permission to complete his colleague’s unfinished work.

Beringer himself fared much better than his enemies. He lived on fourteen years and published two additional books that earned him considerable recognition. The textbook tale of Beringer is far from accurate; he was no small man broken by a student prank, but a victim of professional jealousy who countered the tack as wisely as he could. The pressy part of the Beringer case, which makes it a devastating comment on the effects of professional competition in science—is the tremendous amount of work, expense, and time the perpetrators devoted to their project, presumably out of mischief alone.

In all three of these hoaxes, one deliberately tampered with fossil record and placed phony material where it would be considered genuine. In the Calaveras hoax, pranksters never anticipated serious consequences, and their skull became celebrated only because Whitney, a well-known scientist, had accepted it as genuine. But Whitney was a gulligist, not a paleontologist, and he had never been sufficiently careful.

Piltdown man, a more complicated case, was the work of someone determined to prove a cherished thesis—the existence of a “missing link” pre-Pleistocene man—event if he had to manufacture the evidence himself. No practical joker would have risked his scientific reputation as this needed. Nor would a prankster have bothered to gauge so accurately the credibility of the scientific community.

While no more credulous than more modern colleagues at Piltdown and Calaveras, Beringer laid his open to treachery because, like many scientists of his period, he substituted reasoning for experience. If he had done his own digging, he would have noticed that the lying stones were never found in undisturbed strata. His book was by no means useless: text was a model of shrewd thinking about fossil formation, and the story of his misfortunes should have served as a warning to future paleontologists. The workers at Calaveras and Piltdown simply had not paid attention.

Dr. Keen is professor emeritus of paleontology and curator emeritus of malacology at Stanford University.
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Despite assurances of bountiful harvests through the use of Green Revolution technology, some Peruvians wisely follow centuries-old planting strategies.

High in the Peruvian Andes before planting time, peasants sort over their collections of seed potatoes, selecting out of a possible fifty varieties those types that will be suitable for particular fields. In spite of low productivity, the many varieties of one plant and the way they are planted assure the peasant that he will not starve if drought, flood, or disease destroys part of his crop. These traditional patterns allow him to farm with minimum dependency on far-flung trade networks that are often liable to economic and political vagaries.

In contrast to the diversity of peasant fields, the advanced agriculture of industrialized nations strives toward the high production of one crop through extensive genetic experimentation and soil fertilization. Peasants in many parts of the world are being induced to abandon their traditional agriculture and to adopt the results of the newer technology. Within the last decade, pressure for this change has increased with the breeding of high-yielding varieties of maize, wheat, and rice, and with the profitability of transferring technology from Western to third world nations. Rapid population growth, the costs of importing food, and the rural exodus to cities have pressed the urgency of this change. The admirable goal of this effort—known as the Green Revolution—is the provisioning of an increasingly hungry world with food. But as this revolution proceeds, lessons that could be learned from traditional peasant agricultural systems are mostly ignored.

In the Peruvian Andes, where traditional agriculture predominates, peasants deal with one of the steepest environmental gradients in the world. Single mountain slopes, often spanning several thousands of feet in altitude, embody numerous ecological zones where there are differences in temperature, rainfall, exposure, slope, drainage, and soil composition. Altitude and exposure determine the different plant communities that grow in these zones.

The agriculture of both peasant societies and great civilizations such as the Inca Empire has been based on a finely tuned understanding of the ecosystems that span the Andes from the dry Pacific coast to the dense jungles of the eastern foothills. This sensitivity persists into the present.

Uchucmarca is one village whose survival has depended on a close adherence to steep valley ecosystems. Located in northern Peru near the Marañón River, a principal tributary of the Amazon River, the village is situated at an altitude of 9,950 feet, halfway up a forty-mile-long valley that covers more than 10,000 feet in altitude. The valley’s climates are as diverse as those along a line from Texas to Alaska.

Slightly more than one thousand people live in Uchucmarca and another thousand live in smaller hamlets and homesteads scattered throughout the valley. Like many other isolated...
ages on the eastern slopes of the Andes, Uchucmarca is connected to outside world by steep mountain trails passable only by foot and on muleback. The nearest road is six hours away and a twelve-hour journey is required to reach the nearest market center with such amenities as electricity.

Uchucmarca’s self-sufficiency lies from the wide variety of crops produced in the valley’s six ecological zones. Although the zones blend into each other, their different altitudes produce a gradient of environments. The lowest zone, between 00 and 4,900 feet, is a narrow alluvial basin between steep, dry hills dotted with columnar cacti and thorny trees. Lying well within the rain shadow of the eastern cordillera, this area receives no appreciable rain, and the zone’s principal crops—sugar cane, coca, manioc, chili peppers, and fruits—must be irrigated.

Above this zone, the kichwa fuerte zone runs up to 6,200 feet. In this area the valley widens and increased rainfall allows a dense scrub forest. Although precipitation is still too sparse and irregular to support extensive cultivation, some families venture to grow wheat and maize here. For most people, the important product of the kichwa fuerte is firewood, a resource rapidly being depleted.

The major grain-producing zone, the kichwa, climbs from 6,200 to 8,200 feet in the wide, middle valley below grass-covered hills. Uchucmarca’s farmers believe this area contains the valley’s optimal agricultural land, with warm days, frost-free nights, and a regular annual rainfall of about twenty inches. During July and August, almost the entire village population decamps for this area to spend a month or two enjoying the mild climate and harvest festivals.

Above 8,200 feet the valley narrows again as the templado zone begins. As its name implies, this is a temperate area situated between the warm, drier zones in the lower valley and the cool, moist ones above. Steep slopes covered with low bushes and trees preclude extensive cultivation. But on more level ground, a wide variety of crops such as maize, wheat, barley, lentils, and field peas are grown.

Uchucmarca is located at the lower end of the next zone, the jalka. Lying between 9,900 and 12,000 feet, this zone is the center of the cultivation of potatoes and other tuberous crops. Potatoes are the bread of the Andean tenant households keep some sheep for two reasons: the wool is used virtually all clothing and manure is the only fertilizer that potato fields receive.

Sugar cane, an abundant crop in the lower valley, is crushed in oxen-powered mills. The resultant cane juice is boiled down and molded into five-pound blocks.
Bread baking is a cooperative activity in which one family owns a beehive mud stove, another contributes firewood, and a third provides the labor. All bread is made from locally grown wheat.
People. No meal is satisfactory without them, and hunger is defined by their absence. The origins of Andean civilization may be traced in part to the niche in the jalka. In this valley, a modern and pre-Columbian population expanded more labor on the flat land for these crops than for any other. Temperatures are cool here, and frosts are common during the short nights of the short dry season between May and September.

Above this zone, the jalka fuerte ascends to almost 15,000 feet. Here, above the limits of crop cultivation, rolling pastures of bunchgrass, sage, and Andean tundra are swept cold winds and are often covered by clouds that tumble down from the Andean cordillera—a line of ragged rock outcrops and cliffs where llamas nest. Llama and alpaca have since disappeared from these tundras, although their prehistoric range is evident in the ruins. Lamb, cattle, sheep, horses, mules, pigs graze here, representing the most important source of cash to the villagers.

The Uchucmarca economic index subsistence strategies depend on providing access to these ecological zones and their products for each individual household. Although each family has absolute ownership of a parcel of land—a right held exclusively by the village—individual households are granted virtually permanent rights through inheritance or the village council.

Like most peasants in Latin America, the Uchucmarquinos prefer a balanced diet. Maize is consumed in several ways: ears are mashed into hominy or dried or partially sprouted, dried, and then fermented into chicha, a traditional Andean beverage.

The Uchucmarcan women are weaving specialists. Weaving a chocho-sized garment may take two weeks, but spinning the wool may take several months. sent an image of egalitarian poverty. Most families, however, are fairly well off in that they have enough food for the table. The daily fare is simple: wheat cakes of stone-ground whole wheat flour, parched and roasted maize, beans or peas, roasted barley flour, mutton soup, a few pieces of dried beef or mutton, and quantities of steamed potatoes.

An average family of four persons cultivates about five acres of land that are spread among small plots in various parts of the valley. Using only simple tools—a short-handled hoe, a pick, and a shovel—and with only oxen to supply power, agriculture is arduous and time consuming. Hiking to and from cultivated plots may occupy several hours per day. My research reveals that the average farmer spends almost 60 percent of his work time tending his fields and herds.

Most households attempt to obtain rights to as many parcels in as many zones as possible. Shortages of land and labor, however, prevent most households from achieving self-sufficiency. These shortages are compensated for by a set of alternative strategies, such as reciprocal labor exchange, hiring laborers who are paid in crops as well as in cash, barter between households specializing in one crop, and a system of sharecropping that exchanges land for labor. Every household in the village employs each of these strategies to some degree.

To insure a full larder, households try to grow six or seven different crops in different parts of the valley. Another guarantee is to plant the same crop in several fields. A single household may thus have three or four potato fields in the jalka, as well as fields planted in wheat, barley, maize, and field peas in two or three of the lower zones. The peasants may also diversify crops in one field: maize, squash, and beans. For example, they are always planted together because these different crops utilize different soil nutrients. This tactic may balance the failure of one crop with success in another if a family does not cultivate numerous plots.

Another way to reduce the risk of food shortage is to plant numerous varieties of one crop, especially potatoes, in a single field. There are more than 2,000 named potato varieties in Peru; in Uchucmarca alone, the peasants can identify some 50 varieties. The potato is indigenous to the Andes, and the area harbors a tremendous gene pool, both wild and domesticated. In the Andes, continuous cross-pollination between domesticated and wild potato varieties frequently creates new strains.

This large number of potato types provides some measure of security for the average Andean peasant. Agricultural success in Uchucmarca is fraught with danger: from earthquakes, landslides, hail storms, and sudden frosts, as well as damage by insects and disease. Saints, such as San Isidro, who watch over the fields and who are favored with candles, prayers, and fiestas do not guarantee success. Although all families depend on different crops as well as on their kinsmen and neighbors, their final safeguard against hunger is their ability to grow enough potatoes.

In most traditional communities, a first line of defense against crop destruction is maintenance of a wide genetic base as possible and selection of different types more resistant to frost, blights, and insects. But no single variety of potato is able to withstand all of these, and none has total resistance to any single pest. By growing many varieties, however, the peasant reduces the risk of hunger if one field or variety is attacked by a particular pest.

In Uchucmarca, a common practice is to plant fast-growing varieties during the drier part of the year; this avoids late blight, which increases during the months of heavy rain. Another practice is the cultivation of certain frost-resistant varieties in flat, bottom areas of the high valley where frost, but not late blight, is common. Other varieties are cultivated on hillsides where late blight, but not frost, is common.

A third stratagem used by Uchucmarcan peasants to assure a potato harvest is to cultivate fields for only one to three years before returning them to a long fallow of eight or more years. Farmers usually sow potatoes in the first year and other Andean tubers—oca (Oxalis tuberosa), mashua (Tropaeolum tuberosum), and ullucu (Ullucus tuberosum)—for one or two subsequent years. The long
fallow period lowers subsistence risk in two ways: by reducing the amount of erosion and soil loss and by killing disease vectors such as nematodes and fungi, which remain in the soil and depend on continued potato plantings to survive.

A final means of reducing crop destruction is the bordering of fields with hedgerows of living plants such as sauco bush and agave. Ostensibly maintained to keep out destructive livestock, the roots of the plants retard soil loss due to wind and water erosion and create quasi terraces. Soil loss is also reduced by plowing and cultivation, which tends to build up soil behind the hedgerow, slightly leveling the field on steep slopes. Hedgerows also provide refuges for wild varieties of domesticated plants as well as for insects, which pollinate, and birds, which prey upon pests. Despite criticism leveled at hedgerows for the space they require, they are one of man's most important agricultural inventions.

In spite of the success of isolated villages in meeting their food requirements, Peru faces annual food deficits and must import food. Agricultural production has not grown as rapidly as the population. To meet this dilemma, the Peruvian government and international development agencies initiated a program in 1974 to develop high-yielding potato varieties and to promote advanced agricultural technology based on the extensive use of chemicals. This effort, centered at the International Potato Research Center outside of Lima, is modeled on research programs for maize and wheat in Mexico and for rice in the Philippines. Although a miracle-variety potato may never be produced, several new strains have been developed that are capable of substantially higher yields than the traditional ones. These new varieties may increase yields by two or three times those of traditional varieties, lifting production from roughly three to eight or nine tons per acre. Along with agrochemical technology, these varieties have been introduced to several areas of Peru.

Uchucmarca and other villages along the eastern slopes of the Andes, however, have not adopted these new varieties or the new technology. Peasants say that the new strains are tasteless and of a watery consistency. Traditional varieties, especially the favorite floury-textured ones, tend to be higher in protein and have better protein quality than the improved strains. Crude protein of the native types averages roughly 2.48 percent versus 2.07 percent for the new types. Protein equivalency ratios—a measure of protein quality—indicate that some of the native varieties are more than 50 percent higher in quality than the most commonly planted "improved" variety. Also the new strains require heavy fertilization, while the traditional varieties do not. Good-tasting potatoes, by Andean standards, are incompatible with heavily fertilized fields.

Another deterrent is that the seeds of the new varieties and the technology they require are far too expensive for peasants: fertilizer, fungicides, and insecticides alone cost about sixty dollars per acre. There are no public or private loans available in the valley, and the present scale of potato production by an individual household does not now justify the long and expensive journey needed to search for credit. Uchucmarcan peasants are accustomed to producing potatoes with little or no cash expenditure. The average annual cash investment per plot is less than two dollars, the cost of hiring a team of oxen for two or three days. Outside labor, if needed, is traditionally paid for in the crop itself.

The general adoption of the new varieties would eliminate the rich gene pool of indigenous varieties and force the farmer onto an ecological high wire where the narrowly based genetic crop may fall prey to a recently evolved disease. Examples of such disasters are plentiful: the 1970 corn blight in the United States, coffee blights in Brazil, and the Irish potato famine of 1845. Further reduction in the gene pool of indigenous varieties may severely limit the ability to respond to such genetic dangers.

The developers of new high-yielding varieties are aware of this danger and have countered it by creating germ-plasm banks such as the U.S. Department of Agriculture station at Fort Collins, Colorado, where seed varieties of one crop are frozen or tubers are kept in cold storage. Such methods are satisfactory, providing the seeds and tubers remain viable under such conditions and the machinery for keeping them does not fail. Recognizing that neither of these provisions is certain, Hugh Ilitis, a botanist at the University of Wisconsin, has proposed maintaining selected "genetic landscapes," that setting aside regions where specific crops would be off limits to agricultural technology. Such a proposal would avoid accidents, such as potato blight, and allow the natural process of cross-pollination between wild and domesticated species. Ilitis recommends the establishment of an international potato diversity preserve along the Lake Titicaca basin of Peru and Bolivia.

Like the native potato fields, economies of traditional villages are relatively stable, but low-yielding systems. The adoption of new, high-yielding crop varieties and agrochemical technology depends on restructuring traditional cultural and economic patterns. But Keith Griffen, economist at Oxford University, notes that the credit and rural assistance that supports the Green Revolution is often biased away from peasant in favor of large commercial producers. Francine Frankel, economist at the University of Pennsylvania, has observed the effects of this bias in India, where the living standards of the poorest peasants have deteriorated in some areas where the Green Revolution has undermined traditional peasant relationships. If these services and subsidies fail, the peasant may have no alternative but to join the exodus to cities.

The passing of traditional culture under the guise of modernization fails in a world made the poorer. The passing may be inevitable. What is not inevitable, however, is the loss of these cultures' insights and sources, so essential for the future of our hungry planet.

After harvesting and threshing barley, peasants dry the grain in the lofts of houses. Hydraulically operated mills in Uchucmarca grind the grain into flour.
How Mussels Get Attached
by Arnold Tamarin

This mollusk produces a remarkable adhesive whose strength and durability are of interest to dentists and surgeons.

The animal kingdom has numerous examples of species whose life-styles entail attachment to a surface. The methods of attachment used by different animals demonstrate a wide range of mechanisms developed in response to various environments and feeding habits. In the world of fish, for example, the remora is a hitch-hiker and saves energy by clasping the underside of sharks by means of a suction device on the top of its head. By detaching and reattaching from the shark at will, this fish can swim independently when necessary. At the other end of the spectrum are species, such as barnacles and oysters, that anchor themselves permanently to available hard surfaces and are not free to move about on their own. Such animals have developed specialized glands that secrete cementing substances, which become mineralized to create rigid, unbreakable connections between their shells and the sites of attachment.

The sea mussel (Mytilus) and some other bivalve mollusks have developed a unique attachment mechanism termed the "byssus," which consists of materials secreted by glands located in the foot. Marine mussels live mainly in beds along the coastal shoreline, where they are daily exposed to pounding surf and changing tides. The byssus accommodates the mussel's requirement of semipermanent attachment in its variable environment. Although mussels are considered to be sessile, or permanently attached, animals, they do retain a limited freedom of movement that enables them to survive the shifting currents and silt in their intertidal habitat.

Aristotle appears to have provided the first description of mussels being "rooted" in sandy and muddy places. A few medieval treatises on bivalves provided accounts of the byssus and interpreted the structure as a plant growing from the surface to which the animal attaches. The first accurate interpretation of the byssus as a holding device fabricated by the mussel itself was published by the German naturalist Conrad Gesner in 1558. The first scientifically detailed study of a byssus-forming bivalve was printed in 1882. Around the turn of the present century, greater interest in the biology of mussels was generated by the fishing industry's recognition of their commercial value as human food and as bait. In England, and especially in Scotland, marine biologists were becoming sensitive to the effects of water pollution and of man-made topological changes, which adversely affected the ecological status of natural mussel beds in estuaries.

Some of the current interest in the biology of mussels comes from a new quarter. Since adhesives play a fundamental role in a vast number of modern manufacturing processes, the bonding substances formed by living organisms are exciting the curiosity of scientists as a possible source of more knowledge concerning the physical-chemical nature of adhesives in general. Further, the possibility of discovering new "glues," which might solve some present problems, being adapted to new uses, is a tantalizing prospect. From the standpoint of glue technology, the mussel is a particularly good subject from which to learn some secrets about adhesion.

The byssus is formed and holds fast under adverse conditions—underwater and in the presence of errant stresses caused by the turbulence of currents and waves. In addition, the bonding material withstands repeated wetting, drying, and temperature changes caused by the ebb and flow of tides. Mytilus is also a good subject for study from an experimental standpoint because living specimens are easy to get, they do well in laboratorv aquariums, and they are easily induced to form new attachments.

In the species M. californianus the byssus has a tan color and consists of five parts, one of which (the rod) is discernible only upon dissection. At low tide the casual wader in mussel beds can recognize a cylindrical rod extending from near the middle of the straight edge of the thin...
The flattened disk, or attachment plaque, with which the mussel holds fast to various surfaces, can be seen at the end of a thread in this micrograph taken with a scanning electron microscope.

closed shells. Attached to this rod, the byssus stem, are a variable number of threads, usually about a dozen, but occasionally as many as one hundred. The end of each thread terminates as a flattened disk, called the "attachment plaque," that adheres strongly to the surface of rocks, the shells of neighboring mussels, or whatever surface is convenient. When forcefully pulled, a mussel can be lifted from the bed, but only at the expense of broken threads since the disks remain firmly attached to the underlying structure.

Close examination shows that the threads are connected to the stem by means of overlapping flattened rings, arranged like a stack of paper cups, that encircle the stem. The part of the thread adjacent to the ring is slightly flattened and corrugated. When the mussel shell is pried open, the stem is seen to protrude from a pit in the fleshy eminence at the base of the animal's foot. By patiently working the stem back and forth with a firm twisting motion, the root can be extracted. The root consists of innumerable thin, parallel, opalescent gelatinous sheets, which converge to form the base of the stem.

How does the mussel make this remarkably complex anchoring device? What is it made of? How does it work? Some of these questions can be answered by observing a mussel as it attaches to the side of a laboratory aquarium. The shell opens slightly and the foot is extended by an internal hydraulic system so that the tip is free to grope for an appropriate attachment site. When ready, one side of the tip is firmly applied against the glass with a squirming motion, like that of a child pressing its tongue against a windowpane. A turbid material then flows out of a depression near the end of the foot, and after a few moments, the foot is withdrawn leaving behind a disk and a thread that emerges full length from a longitudinal groove on the surface of the foot. The groove extends the length of the foot, from the depression near the tip to the pit from which the stem emerges. Thus, the depression, the groove, and the area around the stem within the pit form one continuous space that acts as a mold for the "casting" of the disk, the thread, and

Starfish are predatory creatures. Among their prey are mussels whose shells the starfish can open by means of the suckers on their several arms.
rings as a continuous structure. Microscopic studies provide an insight into the manner in which the different parts of the byssus are made and secreted. At least five different substances are synthesized in the byssus in five distinct types of gland cells. The individual cell is tipped somewhat like a rounded hot-water bottle, with a long, narrow, dangling extension at one end. The cell body is about one-thousandth of an inch in diameter while its extension is one-fifth as wide but may reach a fourth of an inch in length. Although their shapes and sizes are not or less comparable, the five cells differ in their distribution and the appearance of the characteristic granules they secrete. One cell variety makes granules, shaped like somewhat rounded footballs, that are used with evenly spaced parallel filaments. This material is a form of collagen, the protein responsible for the tough, stringy character of tendons. Other granules are formed in the ale part of the cell, they move along a narrow extension that terminates in a free surface where they are exposed. Other gland cells have differently shaped granules containing other materials but secrete them in the same manner. The nature of one of the remaining materials is still not known, but the chemical composition of the others has been tentatively characterized as a type of mucous, a phenolic protein, and an enzyme that converts the phenolic protein into a tanning agent. Collagen is reticulated in all parts of the byssal apparatus. The mucus, the phenol compound, the enzyme, and the unknown material are selectively secreted. Thus, each part of the byssus stains some collagen but has its individual total composition. Too little is known about stem for- mation to offer much information at this time. But it seems that secreted collagen mixes with the chemically unidentified ingredient to form the gelatinous root sheets that form the stem. Hardening of the stem may be the result of contact with seawater.

It is thought that formation of the tough byssus threads may result from a chemical sequence in which the enzyme converts the phenolic protein into a tanning agent, which, in turn, cross-links the collagen molecules—a process akin to the tanning of leather. At this point it is interesting to note that the tough character of the byssus has been recognized by Mediterranean coast dwellers for at least a thousand years. Weaving the threads into gloves, scarfs, and purses was long a common home industry, which, unfortunately, is now becoming a forgotten art.

The formation of the adhesive disk is less straightforward and less well understood than the formation of other structures. But on the basis of electron microscopy, a plausible theory has been formulated. Through the mixing action of specialized paddelike fine hairs, or cilia, within the depression in the foot, the mucus is suspended as tiny droplets in the phenol compound. When this emulsion contacts an appropriate surface, the droplets act as points of instant stickiness that are temporarily enhanced by the presence of water—a characteristic of mucus in general. The phenol compound, which forms most of the common boundary between the disk and the attachment surface, requires more time to establish chemical bonds between its molecules and those of the attachment site. The temporary stickiness of the mucus allows this to happen by immobilizing the disk long enough for the phenolic chemical cross-linking to take place. Since cross-linked phenol compounds are insoluble in water, and since their synthetic industrial counterparts make good glues, this theory of disk formation is compatible with current knowledge about the physical and chemical requirements for strong adhesion.

From the foregoing, it appears that the byssus works in the following manner: the threads serve as guy wires, cemented by the disk at one end and attached to the stem at the other. The flat corrugated segment next to the stem acts as a shock absorber, which stretches out in response to the buffeting of waves. The flat rings are structurally an extension of the thread, connecting it to the stem. The stem and root function as a continually replenished connector between the animal and the threads and also as a fixed point from which retractor muscles gain leverage.

In its watery environment the mussel can use its byssal apparatus for locomotion much as an expert mountain climber uses ropes and pitons. The powerful retractor muscles enable the animal to snap a few threads on one side by pulling against many on the other side. This allows the mussel to crawl forward using its foot in a snaillike fashion. When the remaining threads are drawn taut, the foot is extended to deposit a new set of disks and threads. By repeating this process, a mussel can even climb a vertical glass surface. All in all, the byssus is an elegant solution to a complex problem.

There is much more to learn about the byssus, especially with respect to the chemical composition of the various substances from which it is formed, and a number of research teams are currently working on this problem. Since the byssus is very resistant to dissolution, it does not easily lend itself to direct analysis. Therefore, attempts are being made to isolate the glandular tissue within the mussel foot and to separate the different types of cell granules before they are secreted. This is a tricky procedure because the proximity of the various cells causes their long extensions to intertwine. Unfortunately, the available techniques for collecting granules from cells also break some of the granules, and when that happens, a mixture is created in which the intact granules tend to clump, thus resisting separation into pure samples.

Despite such difficulties, progress is being made. As the chemical puzzle unfolds, there is anticipation that certain aspects of the byssus attachment process in mussels may be applicable to the design of better man-made adhesives for use in surgery and dentistry, where moisture and movement are now obstacles to ideal adhesiveness.

Sea Library
Shelters on the Plains

by Roger Welsch

Even today the Great Plains crush travelers between the endless sky and a landscape that undulates like swells of the sea. But now, there are at least occasional trees and farmsteads, roads and telephone lines that delineate and articulate spaces within a land otherwise devoid of landmarks. Most of today’s plains dwellers know the landscape and regard the climate and space as slight discomforts at worst, in contrast to the migrant homesteaders of the nineteenth century who had never imagined such a place in their worst dreams.

Then there were even fewer trees than now and the grasslands were not so neatly and reassuringly divided into sizes the mind could digest. The term “prairie schooner” was only barely a metaphor. Ole E. Rövlaag, the Norwegian-born author, portrayed the life of the immigrants and described the vastness of the plains in his 1927 novel, Giants in the Earth.

Bright clear sky over a plain so wide that the rim of the heavens cut down on it around the entire horizon. . . . Bright clear sky, today, tomorrow, and for all time to come. . . .

And sun! And still more sun! It set heavens afire every morning; it grew with the day to quivering golden light—dawn softened into all the shades of red and purple as evening fell. . . . Pure color everywhere. A gust of wind, sweep across the plain, threw into life waves yellow and blue and green. Now and then a dead black wave would race over scene. . . . a cloud! . . .

It was late afternoon. A small car was pushing its way through the grass. The track it left behind was like wake of a boat—except that instead of widening out astern it closed in again.

The agony of frontier life on the plains is immortalized on tomstones, in the lyrics of folksongs, in journals and daybooks. But archives often do not contain information on how people responded to specific conditions. I therefore turned

All photographs from the Nebraska State Historical Society.
Source usually ignored by those who study folk architecture—the writers of the plains. I reasoned that these poets and novelists had based their tales of success on a sensitive perception and faithful rendering of the pioneer experience. Such subjective and creative data necessitated careful evaluation; but then so must any field-gathered information.

I re-read the works of such writers as Rølvaag, Willa Cather, Mari Sande, and Bess Streeter Aldrich, as well as the essays of architectural historian Amos Rapoport, architectural philosopher Gaston Bachelard, and photographer John Demos, looking for clues to an understanding of the nature and degree of the impact of plains geography on the mind of the migrant. The message was clear: the plains were a mysterious land of frightening, unbounded space.

The intensity of plains geography was made all the sharper by the lens through which it was first seen by the pioneers—the eyes of hopeful immigrants—from Norway, Germany, Czechoslovakia—or of settlers from other parts of the United States, such as Wisconsin, Illinois, and Connecticut, where landscapes were more manageable. These people were accustomed to a perspective foreshortened by trees, rocks, lakes, and streams—rural scenes relieved by stone or timber fences a few hundred feet apart, by farmsteads numbering two or three to the eyeful.

The German farmers were accustomed to walking in the morning to fields they could shout across and then returning in the evening to a house among other houses, where there was company and communion. On the plains they farmed areas ten times bigger than they had in the Old Country. There were no fences, trees, or rocks, few neighbors within an hour’s ride, and the nearest town was days away.

The distances were only one of the brutalities the Great Plains region dished up for its challengers. The temperature range exceeded, by twenty degrees at the top of the thermometer and forty at the bottom, any they had ever experienced in their homelands. The daily range could equal the annual range in Holland. In Czechoslovakia, there had been no prairie fires racing through the tinder-dry grass faster than a man on horseback.

Sod houses could be extremely simple in their construction. The simplest were built low to the ground and had no windows. From a distance, these dwellings often took on the appearance of animal burrows.

Portraits taken in front of sod houses were common during the 1880s. To document their success at surviving on the plains, families wanted all their material goods included in the photographs.
There had been no rattlesnakes and swarms of grasshoppers in Belgium; no cacti, buffalo, or vengeful Indians in Sweden. On the plains, the wind tore the covers from wagons and thunder shook the dishes from shelves. Hailstones, of a size that could kill horses, fell with terrifying abruptness. Trickles that would not have been worthy of a name in Germany were called rivers here, and like the Platte, they flowed—as some said—upside down, "with the sand on the top and the water underneath."

Thus the geography of America's northern plains region—Kansas, Nebraska, the Dakotas—offered climatic, social, and emotional violence that demanded the sturdiest of shelters. Yet, paradoxically, the plains withheld all the materials the settlers had traditionally used for building. There was little stone, even for chimneys; little wood, even for cooking. The most logical first thought would be hasty retreat.

Rolvaag's powerful writing grew from his own experience in the wilderness: one of his characters faces a future on the plains and cries, "How will human beings be able to endure this place? Why, there isn't even a thing that one can hide behind!" Retreat is a universal motif in plains literature and folklore. A character in Willa Cather's novel *O Pioneers!* agonizes, "The country was never meant to live in; the thing to do was to get back to Iowa, to Illinois, to any place that had been proved habitable."

Consider just one aspect of what the pioneers experienced as they moved westward—the change in forestation. During the nineteenth century, Indiana was almost totally forested in hardwoods—mostly oak and walnut. Forty percent of Illinois was forested; Iowa only 18 percent, hinting, perhaps, at what lay ahead. Nebraska, Kansas, and the Dakotas were 3 percent forested, mainly in a line along the Missouri River at the eastern edge of the Great Plains.

And yet the promise of owning land, a farm many times the size of farms in the Old Country (where the possibility of ever possessing even a small one was unlikely) steeled the settlers' resolve to stay and blurred the impact of the catalog of trials they encountered. Besides, most of them had spent everything they had, in both money and pride, to get here, and they could scarcely turn back.

These people had to build houses. They quickly used up the trees crowding the river and creek banks in building their traditional log houses. The next alternative, one that made homesteading on the plains a possibility, was the earth, the sod, or "Nebraska marble." And for thirty years the standard on the plains was the sod house. (How sod came to be used as a building material is uncertain. The settlers may have borrowed the idea from the Mormons, who began building with sod in the mid-1850s. The Mormons, in turn, probably got the idea from the earth lodges of the Omaha and Pawnee Indians.)

Today we make every effort to de-
part of the sod house’s advances. Far from being discomfited by cramped quarters, plains settlers fought the closeness of family members in the evening hours, after a day spent out of sight and hearing of each other or, for that matter, of any other human being. The close contact and association with the family took on a very special, desirable quality.

Writers’ words resound with tales of this premise. To be sure, the settlers saw the plains as a source of wealth, but the riches could be won by facing nature. The plains, with their promise of treasure and freedom, demanded an ardent suitor, willing to face tasks and trials much like those required of fairy-tale brides in their quest for a princess bride. The land was an adversary, an enemy, to be conquered and tamed. Sod was first and foremost an expedient response to plains geography. It not only answered the absence of conventional building materials but also countered the problems of heat, cold, wind, and defense. The two- to three-foot-thick walls kept the sod house warm in the winter and cool in the summer. Neither wind nor bullets could pass through them. Grass fires, a constant threat, would sweep by the sodsies, singeing the door and window frames but leaving the interiors cool. Inside the cavelike buildings, the roar of the wind and thunder was only a faint murmur.

The settlers usually built their sod houses on a slight rise or hillside, never in a lowland or valley bottom where a spring flood might destroy them. They first leveled out a floor area with spades, then wetted and tamped it solid with a fence post or wagon tongue. This was the only foundation the house would have.

Moist bottomlands produced the best sod. Here the grass was toughest and the soil was more likely to hold together during the processes of cutting, moving, and house construction. Preferred grasses were buffalo grass (Buchloë dactyloides), cordgrass (Spartina pectinata), and big bluestem (Andropogon gerardii). Only enough sod for a day’s work—about a quarter acre—was cut at one time so that no sod would lie in the open overnight and dry out. A standard 12- by 14-foot soddie required about one acre of sod. Wherever possible, oxen were used to cut sod because they gave a smoother pull on the plow than horses, which tended to lurch under the heavy task.

The tool used for cutting sod was not the conventional farming plow, the purpose of which was to tumble and break up the soil. Rather, a grasshopper plow, which had a horizontal blade, was used to shave away a ribbon of sod, three to four inches thick and eighteen inches wide, which passed smoothly over a rod moldboard and rolled over upside down behind the plow. Workers used sharp spades to cut this ribbon into “bricks” about two feet long. The bricks were then loaded onto a wagon or sledge and hauled to the house site.

The bricks formed the walls and were laid up grass-side down (for reasons I have never been able to discover) without any sort of mortar. To increase their stability and discourage tunneling by mice or snakes, the bricks were staggered. When the walls reached a height of two to three feet, simple board frames for the door and windows were set in place and propped with sticks. The rest of the walls then went up around them. Later, dowels were driven through

A remarkable number of women, singly or in groups, homesteaded during the nineteenth century. The Chrisman sisters, left, settled in this Nebraska sod house.
the frames and into the walls to hold the windows in place. The slightly pitched roofs were made of from three to five heavy cedar beams, running from gable to gable on each side of the building. Over these beams the builders laid willow or cottonwood rods from peak to eave. Chokecherry or plum brush, then a layer of long grass—usually bluestem or prairie cordgrass—and finally, a layer of sod bricks followed. Here the sod was laid grass-side up so it would continue to grow and hold the roof together.

This early, expedient form of dwelling, often as much cave as house, had severe shortcomings, however. As the lyrics of "Starving to Death on a Government Claim," a folksong of the period, depict it, My house it is built out of national soil,

The walls are erected according to Hoyle; The roof has no pitch, it is level and plain, But I never get wet—unless it happens to rain.

Even after a rain had ended, water from the thick sod roof would continue to drip inside a house for several days.

Before many years this ad hoc house type began to undergo the polishing processes of tradition. A technology of sod construction quickly developed; within twenty years it had transformed the miserable sod hovel into the sometimes elegant sod home. The walls of these more elaborate dwellings were shaved with a spade, giving them clean, sharp lines. Window frames were slanted to permit more light to come through. Commercial or homemade plaster and stucco covered the house inside a out to increase its durability and reduce a major problem of sod houses—fleas. These insects infest the porous walls and plagued the occupants.

Windows, the most expensive component of the house (and one required by many homesteading laws), often cracked or broke with the uneven settling of the heavy walls. Builders ingeniously solved the problem by leaving a four- to six-inch gap above the window during construction. This space was stuffed with paper or grass; as the walls settled the gap simply closed.

Leaking roofs—the perpetual bane of sod houses—were made watertight either by adding a layer of plaster over the thatched and/or using commercial cedar shingles brought in by railroad. Most houses retained a sod covering over the plains at night, believed that the voices coming from the chimneys issued from hell.
angles for insulation and to add enough weight to hold the roof on during high winds.

At the end of the nineteenth century, the suitability of the sod house to plains conditions became most apparent. The Nebraska State Historical Society's photographic collection of sod houses reveals ample amounts of old lumber lying near the dwellings. Those who had settled on the plains during the early part of this century told me that while frame construction was fine for animals, sod was best for people. Wood burns, fits, warps, swells, and shrinks; insects and mice chew through it; and cold penetrates it. The large number of still standing, and frequently still occupied, sod houses that are forty to eighty years old offer further instantiation of the durability of 4.

Why then did plains dwellers almost universally abandon sod for frame construction during the late nineteenth century? The primary cause was class consciousness. Those who had achieved financial security could advertise their success through the frame house.

As another reason, the initial impact of plains geography had begun to wear off. As a familiar plains' line goes, "Living in Nebraska is a lot like being hanged: the initial shock is a bit abrupt but once you hang there for a while you sort of get used to it."

In the demise of sod houses, the forbidding mystery of the plains had dissipated to the extent that inhabitants no longer felt the need for the physical and psychological security that these dwellings offered.

Sod houses still dot the plains. Some are still lived in, but most are just derelicts—abandoned, their roofs overgrown, their door and window frames sagging. These ghosts, however, are more than merely abandoned houses. They are reminders of the grip the plains had on their early settlers. Behind their dark sod, these houses offered protection from a lonely and inhospitable land. They also offer another reminder—their abandonment and replacement by wood frame houses are symbolic of a reversal in attitude. Now, it appears that plains dwellers have a grip on the land instead of the other way around. Thus the sod house was as much a product of the impact of the plains on the human mind as it was a product of the geography of the plains.

A farmer friend of mine commented a short time ago, "We seem to forget that we may have made this land what it is, but first it made us what we are.''

It also made the plains' houses of our parents and grandparents.
On my way home from Borneo in 1966, I got as far as Laos, where I remained for more than three years plying the trade of capturer and exporter of wild animals. I very soon discovered just how lucrative a trade it was; the demand was always far greater than the goods available. I behaved neither better nor worse than my competitors. I merely copied their methods: to catch as many animals as possible and sell them at the highest price without bothering too much about various legal technicalities. In my own way, I was fond of animals; but it was a misconception fondness, as is the case with many hunters and animal lovers.

By 1968 my business had become one of the biggest in Southeast Asia. I employed upward of a hundred trappers and a similar number of beaters and factors, and I had agents working for me on four continents. By wheeling and dealing, I had achieved a virtual monopoly of the trade in gibbons and some rare species such as the serow, clouded leopard, black leopard, and douc monkey.

In order to impress my customers and to be in a position to charge exorbitant prices, but partly also for the sheer fun of the thing, I dubbed myself Doctor of Natural Science and Veterinary Surgeon. And, in the same vein, I christened my business the Laos Biological and Experimental Centre.

For me there was no sudden change of heart, no road to Damascus. Let me merely say that there came a time when I began to ask myself questions, for example, when I found myself compelled to kill animals I was fond of, animals I had become attached to. In 1970 I set off on a tour of my customers—zoos and circuses. With that journey revealed to me was that 80 percent of the animals I had dispatched had died either in transit or during the first few months of captivity.

But it is no light matter to give a job that brings in a great deal of easy money, and it was not until some months later that I finally made up my mind to do it. I continued to receive orders, however, and my reply was to send my customers the following letter: “I am sure that, as the curator of a zooological garden, you must be a true animal lover; you will therefore be delighted to hear that your mon has been used to purchase ten additional gibbons which I immediately released into the forest.”

J.-Y.

Confessions of an Animal Trafficker
by Jean-Yves Domaill

There are trades in which it is impossible for a man to be virtuous

Socrates

Ninety percent of the animals that dealers display have passed along an interminable chain—the chain of trafficking—that links the producer to the consumer. When I use the word “trafficking,” I take it as the dictionary meaning that defines it as “trading of a more or less clandestine, shady, and illicit nature.”

Every year several thousands of tons of animals find their way from the jungle into captivity. This drain of wildlife is readily explained: the last thing the traffickers are lacking in is ingenuity and the financial stakes are so high that corruption inevitably results, especially in the countries in which the animals originate. The resources available to the inspection services are ludicrously inadequate or, in some areas, nonexistent.

In many countries the authorities are hardly concerned about the animal kingdom. The supervision of forests receives much more attention since the interests of large timber-felling concerns are involved. Let there be no misunderstanding: it is not that the forests are actually protected, but their exploitation is carefully supervised. Which means that felling and exploitation licenses bring in tidy sums that quietly find their way into numerous bank accounts, whether in Switzerland or elsewhere, totaling amounts that would cause considerable surprise if generally known.

The man who actually captures wild animals is usually a poor peasant hunter-trapper who sells his catch for very little. A casual glance at a general map of the areas from which the animals are drawn reveals that they are commonly situated in underdeveloped countries, where rules and regulations, if any, are loosely applied. The local trapper operates for the most part without the slightest anxiety. While in some areas vague rules and legislation could be regarded as hampering his activities, the extent of the areas prospected, the inadequate resources available to the gamekeepers, and the widespread willingness to turn a blind eye mean, in fact, that the rules and regulations remain a dead letter.

The peasant hunter understands only one thing, game catching, but he has, in fact, no great understanding of it. He cares little if he catches pregnant female, a nurseries that he is neither able nor willing to feed, or member of an almost extinct species. On the contrary, the rarer the animal the more valuable and the easier find a buyer.

Everything is grist to the peasantry's mill, no one is interested in the welfare of the animal, except, perhaps, for the dog which barks at it. The only laws that are in force in these countries are those that are sometimes used to capture young gibbons, hunt them, and usually shoot the mother.

Gibbons do not make good pets yet there is a flourishing demand in Europe for these primates. To capture young gibbons, hunt them, and usually shoot the mother.
The international zoo trade still traffics in the endangered orangutan. Many captives become obese because of improper feeding and lack of exercise.
The native—a highly skilled trapper as far as hunting to kill is concerned, whether it be by bird traps, pitfall, or plate traps—has regrettably little about the techniques of live capture. Trapping for fur is a subtle and dangerous—dangerous, that is, for the animal, since the trapper runs no great—and requires far more skill than immediate slaughter of game. A pit must possess exceptional years of observation, know everything there is to know of the habits of wild animals, be fully versed in the unique methods of setting traps, and most of all, be capable of keeping his victims alive while waiting to catch them to the dealer. It is a rare sight to find a native endowed with these gifts.

Mortality is high at the time of capture. The native does a great deal of damage to his catches through ignorance and incompetence, but mainly, through lack of concern. The reticulated python, which measures between ten and twenty feet long, is caught in a running knot on the end of a pole. Rather than use a thicker pole, the Thai or the Baule or the Senegalese chooses a piece of thin wire that is deep into the flesh of the neck. Frequently the reptile’s mouth is only bound with a second piece of wire. The animals brought in often or wounds inflicted by a machete. Why does the native trapper, who killed in the use of staked pits for cooper to impale itself on, not use similar pit, somewhat deeper and without stakes, in which to capture the animal alive? There is no rational explanation. He simply prefers the deadly trap that invariably mutilates the animal. On several occasions I have been sent big cats that had been caught uninjured but had subsequently had their front paws tied tightly together with barbed wire. One of these reached me after more than ten days of unimaginable distress and died soon after, the extremities of its limbs appallingly affected by gangrene.

Pangolins, toothless, scaly mammals that feed on ants and termites, are habitually prevented from escaping by having a hefty carpenter’s nail driven through their tails. This is an animal with very powerful claws capable of smashing in termite nests—and no ordinary cage, especially a wooden one, is proof against it; consequently, it is nailed to the floor. Only very rarely have I received an unjured specimen.

After trapping, much brutality is used in getting the animals into crates, especially when the creature involved is dangerous or believed dangerous. A blow over the head with a club is still the most frequently employed method. It is undoubtedly effective but inevitably damaging.

Many species are treated even more brutally: the mother is killed in order to get at the baby. Sometimes three or four females have to be killed before an infant not badly injured is secured. The risk of things going wrong is enormous; the baby may be unintentionally shot or break its neck or its limbs in falling; or again, if the wounded mother runs away and dies in some inaccessible spot, the baby may go on clinging to her and slowly starve to death. Newborn monkeys never survive; even the older ones rarely emerge from the ordeal unscathed and are often left with a hail of shot lodged deep within their bodies.

Land clearance and deforestation are among the most cost-effective methods of capturing young animals. Setting fire to the undergrowth is another commonly employed, but deadly, technique since slow-moving animals and, above all, baby animals are roasted alive in considerable numbers.

Big-scale organized hunts, as shown in popular films, are still a rarity. They are, generally speaking, organized by specialists and rely upon well-trained and supervised local talent. The companies organizing such hunts go for the “big stuff”: elephants, zebras, giraffes—monkeys when there is a major order for them. They enjoy legal status and on the whole abide by the regulations. Modern methods of trapping (radio communication, spotter planes, motorized transport) and the use of hypodermic tranquilizer guns cut down losses considerably, although accidents still happen, usually due to mistakes in the drug doses administered. Once the capture has been completed, men with scientific or parasitological training and a sound veterinary grounding are put in charge of feeding and caring for the animals. As far as I can determine, it is only in east Africa that such companies exist; everywhere else animals are hunted on an individual basis by the indigenous population.

It sometimes happens that an entire village organizes a large-scale netting operation. This involves encircling a large area with a net held in position with stakes and driving primates (gorillas, macaques, and baboons), antelopes, and so on into its meshes. It is a very profitable method of hunting, but as no provision is made to house the numerous animals captured, they stay tied up on the spot until sold.

There is another profit to be made by the hunters and trappers—from dead animals. Pelts, ivory, feathers, teeth, paws, hooves, horns, and tails—they sell the lot, along with organs deemed to possess medicinal properties, such as the eyes, the liver, the heart, the tongue, and the testicles, which acquire, after appropriate prayers have been muttered over them, magical or aphrodisiac qualities. Reptiles, in particular, figure prominently in these commercial bargainings, but whenever there are too many of them on offer or customers are hard to find, they are skinned without further ado, often still alive.

In the next step of the chain, the animals go to the local pickup man. He is sometimes a native, sometimes a “poor white” who has ended up in this backwater, like some pitiful survivor in one of Conrad’s novels.
Hot countries all have their quota of these white outcasts, rejected by both civilizations, who eke out a wretched existence. More often than not, they are to be found in the hutments of the slum areas, but occasionally some take to scouring the lowlands and set themselves up as animal dealers. They tend to be concentrated in townships on the outskirts of the forest and they are willing to take anything the peasant hunter-trappers bring in. Their task is a simple one: to recruit local peasants whose entire catch they will subsequently buy. All they then have to do is to store the animals until the exporters from the capital come out and collect them. In Thailand there are about twenty collection points scattered throughout the country, although the southern forestlands provide the greatest amount of game. Some game collectors employ up to a hundred villagers.

The collector’s decrepit premises are entirely inadequate. Since profits at this point in the chain are very low, the fellow is unwilling to spend a single penny on animals that are merely passing through his hands.

For a gibbon in good shape, that is, with no visible injury, the peasant gets between $10 and $14. The collector gets about $30 from the exporter, who immediately ups the price to $200. When it comes to the European or the American importer, he really makes a killing. The eventual purchaser may have to fork out more than $400 for a monkey valued at $10 at the outset. The fact is, then, that it is the exporters and importers, that is, the middlemen, who make the biggest profits. Their expenses, especially those of the exporters, are negligible: local employees, even if they are incompetent, at least do not cost much, and food for the animals is cheap and dispensed very sparingly. The importer, on the other hand, does have to pay the air freight charges; but even so, these two last links in the chain do very well for themselves.

Birds are a particularly profitable proposition and are, moreover, ordered in large numbers. A consignment of three thousand myna birds is by no means exceptional. A myna, which brings a mere $6.00 to $1.00 to the peasant, is sold for at least $30 by the wholesaler. Those sold as talkers, or that even show promise in that direction, fetch much more. On the Quai de la Mégissière in Paris, it is common for the larger varieties of myna to fetch more than $300, a figure that takes some stomaching when one is aware of what the birds originally cost. It is true that the wastage is considerable, but it is amply compensated for by the staggering profits.

While it is possible to plead excusing circumstances for the uneducated hunters, who scare enough to keep body and soul together, the middlemen stand out as unmentionable, grasping creatures worthy neither pity nor regard. The traffickers, who have never set foot either jungle or savanna, are not influential, or mean-minded, acquisitive, or scrupulous tradesmen.

It is common practice for dealers to revamp their animals in order to make them look presentable. It is
gold con, familiar to horse traders pairgrounds. In the trade they call it giving them a new lease on life." Little whose fur is on the pale side suddenly transformed into an almon with the aid of some hydrogen oxide, with a consequent increase in value from $30 to $1,000. Snakes urer from fungal growths are "cleaned up" before being pack-
ked; all that is necessary is to scrape the caseous magma, thus making a creature presentable for the few engrs required to sell it. Some leopards transformed into black leopards with a coat of paint. I remember what did not survive the experience: they licked off the toxic substances that had been sprayed over the fur. Another frequently employed consists of dyeing dull-colored birds.

Monsieur Saravan, of the French animal import firm Prexotical, relied some of the tricks of the trade on, the sharpest of which was in-
putable the operation he regularly performed on dromedaries. Drome-
daries are expensive to buy but easy to breed. So some fellows out for the latest profit bought several pairs in order to start a stock farm. They were prised to find the animals sterile. Would advise the unfortunate reader to have the testicles of the male camels carefully examined; you will discover that they have been shod by clapboards. This form of castration is very difficult to detect, not by touch, and enables the dealer at least double his sales of male dromedaries, as single-minded traders go on buying more and more breeding animals." The same trick is used in all cases where castration is easy: ungulates, deer, and so forth. One trader, who a few years ago, used to expose all mammals to massive doses of ultraviolet rays in order to achieve the result.

Another shabby device used by the exporter to make a bit more money is the practice of substituting one animal for another. The middlemen always play dumb to achieve their ends, and under the pretext of ignorance—which is often genuine—they dispatch goods only very remotely corresponding to the order placed—

for example, a common green pigeon (Treron curvirostra) instead of a Nio-
cob pigeon (Caloenas nicobarica). The "mistake" can be even more spectacular: it is no rare thing to find a leopard cat (Felis bengalensis) that weighs nine pounds at the outside "muddled up" with a leopard. The not-too-bright purchaser believes he has acquired a baby leopard and, as the months go by, is surprised at how slowly the little creature seems to be growing. The animal dispatched, in fact, costs only $160, whereas a "tamed baby leopard" can fetch as much as $1,000 when sold retail.

Like everyone else, on a number of occasions I off-loaded "rubbish" that had been left hanging about unsold in my cages. The usual way I did so was by playing with words; for example, the Prexotical firm one day received a crate from Vientiane containing four Temminck's cats, whereas according to the terms of the contract...

Waybill confirms the author's shipment of a black panther from Laos to France. Many animal cargoes are illegal, but bribery and false documents get them through the customs.
of sale they were expecting four golden panthers. To give some idea of how ignorant these people were, although they were France’s biggest importers of wild animals, I have to admit that the golden panther does not exist, save in the price list I had carefully compiled for Prexotical. I had, however, taken the elementary precaution of naming a precise scientific name for the cats. Thus, golden panther was Felis temmincki—you had to be pretty stupid to fall for that to the tune of 2,000 francs ($400), an exorbitant price, since Felis temmincki, or golden cat, bought anywhere else was worth only 200 francs ($40) wholesale. Only the extreme rarity of my golden panthers enabled me to put such a price on them. I might add that this objectionable firm found customers for my fabulous beasts even before taking delivery of them and, in fact, sold them as golden panthers.

I have often received insulting letters from directors of zoos, complaining that the animals I sent them were not as ordered, although the order had been scrupulously filled. The person concerned had simply described the animal incorrectly or had made his list by referring to the Larousse Encyclopædia, a nonspecialist production that gives little idea of different species and their proportions.

Occasionally one comes across the reverse situation; someone obsessed with Latin terminology and subspecies. A fearful idiot, who runs a seedy little zoo in Brittany, insisted on being sent a subspecies of leopard cat that only exists in Formosa. I sent him a common leopard cat (Felis bengalensis) in first-class condition, in exchange for which I received abusive and even threatening letters.

Several weeks later I made him another proposition. I had a paralyzed wildcat in stock. Unable to bring myself to destroy the creature in cold blood, I had isolated it from the other animals and it lived a wretched existence in its own corner. I had no idea what to do with it, and it was out of the question to send it to an ordinary customer. But my man in Brittany was no ordinary customer so, after receiving one of his irate letters, I wrote him saying I was able to offer him a Felis bengalensis of the rare variety hemiplegia. Would he be interested in this unique specimen of its type, with which he, as a specialist in rare felines, must surely be familiar? Of course he was familiar with it, of course he was interested, and he agreed to pay the phenomenally high price I had asked!

The number of honest dealers is remarkably small. I am personally acquainted with about fifty exporters scattered over four continents. I have worked with all of them for many years, permanently or on and off, and I am utterly incapable of naming a single one who does not habitually employ such methods.

It sometimes happens that, in a given season, an animal’s skin is worth more than the live animal itself. At such times, colobus monkeys are massacred in their cages if they fail to sell immediately, as they are delicate creatures, especially in captivity. Better a good healthy skin now than a substandard mopping-up cloth in a few weeks time.

In 1972 the Thailand Animal Company slaughtered three black leopards simply because they had no immediate buyers. It was the wrong season of the year, the beginning of winter in Europe and the United States, when no prudent zoologist will take on any exotic creature. The cost of feeding the animals would have eaten up all the profit, so they were poisoned, and their skins, rapidly cured, fetched more than enough to offset the original outlay. The same year an American of Austrian origin, working as a dealer in northern Thailand, shot a batch of four leopards with a pistol. The man, obliged to move to a new house on short notice, had calculated that the cost of moving would be too high for him. Even the Bangkok dealers were horrified. The jungle was at its doorstep; the animals could easily have been set free.

Deception is not practiced exclusively with regard to the quality of the goods dispatched, but also to the methods of dispatch. Permits, waivers, and other official documents are often forgeries from beginning to end. It is extremely easy to get hold of official forms. I myself simply used to have them printed. Then all one had to do was fill them in. Rubber stamps were not expensive and always made the right impression. In any case, even if the papers were genuine, the goods did not correspond.

Clouded leopards, an endangered species, bring high profits to dealers. The animals often end up weeks in inadequate crates a diet of sinew, bones, and fish. What frontier or airport official knowledgeable enough to sort out prohibited species from the vast list of animals that are allowed to leave the country? Who could tell the difference between a flat-headed cat (Felis planiceps) and the common fishing cat (Felis viverrina)? Just help matters, the names are always written in English or Latin. The various forms never appear in the regulations. As far as any petty official knows—and he is frequently illiterate—the two cats referred to are completely identical, especially if the consignment notes and veterinary certificates confirm that they are fishing cats.

The bribing of airport officials is equally common practice and, although a somewhat costly way of going about things, is relatively safe. In Bangkok the going rate is $10 for a gibbon and $100 for a Malay tapir. In Bogota and east Africa the scale of charges is similar. The corrupt officer takes delivery of the cargo and simply forgets to enter it on the waybill. A certain amount of tact is required and, in the case of unexpected changes in duty rosters, plans can go awry. When a big order is involved, it is necessary to resort to other means. Only international airports are supervised, and no serious attempt is made to patrol each secondary road leading into a neighboring country. All that is required is a certificate of origin—stating, for instance, that a given chimpanzee comes from the Ivory Coast—a veterinary certificate. At the front
Tom McHugh, Photo Researchers

**Birds of the Psittacidae family harbor diseases transmittable to man, yet firms in Bangkok export thousands of parrots and parakeets without precautions.**

post in Upper Volta, the smuggler has his official papers stamped and states that his animals are merely in transit. The whole operation is thereby made official and there is no longer any problem in boarding a plane at Bobo-Dioulasso. It is surprising and illogical to find that in the Ivory Coast, as in many other countries, it is quite in order to keep animals in captivity although their export is forbidden. So dealers are able to hold in stock as many creatures as they like and no one subsequently inquires how their cages come to be empty.

Certain firms with impressive letterheads (Allied Institute of Applied Herpetology, Michigan Center for Research, for example) take advantage of an incredible obsession with official-looking documents, which is particularly widespread in underdeveloped countries and in France, to claim special treatment. The legal authorities would be greatly surprised were they to pay a visit to the premises of some of these research centers, for they would find not the slightest trace of scientific equipment. The impressive list of qualifications after the directors' names, although not authentic, suffices to instill confidence.

There are many countries in which the mere use of the title "zoo" is sufficient to obtain special permission to export certain protected species. It is easy to understand how, under these conditions, a set of forged documents and rubber stamps is an essential part of the office equipment of any respecting trafficker.

The last important person in the chain of animal trafficking is the private buyer. He is beyond question the vital link, since without him this sordid trade would not exist. If people were well informed, they would never visit zoos and would certainly not purchase wild animals.

The number of animals living within the confines of our modern cities is staggering. Some dangerous wild species are kept in apartments...
What is the explanation of this extraordinary craze? I believe it is not so much due to a sudden passion for nature as to a fashion resulting in part from the large number of wildlife films and the publicity some of them have received. Many adults and children now want to have in their homes some of the animals they have admired in the wild state in such films, without realizing how serious a problem it is to keep them in captivity and, above all, that the practice is jeopardizing the survival of some species. While some films have made major contributions to the conservation of wildlife, they have also to some extent done indirect damage to the cause. We now have to convince the public that lions were never intended to live in a third-floor apartment, and that alligators prefer the marshlands of the Everglades to a bathful of chlorinated water.

It does occasionally happen that private individuals wish to enjoy the company of animals out of genuine and unselfish affection. But the damage done is still the same, since the wish of such people to have a pet has meant that at least ten others of the species lost their lives merely to satisfy this quirk for wildlife.

Asian snake charmers need a constant supply of fresh cobras. Native collectors capture large numbers of Indian cobras, below, to satisfy the demand.
In order to gratify his passion, whether it be merely a passing enthusiasm or more deeply rooted, the buyer does not hesitate to part with considerable sums of money: a talking myna bird, for example, generally brings between $180 and $300, according to how shrewd the buyer looks. But that is only the beginning. The cage to keep the bird in can cost $100, and that would be for a ludicrously inadequate one. And then there is the special food sold with the myna. Monkeys are much more expensive to buy and maintain. As for the big cats, they are absolutely ruinous: a clouded leopard now costs at least $3,000. Ocelots are greatly in demand, although the species is in danger of extinction in its native forests. An ocelot fetches about $800. But buying an animal is one thing; caring for it throughout its lifespan is quite another.

The smell of wild animals rapidly becomes unbearable, even if they are naturally clean. Many should be housed outdoors, which poses problems in the winter. Others require a higher ambient temperature than a human finds comfortable. Generally speaking, these creatures are exceedingly frail and need constant care and attention. Unfortunately, most veterinarians, used to dealing with cattle or with dogs and cats, are often incapable of diagnosing what is wrong with a kinkajou or a monkey.

It should also be pointed out that such animals, coming as they do from tropical or equatorial countries, carry bacteria and parasites that are frequently transmittable, and sometimes deadly, to man. Even apparently harmless birds may transmit viral diseases to humans, and children particularly vulnerable to infection from many internal or external parasites carried by wild animals.

All these reasons should be sufficient to discourage prospective buyers of wildlife. But the most important remains the protection and preservation of animal species.
CAMPRANOS TUDA CLASE DECA
Fabulous Timbuktu
by Klaus-Friedrich Koch

"Oh you who journey to Gao make a de-tour to Timbuktu, whisper my name to my friends and bear them sweet greetings from the exiled who longs for the soil on which his friends, and family, and neighbors live."

Wall inscription in the Centre Ahmad Baba, Timbuktu

These lines were written—the legend goes—by Ahmad Baba when he saw a camel caravan leaving Marrakesh, in Morocco, for Gao on the Niger River, which it would reach after many weeks of hazardous travel across the Sahara.

The noble status of these visitors to Timbuktu is apparent by their fine robes and animals. Below, a tailor confers with a customer in one of the covered markets of the city.

Ahmad Baba had been a teacher at the famous Sankoré mosque and university of Timbuktu in the kingdom of Songhai when a Moroccan army conquered this Sudanic empire near the end of the sixteenth century. Suspected of encouraging a rebellion, Ahmad Baba was deported to Marrakesh. When he returned to his native city after twelve years in exile, Timbuktu had already begun its decline into the desolate town of mud-brick houses and grass huts that I saw on my visit in 1976.

The author of the travel guide I read on the small airplane that brought me to Timbuktu probably meant to spare me the disappointment other visitors had felt on reaching la cité mystérieuse. "As it is now," I read, "it would be thrilling to stumble on Timbuktu en route to somewhere else, but it can't bear the weight of a special trip."

It can indeed—for those who go to the edge of the Sahara to view the
The famous Sankoré mosque was center of Islamic scholarship.

With an Andalusian poet and architect he had met in the holy city and who now built him a palace and a new mosque, the Great Mosque, in Timbuktu. With the rise of the city’s commercial importance grew the reputation of its schools, where widely known scholars taught history and science and Islamic jurisprudence.

Mansa Musa’s extraordinary journey made his kingdom known throughout the Muslim world. In the 1350s the most illustrious explorer who ever lived, the Berber Ibn Batuta of Tangier (who had previously traveled in South and Central Asia, reached Peking, and seen Sumatra), visited Mali and later wrote about its people:

The negroes have a greater abhorrence of injustice than any other people. Their sultan shows no mercy to anyone who is guilty of the least act of it. There is complete security in their country. Neither traveller nor inhabitant in it has anything to fear from robbers or men of violence.

Such tranquility did not last long. By the end of the fifteenth century, disputes over dynastic succession and battles with the encroaching Mossi of the upper Volta River had weakened the empire. For Timbuktu, a brief period of Tuareg domination ended in A.D. 1468 with the invasion of the Songhai forces from Gao, where a hundred years earlier a kingdom had begun to form that later extended from Lake Chad to the Atlantic Ocean. Following the erratic rule of Sonni Ali, the conqueror who murdered a great number of the city’s learned men and favored others of his choice, the fame of Timbuktu’s teachers spread again under the reign of Muhammad Ture, later known as Askia the Great, one of Ali’s commanders who had usurped regal power from Ali’s son within a year of his father’s death. Askia the Great was a patron of the arts and sciences and during his reign, the Sankoré qadis (judges) achieved international recognition as authorities in Islamic law. The libraries of Timbuktu’s scholars included works from all branches of learning. Catalogs that have survived list ethnographies and chronicles, grammatical treatises and theological commentaries, legal texts and books on astronomy and medicine.

Until the modern-age explorers reached the Niger in the late eighteenth and early nineteenth centuries, most things known in Europe about the Sudan came from a remarkable work that was first published in Venice in 1550 and appeared in an English translation in London fifty years later. Its title was *The History and Description of Africa and of the Notable Things Therein Contained*, written by Al-Hassan ibn Muhammad, better known as Leo Africanus. Hassam was born in the mid-1460s in Granada but he grew up in Fez, Morocco, where his family had joined the large community of Moorish emigrants from Christian Spain. After many years of travels throughout the Muslim world he was captured returning from a trip to Egypt, when Christian pirates seized his ship off the coast of Tunisia. Impressed with his learning, his captors delivered him as a servant to Pope Leo X. The pope, however, baptized the Moor and granted him his own name. Living off a papal stipend, Leo Africanus, who had visited Timbuktu when Askia the Great reigned over the city and it was at its zenith, recorded his knowledge of the interior of Africa.

Here are many shops of artificers, and merchants, and especially of such as weave linen and cotton cloth... The inhabitants, and especially strangers there residing, are exceeding rich, inso-much, that the king that now is, married both his daughters unto two rich merchants... Corne, cattle, milke, and butter this region yeeldeth in great abundance; but salt is verie scarce heree... Here are great store of doctors, judges, priests and other learned men, that are bountifully maintained at the kings cost and charges. And hither are brought divers manuscripts or written bookes out of Barbarie, which are sold for more money than any other merchandize... The inhabitants are people of a gentle and chereful disposition, and spend a great part of the night in singing and dancing through all the streets of the citie... Leo’s report could not help but reinforce Timbuktu’s image as the El dorado of Africa, although European global exploration and exploitation had meanwhile shifted to the Americas, India, and Indonesia.

A hundred years after Leo’s visit the great Sudanic empire of Songhai...
lay in ruins. Following a long diplomatic quarrel and intermittent battles between Songhai and Morocco over the control of the once lucrative, but by then almost depleted, salt mines at Taghaza, the Askia dynasty, already torn apart by dynastic conflicts and civil strife, succumbed to an invading force of the sultan of Morocco in 1591. Timbuktu, which had surrendered without a fight, became the administrative capital of the colony.

Moral turpitude and vile debauchery (which historically often precedes the fall of empires) had spread before the conquest. Far from restoring public order, the conquest demolished it completely. Unable to establish a viable administration even after a guerrilla force of southern Songhai had been defeated, the sultan’s suzerainty south of the Sahara could not take hold. The Tuaregs and the pagan Bambara took advantage of the prevailing anarchy and mounted repeated attacks on Songhai villages and towns.

A seventeenth-century Arab historian from Timbuktu wrote:

Everything changed at that time: danger replaced security, misery followed opulence, trouble, calamity and violence succeeded tranquility. Everywhere people were destroying each other; in every place and in all directions plundering occurred, and war spared neither life nor possessions nor the welfare of the people.

These problems abroad and succession disputes at home forced the Moroccan sultan to abandon any hope of extending his dominion across the Sahara. Less than thirty years after the capture of Gao, his rule ended.

Rival factions of the occupied army, no longer bound in duty to the sultan, began to fight among themselves for control of Timbuktu, as well as sister market towns of Djenne and Gao. The troops married local women, and their descendants up and paying tribute to the Tuaregs, their rivals, the Fulani, who were then encroaching on the Middle Niger region, as these two peoples fought protracted wars against each other. and with the Bambara for hegemony over that area. The chaos that followed Askia’s rule severely restricted, but never stopped, the trans-Saharan trade to the Maghreb, which in the seventeenth century increased its share in slaves and added ivory, which hitherto had found its market in Egypt.

By the nineteenth century, however, Timbuktu and the other trading centers of the western Sudan had lost their role as entrepôts between bordering.
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Africa and the Mediterranean coast from the Maghreb to Egypt. Since the fifteenth century, the Portuguese—and later, during the seventeenth and eighteenth centuries, Dutch, French, and English merchant houses—had established trading settlements along the Atlantic coast and diverted the flow of gold, slaves, and ivory from traditional inland routes. In the end, the ban on slavery by the European powers in the early nineteenth century virtually annihilated the trans-Saharan trade in which, by the mid-nineteenth century, slave transports made up one half the volume. As Timbuktu's export could never depend on the products of local industries, its fate was sealed with the withering of the once-steady caravan traffic.

Although as early as the 1490s King João II of Portugal had sent an ambassador to the Mali court, the geography of the Sudan and the location of Timbuktu remained a mystery outside the Muslim world until the early nineteenth century. The Portuguese had tried early to reach the gold mines, but as one contemporary historian explained in florid language,

It seems that for our sins, or for some inscrutable judgment of God, in all the entrances of this great Ethiopia that we navigate along. He has placed a striking angel with a flaming sword of deadly fevers, who prevents us from penetrating into the interior to the springs of this garden, whence proceed these rivers of gold that flow to the sea in so many parts of our conquest.

At the end of the eighteenth century, in spite of Ibn Batuta's correct description of the Niger's easterly course, most European maps still showed the river flowing to the west because both a respected Spanish-Arab geographer and Leo Africanus had erroneously written of its westward flow. By that time the quest for Timbuktu and the direction of the Niger's course had become an obsession of some Europeans, scholars and adventurers alike.

In 1793 the Association for Promoting the Discovery of the Inland Parts of the Continent of Africa, a fancy London dinner club, sent Mungo Park, the intrepid Scottish explorer, to Africa "to ascertain the Niger's course" and to "use his utmost exertions to visit the principal towns and cities in its neighborhood, particularly Timbuctoo and Houssa." Park, coming from the Gambia, reached the Niger at Ségou, the capital of the Bambara, in and described its view in a passage often quoted in the annals of African discovery as Stanley’s meeting Livingston:

Looking forwards, I saw with in pleasure the great object of my mission the long sought-for majestic Niger, tering to the morning sun, as broad as the Thames at Westminster, and flowing slowly to the eastward. I hastened to thank God, and, having drank of the water, lifted up my fervent thanks in prayer to the Great Ruler of all things, for he had thus far crowned my endeavours.

"Thus far" only, for insurmountable difficulties forced Park's return to England before he could once again attempt to reach his main goal: to locate Timbuktu and to determine the Niger's estuary. During Park's second journey-expedition, 1805–1806, forty-three of his European companions perished and he himself, traversing downstream by boat, lost his life in the rapids near Bussa, in today's Nigeria, 800 miles from Timbuktu.

Although he had reached its location, Mungo Park never saw Timbuktu. He was barred by hostile natives from leaving the river at the city's port of Kabara. When
Caillée was not the first Christian to reach Timbuktu. A year and a half before, the Scotsman Alexander Gordon Laing had entered the city, but he was slain by treacherous nomadic tribesmen on his way back through the Sahara.

Caillée’s report shattered Timbuktu’s splendid image, which had intrigued Europeans long after the city had begun to decay. Yet, some people apparently had their doubts before the truth was known. In 1829, Alfred Tennyson, then a student at Trinity College, was awarded the Chancellor’s medal for poetry at Cambridge University for his poem *Timbuctoo*, which contains the following prophetic lines:

> . . . Wide Afric, doth thy sun
> Lighten, thy hills unfold a City as fair
> As those which start’d the night o’ the Elder World?
> Or is the rumour of thy Timbuctoo
> A dream as frail as those of ancient Time?
> . . . the time is well nigh come
> When I must render up this glorious home
> To keen *Discovery*: soon yon brilliant towers
> Shall darken with the waving of her wand;
> Darken, and shrink and shiver into huts,
> Black specks amid a waste of dreary sand.

Low-built, mud-wall’d, barbarian settlement,
How chang’d from this fair City.

Nonetheless, the legend and the lure persisted. The next European to visit Timbuktu was the German Heinrich Barth, who, in the service of the British government, reached the city from the east in 1853. That was twenty-two years after two Englishmen, Richard and John Lander, had followed the Niger from Bussa, where Park had perished, to its mouth at the Bight of Benin, thus solving one of the most tenacious riddles in the geographical exploration of the world.

Barth describes his entry into Timbuktu in the following words:

Having then traversed the rubbish which has accumulated round the ruined clay wall of the town, and left on one side a row of dirty reed huts which encompass the whole of the place, we entered the narrow streets and lanes . . . which scarcely allowed two horses to proceed abreast.

In spite of this uninviting scene, Barth—often sick with fever—remained in and around Timbuktu for eight months, detained there by his protector, Sheikh Ahmad al-Bakai of the Kunta Arabs, a desert tribe, who at great risk to his own welfare guarded his infidel guest against the murderous designs of the Fulani.
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slight editing for clarity is required. We trust you

trust us. Thank you!

Barth finally escaped from this protective custody; he went down the Niger and onward to Lake Chad from where he crossed the Sahara to Tripoli on the Libyan coast. Upon his return to England he wrote his famous work, Travels and Discoveries in North and Central Africa, Being a Journal of an Expedition Undertaken Under the Auspices of H.B.M.’s Government in the Year 1849–1855, which probably contains, except for Ibn Batuta’s work, the most distinguished travelogue ever published, although it received scant attention at that time.

In spite of Barth’s perceptive description of the geography and history of Timbuktu, its mystique continued to entice travelers, scholarly explorers and eccentric adventurers alike, to go there, too. Laing, who was not the first—or the last—to die in the quest, at least had reached the city. All but one, the Austrian Oskar Lenz, who followed Barth before the French occupied the Niger plain, were forced to give up their goal en route or, in most cases, were killed in the desert before they reached the city.

In 1893/94 a French military expedition entered Timbuktu despite fierce opposition from the Tuareg who massacred two detachments in a cleverly executed ambush.

Today Timbuktu, once a metropolis of fifty thousand, is a sleepy place of about ten thousand inhabitants in the Republic of Mali. The famous mosques still stand and an occasional camel caravan still reaches the town from the Taodeni salt quarries, where production began after the loss of the Taghaza mines in the late sixteenth century. The mosques, the caravans, the tombs of some of Timbuktu’s scholars, and, of course, the ethnic and cultural diversity of its population remind the visitor of the town’s historic past.

Travelers who occasionally arrive by car or boat or plane need not fear the local Tuareg, who long ago discovered the benefits of the tourist trade. They offer camel rides through the dunes that ring the town and compete with other local merchants in the sale of African ‘antiques’.

But Timbuktu’s scholarly tradition finds its continuation in the archival work of the UNESCO-sponsored Centre Ahmad Baba, which collects the scattered remnants of the medieval libraries that have survived the destruction and pillage of the town’s numerous conquerors.
Celestial Events
by Thomas D. Nicholson

Sun and Moon The sun's movement along the ecliptic (the projection of the earth's orbital plane on the sky) takes it from the constellation Aries into Taurus in mid-May. It passes south of the Pleiades (the Seven Sisters) on May 20, north of the Hyades (and Aldebaran) about May 28, and remains in Taurus through mid-June. By the end of May, the sun will have moved to within less than 2° of its most northerly position above the earth, and the extent of daylight will be within 15 minutes of the greatest length it reaches during the year.

The moon is full in early May (on the 3rd), and it will be a morning object through mid-month (last-quarter is on the 9th, new moon on the 17th). The evening (waxing) crescent moon ought to appear by May 20, and first-quarter moon is on May 25. The moon remains a bright evening object through the end of May, becomes full again on June 1, and reaches first-quarter on June 8. Look especially for the morning crescent near Venus and Mars on May 14 and again on June 12.

Stars and Planets Saturn is the only planet on the May Star Map. Located in Cancer, between Pollux and Castor (in Gemini) and Regulus (in Leo), it appears high in the southwest at dusk and sets before midnight.

In the morning sky, Venus and Mars play out an interesting little drama. Venus, which became a morning star in early April, is rapidly becoming increasingly prominent and is easily seen in early May low in the east at dawn. Mars is also a morning star and has been since November. But it has remained dim and inconspicuous since then, dawdling along to the right of the sun. On May 13, Mars overtakes Venus and passes about one degree below it. But Venus, speeding up its easterly movement, soon keeps pace with Mars, then outpaces it, and passes it on June 3. So, for about three weeks, Venus and Mars stay close together, and Venus—easy to find because of its brightness—can help you find the dimmer Mars immediately to the south.

May 4: Expect perigee spring tides.
May 5: The Eta Aquarid shower reaches maximum. Observers may see up to 20 meteors per hour, some quite bright, in the hours after midnight, and perhaps half that number a day or so before and after.
May 11: Venus is at greatest brilliancy as a morning star.
May 13–14: Venus is in conjunction with Mars on the 13th; both are in conjunction with the moon on the 14th.
May 16: Mercury is in conjunction with the moon.
May 18: The moon is at apogee, farthest from the earth.
May 23–24: The bright object near the moon on both evenings is Saturn.
May 27: Mercury is at greatest westerly elongation, but it is not favorably placed as a morning star.
June 3: Venus and Mars are again in conjunction but begin to separate as Venus moves east more rapidly.
June 4: Jupiter, in conjunction with the sun, leaves the evening sky and becomes a morning star.
June 12: Early this morning, look at Venus, Mars, and the crescent moon. Venus is the brighter of the two starlike objects near the moon.
June 14: The moon is farthest from earth.
June 15: Venus is at its greatest distance to the right of the sun (westerly elongation), enhancing its prominence in the morning sky.

Hold the Star Map so the compass direction you face is at the bottom; then match the stars in the lower half of the map with those in the sky near the horizon. The map is for 11:20 P.M. on May 1; 10:25 P.M. on May 15; 9:20 P.M. on May 31; and 8:20 P.M. on June 15; but it can be used for an hour before and after those times.
A Matter of Taste

Bananamania

This cheap and tasty fruit is definitely not for monkeys only

Almost everything about bananas is funny. Their peels proverbially produce pratfalls. Burlesque comedians were known in the trade as "bananas," and lead comics were "bananas." There are many banana jokes, most of them capitalizing on the phallic shape of the fruit. And a story about the man with the banana...
ears who apologize for not hearing what you say because, he ex-
ternal, he has a banana in his ear, is
kind of humorous, cryptosexual.
Freud would have said made us
because it relieved the tension
and fear that sex and sexually sym-
bulic objects induce.
At any rate, bananas are intrinsi-
cally embarrassing. Peeled at the
table and eaten raw, they make us
think of monkeys snacking at the zoo.
In my high school yearbook, the cap-
tion for a photograph of a notably si-
manian student, in full wrestling regalia
and crouched for a quick takedown,
read: "Give him a banana and maybe
he'll go away."
Still, most people do eat bananas.
They are cheap, nonfatting (262
 calories per pound), nutritious, re-
quire no cooking and almost no chew-
ing. The problem, for etiquette con-
scious folk, is how to consume ba-
nanas without doing an imitation of
a chimp. Amy Vanderbilt advises us
that, except at picnics, we should peel
the banana and then break it up "as
needed into small pieces." Then it
should be "conveyed to the mouth
with the fingers."
I have not tried this dodge, but I
did recently learn, from an exquisite
Minnesotan, an even more elegant
modus banandi. This polite Min-
neapolisian slices away one panel of
the peel with a knife. Then, holding
the remaining fruit on his plate, he
slices the fruit while it is still safely
ensconced in the rest of the peel.
After squeezing on some lemon juice
(which incidentally will prevent
browning of banana flesh exposed to
air), he proceeds with a fork, neatly,
and with hands dry.
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bananas have, of course,
worked out over the thousand
years since the first human being
downed the "elongated yellow f
(as a New York Times reporter.
loss for a banana synonym,
rote) in southern Asia, when
Musa genus is probably native
has been known throughout his
times. A facetious list of bat
dishes occurs early on in The
Pynchon's novel Gravity's Rain.
But even a realistic, "serious"
log of bananisms runs the risk
sounding silly; banana bread, b
bananas with brown sugar, ba
split, banana mousse, banana
cream (see recipe below), ba
cream pie, bananas and cream
manas and corn flake, banana fr

There are a few imposing F
banana desserts, such as the elab
the tart called bananace and

\[ \text{Bananaland,}\]
can even make a banana souffle if
remember to push the mashed
through a fine strainer; otherwise
resultant dessert will contain fl
and taste like bread pudding. There
are a small number of ex
banana dishes, especially the Chi
dessert in which sliced banana
coated in hot caramelized sugar
the bananas are dipped in ice water so
long strands of caramel solidify
stand for long life. And, if you
the patience, you might want to
boiling down a puree of pineap
sugar, and bananas to make the M
then dessert cajeta de piña y plát
Diana Kennedy learned to do
from her maid, Luz, and it takes
to six hours before the purée t
into a spectacularly rich and mys
tus dark paste (see recipe below

Finally, by mentioning ban
flamed in rum, we come essent
to the end of banana cuisine, an
can fairly claim that most of the t
es are American or, at least, they
have been completely natu
here, just like the banana it

By the early sixteenth cent
bananas had been transplanted to
hemisphere. This was part of a wo
proliferation that has seen
Musa clan thrive in virtually all tr
locations on the planet. We th
of Honduras and Costa Ric
the preeminent banana republi
cities, it is also the case that Queensl
Australia, is familiarly known
Bananaland, from the prevalence
the crop there. Banana beer is
characteristic drink of the Ch
who live in Tanzania around Mt

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key to determine the page where your plant is described and
shown. No knowledge of botany is required.

N.B. 1
Banana Ice Cream

3 bananas
1 cup sugar
1/2 cups heavy cream, chilled

1. Puree the bananas in a blender.
2. Heat the sugar in a saucepan with 2 tablespoons of water until the sugar dissolves.
3. Stir together the sugar and banana puree and let the mixture cool.
4. Stir in the heavy cream and chill the mixture for one hour.
5. Freeze in an ice cream freezer.
Yield: 1 quart

Cajeta de Piña y Platano

(After a recipe in The Cuisines of Mexico, by Diana Kennedy)

1 1/2 cups brown sugar
1 2-inch stick cinnamon
1 four-pound pineapple
2 pounds bananas
Juice and peel of 1/2 lime
2 1-inch sticks cinnamon

1. Bring 1 quart of water to a boil, add brown sugar and 2-inch stick of cinnamon, and continue boiling briskly for 20 minutes, uncovered. The liquid should reduce to approximately 1/4 to 3 cups. Remove cinnamon and discard.
2. While the sugar-cinnamon mixture reduces, peel and dice all the fruit. Discard the central core of the pineapple.
3. Preheat oven to 325 degrees.
4. Mix together the reduced syrup and the fruit. Puree this mixture, coarsely, in a blender, in three batches.
5. Pour the puree into an oven-proof dish just deeper than 3 inches. Add the lime peel and juice and the 1-inch sticks of cinnamon.
6. Set the dish in the oven and cook for 5 to 6 hours. Cooking times will vary according to the depth of the dish: the deeper it is, the longer it will take to produce a rich, dark-brown, sticky mixture. Scrape the sides of the dish from time to time, more frequently toward the end, and mix the scrapings back into the cajeta.
7. Glaze the surface of the cajeta quickly under the broiler. Then let cool and serve with cream cheese.

Yield: 6 servings

Raymond Sokolov’s most recent cookbook is The Saucier’s Apprentice, a guide to French sauces.
The Cygnus A Conundrum

No theory yet devised fully accounts for the phenomenal amounts of radio energy released by this galaxy.

In 1943, an electrical engineer in Wheaton, Illinois, whose hobby was astronomy, used a dish-shaped backyard antenna to survey celestial radio emission. Based on his observations, he prepared a contour map of a large part of the sky. The contour lines, which resembled those that indicate height above sea level on a geological survey map, showed the strength of radio waves received from different directions in space. The engineer’s map revealed an intensification of the radio waves coming from the direction of the constellation Cygnus.

It was thought at the time that celestial radio emission is produced by electrically excited interstellar gas distributed throughout our Milky Way galaxy. Since Cygnus straddles the central plane of the Milky Way, where the interstellar gas is concentrated, the finding was not very surprising. The surprise came three years later, when researchers employed by the Ministry of Supply in England discovered that the Cygnus radio waves were fluctuating. A graph of their measurements showed notable increases and decreases in the strength of the received radio waves occurring only seconds apart.

These rapid changes reminded the English observers of the variable radio emissions that come from spots. Thus, they suggested that the fluctuating radio waves from Cygnus were produced by one or more specific objects, perhaps stars with disturbed regions, or “starspots,” rather than from a broad distribution of gas in space.

It was later proved that the fluctuations are not inherent in the radio waves.
as but come from turbulent convection in a layer of the earth's atmosphere. They are caused by a process analogous to that responsible for the flaring of visible stars. However, the conclusion that Cygnus A, as the remnant of a supernova explosion, is a highly localized, or "discrete," object was correct. Once astronomers knew that there were discrete radio sources in space, the hunt was on to find their associated celestial phenomena.

In addition to Cygnus A, several other discrete radio sources were found and identified with known galactic objects, including the Crab Nebula, the Andromeda galaxy, a member galaxy of the Virgo cluster (a group of galaxies that is relatively close to us by cosmologists' standards). Thus, it was discovered that no conspicuous astronomical object appeared on photographs of the region of Cygnus A, the first discrete radio source, whose optical counterpart is about three million times weaker than the radio emission from the Milky Way. Cygnus A is, in fact, the second strongest radio source in the whole sky. (The strongest is Cassiopeia A, a supernova remnant like the Crab Nebula.) Finally, in 1951, British radio astronomer at the Cambridge Laboratory succeeded in obtaining exceptionally precise measurements of Cygnus A's position. These radio astronomy observations, a search was made using the 200-inch optical telescope on Mount Palomar in California for this A's optical counterpart. On

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a September evening in 1951, the region of Cygnus A was photographed from Palomar by Walter Baade, a noted extragalactic astronomer associated with the Mount Wilson and Palomar Observatories. The photographs revealed a dim galaxy of peculiar appearance in the midst of a cluster of even fainter galaxies. Other observations showed that the galaxy was about 110 million light-years from the earth. (More recent revisions in the extragalactic distance scale used by astronomers show that the true distance of Cygnus A may be as great as 1,000 million light-years.) At that distance, Cygnus A was far beyond the Virgo cluster and thus was the most remote radio source yet located. This was astounding because, as the second strongest source observed from the earth, Cygnus A might logically have been one of the closest ones. The few other galaxies then identified with radio sources produced far more energy in the form of visible light than as radio waves, but Cygnus A’s radio waves were as powerful as its light.

On the Palomar photographs, the Cygnus A galaxy consisted of a rather faint, round, fuzzy image, centered on two brighter condensations. Baade proposed that this presumed galaxy was actually two colliding galaxies. The condensations were interpreted as being the respective central nuclei of the galaxies, while the fuzzy region was regarded as a superposition of their main bodies, seen in perspective. Although a large galaxy may contain hundreds of billions of stars, the stars are, on the average, very far apart. Thus if two galaxies did collide, their member stars would sift through each other with few direct hits, very much like two squads of a stadium marching band parading through each other at half time without bumping. The theory of colliding galaxies, which had been worked out even before Cygnus A was photographed, predicted that the interstellar gas of the two galaxies would be heated by the collision. And subsequent observations of Cygnus A had indeed revealed intense spectral lines caused by the emission of light by neon, oxygen, and nitrogen gases in a hot, excited state.

Later calculations, however, showed that, although the collision theory correctly predicted lines of hot gas, a collision is not sufficiently energetic to power a radio source as strong as Cygnus A. In addition, ob-
radio waves emitted by A are so powerful that, as one put it, "less than one source million" has a comparable intensity. Astrophysicists attempting to account for this energy are also concerned with a difficulty known as the "inversion problem." This term refers to the puzzling fact that the lobes are much smaller than the galaxy. If, as many astronomers believe, the lobes are clouds of gas, or electrified gas, then, like the rings drifting away from a planet that blows them, they should expand rapidly as they recede from the center galaxy. However, a comparison of Cygnus A with other double radio sources in various stages of development shows that the lobes do not expand as rapidly as predicted. Does this mean that something is confining the lobes, or are the lobes not built plasma?

To both questions is the issue of the Cygnus A radio source treated by one of the recent events or continuously supplied with the energy to power the lobes. The now-dissolved colliding galaxies theory, the first example of a violent concept to explain Cygnus A, never such theory involves the interaction of cosmic clouds and matter, that is, material composed of the components of the galaxies but with the added electrical charge. This idea dropped when physicists realized there is no way to accumulate lint antimatter. Opinion dates methods of continuous energy release.

A variety of new theories have been advanced by radio-source researchers to account for the intensity of the Cygnus A emission. Among one concept, intergalactic colliding into a giant black hole at the center of Cygnus A generates a continuous supply of energy to power the radio source. Unfortunately, the reality both of black holes and of sufficient gas in intergalactic space remains to be proved.

Another hypothesis postulates the existence of a "spinar," a "massive, rapidly rotating, magnetized object" in the galaxy. The spinar supposedly emits energy in two opposite directions, and where the beams of energy strike the intergalactic gas, they produce the radio lobes.

A third proposal is the "ram pressure theory." This concept suggests that plasma blobs shot out from the center of the galaxy are compressed by the intergalactic medium, thus accounting for the confinement of the radio lobes. However, double radio sources similar to Cygnus A are found to have comparable properties whether or not they are located in clusters of galaxies. Since the intergalactic gas should be denser in a cluster than elsewhere, this simple observation suggests that the intergalactic gas does not play a major role in the development of radio sources.

Yet another hypothesis, known as the "slingshot theory," addresses the confinement problem and combines the ideas of a violent event and a continuous energy supply for Cygnus A. In March 1976, physicists at the Massachusetts Institute of Technology and Harvard University proposed a new version of this theory. According to their reasoning, spinars were hurled out of the galaxy in opposite directions either when a parent object spun so fast that it broke apart or when an orbiting system of several spinars was disrupted. Traveling outward, each spinar generates high-energy electrons that circle it and produce the radio lobes. Although the radio emission of the electrons fades as they dissipate into space, they are constantly replaced by new electrons from the spinars. As in previously espoused theories, however, basic assumptions are made in this one that cannot yet be proved. Thus, no one knows if this latest concept is correct. But at least it avoids some objections leveled at the earlier theories and accounts for the main characteristics of the double radio source. That is probably the best we can hope for at this stage in the investigation of Cygnus A.

Stephen P. Maran is an astronomer at NASA's Goddard Space Flight Center in Greenbelt, Maryland.

For most of us, insects and other allied arthropods are a nuisance to be endured during summer excursions to the beach or mountains or around the picnic table. Diseases, such as plague and typhus, or crab louse infestations are usually relegated either to the Middle Ages, the third world, or the promiscuous. And while we marvel over the industrious bee and ant, the beautiful butterfly and moth, we are for the most part less familiar with those hematophagous arthropods that, in addition to causing wheals and welts, transmit numerous disease-causing viruses, rickettsiae, bacteria, protozoans, and metazoans.

Equally unfamiliar to most people is the microenvironment of skin where each second, on each millimeter of epidermis, a complex ecosystem—involving sweat, sebum, hair, and commensal bacteria and fungi—is continually evolving. Here then is an intriguing voyage, not unlike Gulliver’s trip to the land of the Brobdingnagians, that describes the exotic microscopic fauna, flora, and other biota that surround, suckle, and invade our integument. And lest those who suffer from hypochondria or entomophobia be taken aback, it should be immediately pointed out that Michael Andrews’s descriptions of our skin and the critters that crawl across it is more reminiscent of the African veld than an advertisement for psoriasis.

The mite, flea, and louse are parasites, true enough, but they are also predators. Some of the descriptions given these arthropods by Andrews raises them to the sinister majesty of the cheetah, wild dog, and hyena.

Bacteria and yeasts are also perceived (especially with the use of excellent photomicrographic reproductions) as highly complex living creatures. The book, we are told in the flap copy, is a collection of BBC programs that has been developed in greater detail for publication. This might account for a certain choppiness in presentation and duplication of material. Nevertheless, the author has assembled an eclectic assortment of personal experiences, philosophical asides, historical accounts, remarkable photomicrographs, illustrations, sketches, and interventions into chapters that describe the significance of microbes and arthropods impinge upon people. Unencumbered by the talmudic preciosity of a doctoral candidate or the rhetoric of a diagnosing physician, Andrews...
Hisiasm for his subject is infectious. He is alternately enamored by his topic; amazed by the exfoliation of it; "scurf," we are told, is made up of millions of mote-sized particles of skin, which float off us each time we bathe, dry ourselves, turn over in bed or put on our clothes; angry at the more dubious medical experiments performed in the name of science; and justifiably worried about the emergence of resistant bacteria that may result from the injudicious use of antibiotics. He describes these subjects accurately, documenting without footnoting and with a minimum of sensationalism.

The initial chapters introduce the physiology of skin and review historical and contemporary attitudes toward various insect parasites. These are amusing and informative, compelling one to plunge into subsequent chapters. The ecological niches of the mite, tick, flea, and bedbug, as well as that of head, body, and crab lice, are described in great detail. The microbiota of the skin and bubonic plague receive special attention in separate chapters. The final chapter summarizes the ecology of man-microbe-arthropod interdependencies and suggests that recent technological "advances" may in the near future upset these balances.

There are, however, a few mistakes that are at times distracting. An entomologist friend of mine happened to read the book. He greatly enjoyed it and was enchanted to discover that, among other things, a Rothschild first discovered the vector of plague (Xenopsylla cheopis, Rothschild). Nevertheless, he noted some errors and, although his concerns were different from mine, they were of a somewhat similar nature. Some of Andrews's taxonomic descriptions are dated: lice are now considered to be in one order, Phthiraptera, and not separately grouped under the Anoplura and Mallophaga. Aphids are in the order Homoptera and not Heteroptera: the former are predominantly plant feeders (not bloodsuckers) while the latter often are predacious and not plant feeders. The insecticide carbamyl is a carbamate and not an organophosphate. A plate depicting the vector of plague X. cheopis is missing a diagnostic episternal line. So much for the exacting doctoral candidate.

I was concerned with the dated use of Pasteurella as the genus for the plague bacillus Yersinia pestis. (It was Yersin, not Pasteur, who first identified the organism.) In addition, a minor mix-up attributes the many deaths among American Indians and frontiersmen in the Bitter Root Valley of Montana and Idaho in the 1880s to a viral disease. The author confused the arbovirus causing Colorado tick fever with the rickettsia of Rocky Mountain spotted fever. This mistake is important since it was the pioneering work of H. T. Ricketts (among others) that elucidated the epidemiology of this disease. And while most arthropod-borne diseases in the United States appear to be decreasing, the incidence of Rocky Mountain spotted fever has risen alarmingly over the past decade. Andrews mentions that there were 380 cases in 1970 and neglects to comment on the continuing upward trend, from 200-odd cases in 1959 to nearly 900 cases in 1976. He does not comment on the deceptive name given the disease—although first discovered in the Rocky Mountains, most cases occur in the Appalachians. His geography is also off when he describes a small outbreak of malaria in 1952 as having occurred in the Rocky Mountains when, in fact, it occurred in northern California.
The magnification attained in this photomicrograph has transformed an innocuous dust mite into a creature of formidable appearance.

There is one additional point about which Andrews is a bit vague. In an early chapter he implies that the head louse transmits epidemic typhus. Then, in a later chapter describing mite and head louse infestations, he corrects himself, stating that the head louse (in contradistinction to the body louse) could transmit the infectious organism, but that this is a theoretical possibility and has never happened. Parents of children infested with head lice (a not uncommon problem these days) should not have to be seriously concerned about epidemic typhus in their children. Also, he laments that the only researchers addressing themselves to the head, body, and crab lice problems are in Great Britain. This I seriously doubt, attributing this bit of chauvinism to his British resources. We in the United States do not have, and should not worry about, a louse-gap problem.

The author's great enthusiasm for the subject leads me to speculate on how the original BBC program (and eventually, the book) was created. I imagine that Andrews happened across an article about a mite or, perhaps, the workings of a hair follicle. This led him to further discoveries and revelations about the skin and its microscopic and macroscopic inhabitants. Intellectual curiosity mandated a review of the literature, discussions with researchers, and a careful historical search for origins and opinions on these matters. The beginnings of the project were probably confined to the skin and its immediate occupants. The commensal bacteria and fungi were studied, followed by the intra-cutaneous and cutaneous parasitic mite and louse. This presumably led to other bloodsucking arthropods that, although obligate or facultative parasites, live independent of humans (and other mammals) for days, months, or years. If this is not how Andrews's project began, it at least gives a logical explanation of the book's progression. However, by discussing the flea and bedbug, insects that only upon occasion—and then but briefly—attack humans, there is an implied omission of other, similar bloodsucking arthropods, their historical importance, and the researchers who first realized their significance. What about the Diptera, for example, the mosquitoes (culex, anopheline, aedes, culiseta) and the flies (sand fly, blackfly and tsetse), as well as the other orders of Insecta that also have caused so much misery to people?

Certainly the mosquito shares an equally important part of history the louse and the flea (plague to contrary notwithstanding). The torical speculations as to the cause of malaria are fascinating reading. F. ald Ross's research with the "da-wing mosquitoes" (the anophele a hallmark in the history of medic Even today, malaria is ranked as a leading cause of death worldwide. The World Health Organization Other mosquitoes and the gri mischievous have they caused should be mentioned as well. aedes, the work of Walter Reed, the elucidation of the epidemiology yellow fever were omitted. Even Patrick Manson, a British giant tropical medicine, is not mentioned for his work in associating a mosquito with filariais, among his many contribu- tions to medicine.

Other omissions cannot help but noted either for their historical im- tance, the absurdity of the predac insect vectors, or the unusual na of the diseases they cause. Theo Smith, an American, was the doctor to incriminate an anthropo a source and vector of a disease (Texas tick fever). Carlos Chagas Brazilian, through a series of brisk observations theorized that a disease (which now bears his name) might be transmitted by an aggressive, blood sucking bug. He examined the bug, found a trypanosome similar to the trypanosome of African sloping sickness, searched for a similar organism in the blood of acutely ill people, and found it. This was first time a disease was postulated exist because of a researcher's casual observation concerning an insect behavior.

There are other insects, searchers, and diseases that would nicely into the schema of this book but in all fairness to the author, inclusion of all these would have made what is now a thoroughly acceptable few hours of reading into an intimidatingly long tome. Still, the stories should be popularized, preferably by a writer like Andrew would like to think that the author planning a sequel to tweak and en- tain us again with fact and fic about the unseen or inapparent just in, on, and around us.

John S. Marr is the director and principal epidemiologist of the Bureau of Preventable Diseases, Health Department of New York City, coauthor of The Black Death.
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Margaret Mead at 75, an exhibit honoring Margaret Mead, curator emeritus of ethnology at the American Museum, is on display in the Museum’s temporary exhibit hall on the second floor, between the African Mammal Hall and the Man in Africa Hall. The display features photographs of Mead as a child, as a student, and as an anthropologist in the field and in the Museum. Quotations from Mead, which explain her attitude toward her work and the study of anthropology, accompany many of the photographs.

The American Museum of Natural History is sponsoring a two-week Voyage of Discovery: The Island World of Britain from June 17 to July 3 aboard the luxury motor yacht Argonaut. Participants, limited to 150, will visit the unspoiled Scilly Islands, the Inner and Outer Hebrides, and the Orkney and Shetland islands, as well as mainland ports. They have an opportunity to study the culture, history, flora and fauna of the ancient islands. Prominent scientists will lecture on a variety of anthropological and natural history subjects during the cruise. Further information and application forms may be obtained from Ellen Stancs, American Museum of Natural History, Central Park West at 79th Street, New York, N.Y. 10024.

As part of its four-day-long centennial celebration, The New York Historical Society will hold open house on May 14 from 10 A.M. to 3:30 P.M. in room 419 of the Museum. During the event, entitled “Wonders of the Micro-World,” members of the society will display their microscopes, many of them antique. Visitors will be able to examine microscopes firsthand and view slides of colorful crystals and fish as well as examples of living protozoans and other forms of microlife. The open house will be an excellent opportunity to introduce children to a rarely seen world. The event will also include a display of photomicrographs and photomacrophotographs by society members. Although connected with the Museum, the Historical Society is a separate organization and not part of the Museum.

An exhibit entitled Maps and Science and Art will open on May 11 in Gallery 77 on the first floor of the Museum. The display will explore the scale and projection of maps, how they are made, and how scientists use them in various aspects of research. Featured in the exhibit will be many maps of the New World region—some of great historic value—on loan from the American Geographical Society.
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**Additional Reading**

**Andean Agriculture** (p. 32)  

**Mussel Attachment** (p. 42)  

**Sod Houses** (p. 48)  
Through insightful descriptions of the impact of climate and geography on the settlers of the Great Plains, two of Everett Dick’s books—*The Sod-House Frontier: 1854–1890* (Lincoln: Johnson Publishing Company, 1954, $8.95) and *Conquering the Great American Desert* (Lincoln: Nebraska State Historical Society, 1975, $10.95)—provide a rich sociohistorical context for understanding the rise of sod house construction. In *House Form and Culture* (Englewood Cliffs: Prentice-Hall, 1969, $2.95) architectural historian Amos Rapoport discusses theories of the interaction of geography, social structure, and traditional architecture. Illustrated with a fine series of line drawings, Rapoport’s work deals mainly with primitive folk cultures and how their housing relates to their environment. Roger L. Welsh’s own studies of the folklore of plains architecture can be found in *Sod Walls* (Broken Bow, Nebraska: Purcells, 1968, $10). Based on his analyses of more than 1,000 photographs of sod structures, Welsh’s book describes variations in form and construction and documents the evolution of this folk-lore by drawing on oral histories from those who built and lived in houses. His article “‘Sod Construct the Plains’” (Pioneer America, 1969, pp. 13–17) has been reprinted pamphlet; write the Nebraska State Historical Society, Lincoln, NB 68501, ask for “The Nebraska Soddie.” We recommend a fine spring day, with promise of good weather to folio counter the depressing effects of reprinted Ole E. Rölvaag’s *Giants in the New World: Harper & Row, 1942* ($1.25), a novel that captures and puts vivid prose the impact of the Plains on the minds of Scandinavian migrant farmers.

**Animal Trafficking** (p. 54)  
F. Wayne King’s “‘Adventures in Skin Trade’” (Natural History, 1971, pp. 8–16) and Bernard Niemann’s “‘The Nicaraguan Skin Trade’” (Natural History, January 1975, pp. 28–30) offer complementary views of the attempt to control the internal trade in animals and animal products. Jaclyn H. Wolfheim’s “‘The Perils of Mates’” (Natural History, October 1975, pp. 90–99) details the impact of trade activities on the dwindling habitats of many species of primates. Two books, the world-renowned Swiss zoologist Heini Hediger—*Wild Animals in Captivity: An Outline of the Biology of Zoological Gardens* (1950) and *The Psychology and Behaviour of Animals* in Zoos (1955)—have been translated by Geoffrey Sircom and reprinted in a paperback edition (New York: Dover Publications, 1964 and 1965). Hediger’s books contain much data and many observations not found elsewhere as well as offering a zookeeper’s perspective on acquiring, keeping, and exhibiting wild animals. Gerald Carson’s *Beasts, and Gods: A History of Cruelty and Kindness to Animals* (New York: Charles Scribner’s Sons, 1972, $2.95) traces the relationships and attitudes toward the “lower” animals throughout recorded time. Definitive counts of the status of many world’s animals and plants, and the aspects of obtaining or possessing alive or as products, can be found in the endangered and Threatened Wildlife...
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Plants" (Federal Register, Oct. 1976, vol. 41, no. 208, pp. 47,119) which lists species and common population estimates, portions of the range where pressures are severest, and other useful information. This grafted Species List can also be obtained from the Office of Endangered Species, U.S. Department of the Interior, Street, Washington, D.C.

**Timbuktu** (p. 68)

J.O. Hunwick’s "Religion and the Songhay Empire, 1464–1591, 1591–1635") in Islam in Tropical Africa edited by J.M. Lewis (New York: University Press, 1966), is a well-documented study of Islamic tradition and the political and social history of the Songhai empire in the eighteenth century. His book "Timbuktu and Mali" (New York: Bantam Books, 1973, $7.50) is a work of great historical scholarship and can be seen in Edward W. Bovill’s classic, The Golden Trade of the Sahara (2nd ed. New York: Oxford University Press, 1970, $2.95), a most readable account of the rise and fall of the Songhay empire. Bovill has also written an engaging account of the search for the area’s most important oasis, The Niger Exploded (New York: University Press, 1968). Horace Mann was the first to recognize the importance of the Timbuktu region, and his book, The Quest for Timbuktoo (London: J.M. Dent, 1968), is a well-researched and engaging history of the search for the "mystery city." The book is based on the original autobiographies of Timbuktu’s early explorers. Many of these accounts, which Professor Koch has translated in his pieces of this volume, have been reprinted and, as such, are available in many libraries. These include Le canu’s The History of Explorers in Africa of the Notable Things Contained, edited by Robert Broomfield (London: John Pory, 1963); Mungo Park’s Travels in the Interior of (Saint Clair Shores, Minnesota: Anchor Press, 1973); Heinrich Barth’s Journals and Discoveries in North and Central Africa and René Cailliat’s Through Africa to Timbuktoo (Baton Rouge, Louisiana: International Book Services, 1965 and 1968).

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2 Authors

12 Post-Human Intelligence Robert Jastrow
Our chapter of earth's history may be ending. What comes next?

22 This View of Life Stephen Jay Gould
The Return of Hopeful Monsters

32 Social Commentary from the Cemetery Edwin S. Dethlefsen and Kenneth Jensen
One societal indicator shows God declining and husband-wife bonds growing.

40 Monarch Migration Lincoln P. Brower
Some 100 million butterflies overwinter at a small, secret site in Mexico.

54 The Alligator Revealed Leslie D. Garrick and Jeffrey W. Lang
The one serious predator of this endangered creature may be learning enough to save it.

62 California Litter Bruce E. Bechol and Jerry R. Williams
For impact on beaches, children rank first, followed by young beer drinkers.

66 Bolts from the Blue Richard E. Orville
If you can hear the thunder of lightning, relax . . . the strike missed you.

74 Letters

78 Book Review Garland E. Allen
Lorenz Observed

86 The Changing City

88 A Matter of Taste Raymond Sokolov
Oranges and Their Cousins

92 Additional Reading

94 Celestial Events Thomas D. Nicholson

96 The Market

97 Announcements

Cover: Thousands of monarch butterflies cluster in a tight mosaic on a cypress tree in Mexico, where they have migrated to escape winter in the United States. Photograph by George D. Lepp. Story on page 40.
No stranger to these pages, atmospheric physicist Robert Jastrow last appeared in the March 1977 Natural History ("Report from Mars"). A commuter between New York and New Hampshire, he is an adjunct professor of geological science at Columbia University and of earth science at Dartmouth College. For the past fifteen years, he has also been the director of the Goddard Institute for Space Studies in New York City. The author of several books, with a new one currently in progress, Jastrow appeared in a series of television programs on space science that ran in 1964 and 1971 on CBS-TV. He has been a recipient of the Columbia University Medal for Excellence (1962), the Arthur S. Flemming Award (1964), and the NASA Medal for Exceptional Scientific Achievement (1968).

Unknown to each other until a year ago, both Edwin S. Dethlefsen and Kenneth Jensen had been independently studying gravestones for a number of years: Dethlefsen in New England ("Death's Head, Cherub, Urn and Willow," Natural History, March 1967) and Jensen in Alabama. They met last July at a seminar on American civilization and discovered their mutual interest. Dethlefsen, who teaches anthropology at Franklin Pierce College in New Hampshire, is continuing his research on New England cemeteries, using them as models for cultural change. He is also excavating several Spanish and English shipwrecks off Bermuda. Jensen, who teaches anthropology at Oregon College of Education, has shifted his attention from southern to western cemeteries.

Professor of biology at Amherst College, Lincoln P. Brower has been studying the behavioral ecology of monarch butterflies for many years, with support from the National Science Foundation. Part of his current research involves the ecology of Danaidae butterflies, the milkweed plants on which they are reared. Brower is also interested in riverine ecology and federal control policy. He writes that he wants to "provide an intellectual Achilles' heel to divert the Army Corps of Engineers, the Soil Conservation Service, and the Bureau of Land Reclamation from ruining rivers with dams and channelization." A professional science filmmaker, Brower's movie on a monarch butterfly will be released this month by Harper & Row.
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Well friends, you heard what the man said. Some sacrifices will have to be made. But getting into a Volkswagen won't be one of them.

Volkswagens may look like small cars, but only on the outside. Inside is another story altogether. A VW Rabbit, for example, has (incredibly!) more space for people than 19 other cars in its class, including Monza, Mustang, Pinto, Sunbird, Datsun F-10, and Toyota Celica.

The Rabbit also has (shockingly!) more trunk space than 34 other cars, including Cadillac Seville, Thunderbird, Camaro, Monza, Nova, Comet, Starfire, Firebird, Skylark and Ventura.

These are official U.S. Government statistics, by the way, published in the Office of Environmental Protection Agency 1977 Mileage Guide.

The Rabbit also goes like a bat out of hell, from 0 to 50 in 7.7 seconds.

Moving along smartly to our Dasher, hope you'll be floored to learn that the Dasher Wagon, according to the same guide, has more trunk space than wagon in its class made by any other manufacturer. Meaning General Motors, Chrysler, Datsun, Toyota.

Rabbit
energy crisis into a small car.

Dasher

Dasher doesn't need that much space. Dasher comes in a beautifully appointed Hatchback and 4-door Sedan. Yet Dashi Dashers have way more passenger and trunk room than any Japanese car in their class and more than most Americans in their class.

Really, Scirocco. The VW Scirocco is a true sports car that can bring home six feet of stuff on days and racing ties on Sundays. Scirocco is just somewhere, beating everyone in its class (and a lot of other classes). Yet it has more trunk space than any—and repeat—any car in its class made by any—repeat any—manufacturer.

All the new Volkswagens were made for the times that are on us now. All three get 24 MPG in the city. Rabbit and Scirocco get 37 MPG on the highway. Dasher gets 36. (EPA estimates with standard transmission. Actual mileage depends on how and where you drive, optional equipment, and the car's condition.)

Yet even with all this economy, there is nothing quite like them for their combination of handling, performance, reliability, safety, space and just plain wisdom of design.

You're going to appreciate them. Better still, you're going to love them.
Leslie D. Garrick is a research fellow with the Center for Field Biology and Conservation of the New York Zoological Society. His present research is on the ecology and behavior of the American crocodile in the Greater Antilles. Garrick has studied alligators and crocodiles in Florida, Jamaica, Panama, and the Dominican Republic. A strong interest in crocodile conservation has led him to serve as an observer for the American Crocodile Recovery Team in Florida.

While working toward a doctorate in meteorology at the University of Arizona in the 1960s, Richard E. Orville witnessed many severe thunderstorms and became interested in the dynamics of lightning. A serious amateur photographer, he has since then pursued his interest, camera in hand, in Switzerland and, most recently, as a member of an investigative team based at the Kennedy Space Center in Florida. An article by Orville entitled “Lightning Through a Lens,” illustrated with his photographs, was published in the January 1966 issue of Natural History. Orville is currently a professor in the Department of Atmospheric Science at the State University of New York at Albany. He and his family like to go on camping trips in New England and know exactly what to do when caught in a thunderstorm they crouch, but don’t lie, on the ground, with their feet close together.

Bruce E. Bechtol and Jerry R. Williams began their study of litter on a California beach in 1969 with a community clean-up project. A few years later the authors used the beach as a classroom for courses in environmental sciences at California State University, Chico, where they both teach in the Department of Geography. Bechtol and Williams are looking into the nature of litter and ways of dealing with solid waste. One research method they frequently employ is to survey the amount and kind of litter in and around roadside trash cans. Their principal effort, however, lies in pointing out the damage such pollution does to both the environment and human beings.
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OPERATION

A report on how the forest industry is working to get twice as much wood from America's commercial forests. Year after year. Forever.

Wood is one of the world's most valuable resources.

It's America's busiest building material. It's also the basic ingredient in pulp, packaging and a thousand other products—right down to the paper this ad is printed on.

More Wood From Less Land.

But while world demand for wood is increasing, the amount of land available for commercial forests is shrinking. Some of it has been set aside for parks and wilderness areas. Much of it has been turned into farms, freeways and new developments.

The chart above shows that U.S. consumption of all wood and paper products will double in less than 50 years. Thus the reason behind Operation Double Tree—the forest industry's name for intensive forest management that can double the amount of wood grown on a given piece of land. And do it in such a way that the forest remains a valuable part of the ecosystem.

Commercial forest is described as that portion of the total forest which is capable of, and available for, growing trees for harvest. Parks, wilderness and primitive areas are not included.

Double Tree is ambitious and is already working.

All across the U.S., forest product companies are working to double forest yield. In Oregon and Washington, forest product companies are predicting triple growth with genetically superior trees planted in prime forestlands.

Through thinning efforts alone, some companies in the Great Lakes States have increased diameters of remaining trees enough to double wood volume per acre over a 35-year period.

Double Tree isn't limited to large trial tree farms. Individual owners from Maine to Georgia are turning idle lands to work, creating belts that offer the twin payoff of increased harvest and eternal forest.

That may sound like a paradox: eating a cake and having it, too. Like oil or coal, wood is one natural source that is renewable. And forestry has found ways to make Nature more productive.

Today's intensive forest management is rooted in nature's own ecological processes. Using methods that begin with the harvest, slower growing trees are thinned out. Others are left to grow.

An actual tree diameter barely changed.
is made to use every last part of the tree: tops, limbs and bark.

Real Forest.

But the real key is in the new forest. In some areas, foresters plant new trees by machine, or by hand. Helicopters are also used to re-seed. When seedlings go in, the forest often needs a five-year head start over natural regeneration in the same area. Whether any of them are of genetically superior stock, the result of years of selective breeding, Seedlings by the hundreds of millions are grown in special nurseries. They're healthier, faster growing and will mature faster and can be harvested sooner.

In the forestlands, such as in the Northeast States, are a mother Nature because natural regeneration does a better job.

Soil studies determine prime growing areas. When necessary, nutrients are added. And the young trees are protected from destructive insects, fires and natural enemies.

The result is a better quality forest, one that can be at least twice as productive.

Who Owns The American Forests?

Significantly, the principles of Operation Double Tree are being used on only a small portion of America's forestland. And good as Double Tree is, it might not be enough. Too much of the American forest is still under-utilized and under-productive.

Overall, industrial forestlands are working the hardest. Industry owns only 13 percent of the commercial forestland, but it provides almost 30 percent of the total harvest. Some 4 million private individuals own 60 percent. Government owns about 27 percent.

All of which means we must join to make the most productive use of our remaining commercial forestland. Industry has invested millions to make the concept a reality. But money isn't enough. Leaders and landowners alike must understand the problem. And, more important, the solution.

For more information, write for our free booklet, "Managing the Great American Forest," American Forest Institute, P.O. Box 873, Springfield, VA 22150.

Trees. The renewable resource.
Post-Human Intelligence
by Robert Jastrow

By the twenty-second century, biological organisms may not have the highest intelligence on earth.

Some twelve to fifteen million years ago, a few venturesome primates emerged from the safety of their forest dwellings and moved onto the savanna. At that time the line of human descent split off from the main stock of the apes. A record of the migration of this splinter group remains in the form of scattered jawbones whose dentition suggests a grassland diet and a life in the open. For many millions of years thereafter, the record of human origins is nearly blank. The trail reappears in rocks about five million years old that contain the fossilized remains of a small animal—in size and appearance like a pygmy chimpanzee, yet with a curiously humanlike posture. This was Australopithecus, the ape-man.

Bones found in the campsites of Australopithecus in Africa reveal that the primate had developed a strong taste for meat. It ran with the other carnivores of its time and was a competent hunter, holding its own against the lion and the giant hyena. Yet it was a puny creature, slight in build, weighing perhaps seventy pounds, and without slashing canines, claws, or other weapons. But its physical weaknesses were balanced by the strength of its intellect.

The brain of Australopithecus was not of impressive size, being about as big as a fist and only moderately larger than the brain of the chimpanzee. But in proportion to the weight of the body, the brain of Australopithecus was twice as large as the brain of the ape. Every animal uses a part of its brain as a telephone exchange, receiving signals from the body and sending out messages in return. Australopithecus, with a body considerably smaller than the ape's, required fewer brain cells for that purpose and had more gray matter available for the storage of past experience and the contemplation of future actions. Australopithecus achieved this brain size four or five million years ago, about ten million years after its ancestors had moved to the savanna. The primate seems to have changed little thereafter, either in brain or body. Like many prior forms of life, the ape-man had reached an evolutionary dead end; it had become a living fossil. Between one and two million years ago, it became extinct.

Well before Australopithecus vanished, another intelligent animal appeared in Africa. This creature was a relative of Australopithecus, with similar bodily traits, but its brain was considerably larger. The new animal was Homo—the first man. Australopithecus and Homo lived on the same continent for several million years. Throughout that long interval, while the intelligence of Australopithecus remained unchanged, the brain of Homo continued to grow. The fossil record has not revealed why one cousin became more intelligent than the other; we only know that a million years ago, when Australopithecus disappeared, Homo's brain had become twice as large as that of the ape-man.

Homo was a bright animal one million years ago, and a determined one. Its technology for making stone tools represented a high level of organization and planning. Mary Leakey, widow of British archeologist-anthropologist Louis Leakey, has found evidence that Homo scavenged the neighborhood for miles around a search for the particularly fine kinds of stone needed for its tooling activity. When such stones were found, the animal brought them to its workshop. The implication is that Homo had developed an industry: it thought out its needs in advance; gathered its materials; worked them from day to day; and when it had fashioned the tools, saved them for repeated use. In intellect, Homo was superior to all other animals of its day; yet nature's work on its brain was far from complete. Homo was a nearly finished creature from the ground, but its skull held a brain only half the size of the brain of modern man.

Starting about one million years ago, the human brain began to grow at a considerably faster pace. It expanded at first at the rate of one inch—a heaping tablespoonful of additional gray matter every 100 years. Then the growth rate doubled again, and finally, it doubled once more. Between 300,000 and 500,000 years ago, the rate of growth hit its peak. At that time the human brain was expanding at the phenomenal rate of ten cubic inches every 100,000 years.

No other organ in the history of the world is known to have grown so fast. What factors generated this explosion in growth? The toolmaking industry of the early man is part of the answer. The possession of a good brain enabled Homo to make tools in the first place, but the use of tools became, in turn, a driving force toward the evolution of an even better brain. The evolution of speech was also important. Through the spoken word, a new invention in toolmaking could, for example, be communicated rapidly to others. In this way the innovative power of the individual enhanced the
prospects of the group, and the native strength of one became the length of all. Spurred on by these circumstances, the centers of the brain devoted to speech grew in size and complexity, and in the course of many generations the whole brain grew with them. As in the technology of toolmaking, reciprocal forces were into play in which speech stimulated better brains and better brains proved the art of speech and the use of brain growth spiraled upward.

A change in climate that set in about two million years ago may also have played a role. About that time, the world began its descent into a vast Ice Age, the first to afflict the planet in hundreds of millions of years. Sheets of ice moved steadily southward, and by the time humanity had established itself in temperate latitudes, ice covered large parts of Europe and Asia. European summits then were nearly as cold as those today. In that difficult period, traits of resourcefulness and ingenuity must have been of premium value. The individual who first thought of stripping the pelt from a shaggy beast and wrapping it around or his or her shivering limbs was a trailblazer of the day. Only by such creative flights of the imagination could the naked animal survive the winters of a harsh climate. These circumstances must have further expanded the higher centers of the brain which new ideas were conceived and past experiences were recorded. Which factor played the most important role in the evolution of human intelligence? Was it tools? Large or the pressures of the Ice Age? No one can tell; all worked together through natural selection to produce the dramatic increase in the size of the brain that has been recorded in the fossil record of the last millions of years.


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The New Chevrolet offers more convenience, too. The rear door-gate opens down for cargo, or out for people when they’re entering the available third seat.

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And the seats fold flat in nothing flat when you want to haul paneling, railroad ties, grandfather clocks or what have you.

Big wagons are supposed to be roomy and practical. But nowhere does it say they also have to be quiet, comfortable and smooth riding. But this one is, and that’s more like it. See for yourself at your Chevy dealer’s Wagon Stop. The mileage you get will vary depending on your type of driving, driving habits, car’s condition and available equipment.
Vega. 5-year/60,000-mile engine guarantee.

Vega is a great starter wagon for small families. It seats four with room for gear behind. Vega's Dura-Built engine guarantee is an added value feature that's good for 5 years or up to 60,000 miles, whichever comes first. It covers repairs to the cylinder block and head, manifolds, water pump and all internal engine parts made necessary due to defects in materials or workmanship. It means that should something go wrong with the engine your Chevy dealer will fix it free. It does not cover repairs required because of accident, misuse or lack of proper maintenance. Your Chevy dealer has the complete guarantee statement.

The smart, mid-size Chevelle.

Sensible value in a glamorous mid-size, that's part of Chevelle wagon's strength. The other part is a wagonload of practical features. Automatic transmission, steel-belted radials and power steering and brakes are standard. The liftgate swings up and out of the way. There are storage trays in the wheel wells and concealed space under the floor. Full Coil suspension system with front stabilizer helps it handle roads as well as loads.

Suburban. Our superwagon.

This is our superwagon that holds more than most wagons and tows more than many trucks. Properly equipped, a C20 Suburban can move up to 15,000 lbs. of Suburban, passengers, cargo and trailer. Super also describes Suburban's inside space. There's available seating for up to nine with 35 cubic feet left over for cargo. With seats removed, Suburban can handle 144 cubic feet of cargo. And you'll find a wide range of available options to make it convenient, personal and complete.

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Got a crowd to move? We've got something just for you at the Chevrolet Wagon Stop. Sportvan can take up to 12 passengers with available seating. Passengers enter through a wide-opening, easy-sliding side door. Take out the quick-release rear seats, throw open the wide double rear doors, and you've got your own personal moving van with up to 260 cubic feet of cargo space. 125" or 110" wheelbase available.

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It's tough enough to take you to parts of the U.S.A. you never knew were out there. With the full-time 4-wheel-drive system that's standard when you order automatic transmission, it looks and feels easy. And Blazer offers many fine wagon attributes. There's seating for up to five, generous cargo space and a wagon-type tailgate for rear access. Standard Blazer has a steel front half top and removable rear fiber-glass-reinforced plastic top.
I put myself on Sigmund’s couch

Here in the Sigmund Freud Museum at Vienna’s Berggasse 19, I dreamed I met the great Doctor himself. What would he say about the mystery I felt in that room?

Elsewhere, in houses on streets I can’t name, I heard echoes of Beethoven, Mozart, Schubert, Haydn. I visited the many museums and monuments reflecting the past that brought me here to Austria. I saw the Lipizzaner stallions of the Spanish Riding School, sailed the Danube, walked through the Vienna Woods.

In the mountains near Innsbruck I relived the breathtaking races of the Winter Olympics. I listened to the sound of music in the hills of Salzburg. And I was changed.

It’s easy for you, too, to put yourself on Sigmund’s couch… to encounter Austria.
re, humankind is destined to have a more intelligent successor. 
What form will that posthuman intelligence take? A common picture is as a creature very much like ourselves, but with an even larger brain. Some futurists, however, believe this point of view is too narrow. They see powerful forces of evolution—cultural rather than organic—that could lead to a completely different form of intelligence. These experts are impressed by the rapidly developing computers. They view the great difference between human intelligence as one of degree, not of kind, and predict that in the coming years, computers might give us the thought before we reject the vision.

To understand the significance of the developments, compare the human brain with existing computers. An average brain weighs three dollars, consumes electrical energy at the rate of 25 watts, and occupies a volume of one-cubic foot. In this small volume, the brain processes between ten billion and one hundred billion items of information. Most powerful computers in use have memories that hold a few billion items of immediately accessible information. Although the capacity of such a machine is far less than that of the brain, it consumes about 4,000 watts of electrical power, occupying hundreds of cubic feet. Scaling today's computers by size, a machine matching the human brain in memory capacity would consume electrical energy at a rate of one billion watts—half the power of the Grand Coulee Dam—occupy most of the space in the State Building, its cost would run to hundreds of billions of dollars.

The qualitative superiority of the human brain is even more striking its adaptability. Every brain cell is directly connected to many other cells, some cases as many as 100,000. As a result, when we send a conscious stimulus to the recesses of the head to summon forth a point of information, the cells in which this information are stored communicate a subconscious level with thou-
sands of other cells, and a wealth of associated images pours out at the conscious level of thought. The fruits of the subconscious activity are intuitive insight, flashes of perception, and creative inspiration, all made possible by countless connections among the cells of the human brain. These connections from one cell to another explain much of the brain’s extraordinary power.

The computer memory, in contrast, is like a set of pigeonholes stacked against a wall, with no thinking capacity in any pigeonhole, and no connections from one hole to another. Information can be placed in a pigeonhole or taken out of it, but there are no associations and thinking goes on elsewhere.

It is plain that computers are mini-brains in comparison with the product of millions of years of human evolution. On almost every count, the world’s most powerful electronic brains are hopelessly inadequate in comparison with the one-tenth of a cubic foot of gray matter that resides in the human cranium.

In that case, why is the computer useful? The answer lies in its speed. The latest machines do sums a hundred million times faster than the human brain, performing as many as ten million additions each second, whereas the brain requires a second or more to do a single addition. Speed gives the computer its great power in dealing with problems such as forecasting the weather or keeping track of airline reservations. Yet its small memory and primitive thinking circuits render it powerless to deal with the variety of exercises in reasoning that any human being easily masters in the course of an ordinary day.

But the intelligent machine, still in its infancy, is evolving rapidly. The experience of the last three decades indicates that computer capability increases by a factor of ten every seven or eight years—a period that, in the jargon of the specialists, constitutes a computer generation. This seems a reliable rule of thumb for projecting the state of the computer art into the future. The record is clear. The first generation of computers, based on vacuum tubes, came into use in 1950. The second generation, which appeared about 1958, was based on transistors and was ten times larger and faster. The third generation—ten times faster still—thinks with the aid of “chips,” tiny squares of metal, which replaced both the bulky transistor and the vacuum tube. Large third-generation computers, built around chips, appeared in 1966. The first large computer of the fourth generation was introduced at the Goddard Institute For Space Studies in 1973. That machine is also based on chips, but in it a single chip holds the equivalent of one thousand vacuum tubes. This is the powerful computer previously compared to the human brain.

The fifth generation of computers will come into use about 1981. One important element in these machines will be a “bubble memory,” a new device a thousand times more compact than its predecessors. With the reduction in volume offered by the bubble memory, a hypothetical machine with the capacity of the human memory would shrink from the volume of a skyscraper to that of a suite of offices.

Still more revolutionary electronic devices are in an experimental stage. One has the capacity of an entire computer plated on a single chip roughly one-quarter inch across. This chip-sized computer contains the seeds of a conceptual advance that may bridge the gap between today’s relatively simplminded computer and the elaborate three-dimensional trace of nerve cells in the human brain. Transistors and other circuit elements are fitted so closely together that it becomes feasible to combine thinking circuits and memory units on a single chip. Thus, one cell in the computer’s memory bank can both remember and reason.

This combination of functions is extremely important because a memory chip with thinking capacity can be wired to send out instructions to neighboring chips. Hence, when an instruction is sent to the memory bank to call out the contents—say, an individual’s name—stored in a particular cell or group of cells, the memory cells directly involved can send out inquiries to neighboring cells for related information and produce for the computer user a larger body of information than the user had in mind.

Here we come close to the kind of remembering by association that constitutes such a powerful element in human reasoning. The brain responds to a simple request for information with a large variety of material, all connected with the summoned entity by associations stretching way back into past experience. The thinking process is enormously facilitated by the richness of the brain’s response to such requests, working at the subconscious level by means of the thousands of connections between individual brain cells in a manner as poorly understood. The computers of 1977 are simplistic organisms with capability for subconscious thought but the new advances in electron which will lead to memory—thinking on a single chip, will challenge that.

If the rule of thumb for projecting the state of the computer art continues to hold, then two more generation computer improvement by 1981—bringing us to about 1995—should produce a desk-sized machine that has the memory capacity of some of the thinking power of human brain. Another generation two will see a quasi-human intelligence that can be fitted into a suitcase.

These intelligent machines will undoubtedly be constructed because we will need their help in managing the complex world of the next century. Programmer-tutors will spend perhaps twenty years working with a machine, filling its memory with knowledge and basic skills and developing its ability through graded series of exercises. When the machine’s education is complete, the mind will resemble that of a highly trained Ph.D., with limited experience but strong reasoning power. At the beginning of the twenty-first century, we will come to live in a symbiotic union with these products of creativity, looking to them for specialized, but exceedingly tough, explorations of complex possibilities that cannot be matched by human brain. Lacking our biological inheritance, they will also lack psychological insights; but if we are in a mood for a cerebral conversation, we will find them to be stimulating partners.

What about the twenty-second century? Or the twenty-third? There are no limits yet in sight for the rise of machine intelligence leader in artificial intelligence research. Marvin Minsky of MIT, believes that a machine will ultimately come into being with “the general intelligence of an average human brain... the machine will begin to educate itself... in a few months it will be at a genius level... a few months that its power will be incalculable. And after that? Minsky says, “If we are lucky, they might decide to take us as pets.”
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The Return of Hopeful Monsters

If you start early enough, the creation of monstrous forms is not difficult

Big Brother, the tyrant of George Orwell's Nineteen Eighty-Four, directed his daily Two Minutes Hate against Emmanuel Goldstein, enemy of the people. When I studied evolutionary biology in graduate school during the mid-1960s, official rebuke and derision focused upon a geneticist named Richard Goldschmidt. Although the year creeps up on us, I trust that the world will not be in Big Brother's grip by 1984. I do, however, predict that during the next decade Goldschmidt will be largely vindicated in the world of evolutionary biology.

Goldschmidt was a Jewish refugee from Hitler's decimation of German science. He spent the remainder of his career at Berkeley, where he died in 1958. His views on evolution ran afoot of the great neo-Darwinian synthesis forged during the 1930s and 1940s and continuing today as a reigning, if slightly insecure, orthodoxy. Contemporary neo-Darwinism is often called the "synthetic theory of evolution" because it united the theories of population genetics with the classical observations of morphology, systematics, embryology, biogeography, and palaeontology.

The core of this synthetic theory merely restates the two most characteristic assertions of Darwin himself: first, that evolution is a two-stage process (small, random variation as the raw material; natural selection as a directing force); secondly, that evolutionary change is generally steady, gradual, and continuous.

Geneticists can study the gradual increase of favored genes within populations of fruit flies in laboratory bottles. Naturalists can record the steady replacement of light moths by dark moths as industrial soot blackens the trees of Britain. Orthodox neo-Darwinians extrapolate these even and continuous changes to the most profound structural transitions in the history of life: by a long series of insensibly graded intermediate steps, birds are linked to reptiles, fish with jaws to their jawless ancestors. Macromutation (major structural transition) is nothing more than microevolution (flies in bottles) extended. If black moths can displace white ones in a century, then reptiles can become birds in a few million years by the smooth and sequential summation of countless changes. Change of gene frequencies in local populations is an adequate model for all evolutionary processes—or so the current orthodoxy states.

Many evolutionists view strict continuity between micro- and macroevolution as an essential ingredient of Darwinism and a necessary corollary of natural selection. Still, as I argued last month, Thomas Henry Huxley divided the two issues of natural selection and gradualism and warned Darwin that his strict and unwarranted adherence to gradualism might undermine his entire system. The fossil record with its abrupt transitions offers no support for gradual change and the principle of natural selection does not require it—selection may operate rapidly. Yet the unnecessary link that Darwin forged became central tenet of the synthetic theory.

Goldschmidt raised no objections to the standard accounts of microevolution; he devoted the first half of his major work, The Material Basis of Evolution (Yale University Press, 1940), to gradual and continuous change within species. He broached sharply with the synthetic theory, however, in arguing that new species arise abruptly by discontinuous variation, or macromutation. He admitted that the vast majority of macromutations (for example, two-headed turtles and two-legged sheep) can only be viewed as disastrous—the"monsters." But, Goldschmidt went on, every once in a while a discontinuous macromutation might, by sheer good fortune, adjoin an organism to a new mode of life—a "hopeful monster" in his terminology. Macromutation proceeds the rare success of these hopeful monsters, not by continuous but by discontinuous changes within populations.

I want to argue that defenders of the synthetic theory made a caricat...
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of Goldschmidt's ideas in establishing their whipping boy. I shall defend everything Goldschmidt said; indeed, I disagree fundamentally with his claim that abrupt macro evolution discards Darwinism. Goldschmidt, too, failed to see Huxley's warning that the essence of Darwinism—the control of evolution by natural selection—does not require a belief in gradual change.

As a Darwinian, I wish to see Goldschmidt's postulate that macro evolution is not simply microevolution extrapolated and that major structural transitions can occur without a smooth series of intermediate stages. I shall proceed by considering three questions: (1) can a sonable story of continuous change be constructed for all macroevolutionary events? (my answer shall be no); (2) are theories of abrupt change inherently anti-Darwinian? (I shall argue that some are and some aren't); (3) do Goldschmidt's hopeful monsters represent the archetype of apathy from Darwinism, as his critics have long maintained? (my answer, again, shall be no).

All paleontologists know that fossil record contains precious information in the way of intermediate for transitions between major groups characteristically abrupt. Gradualism usually extracts themselves from this dilemma by invoking the extreme perfection of the fossil record—only one step in a thousand survived as a fossil, geology will not record continuous change. Although I will argue this (for reasons discussed in last month's column), let us get the traditional escape and ask a different question. Even though we have no direct evidence for smooth transitions, can we invent a reasonable sequence of intermediate forms, that are viable, functioning organisms, between ancestors and descendants, what possible use are the imperfect incipient stages of useful structure? What good is half a jaw or half a wing? The concept of "preadaptation" provides the conventional explanation by permitting us to argue the incipient stages performed different functions. The half jaw worked perfectly well as a series of gill-supporting bones; the half wing may have been trapped prey or controlled body temperature. I regard preadaptation as important, even an indispensable concept, and recently defended (Natural History, January 1977) discussing the evolution of a de-
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“fish” on a clam’s rear end. But a plausible story is not necessarily a true one. And, in any case, the issue is not, can preadaptation save gradualism in some cases, but rather, does it permit us to invent a tale of continuity in most or all cases? I submit, although it may only reflect my lack of imagination, that the answer is no, and I invoke two recently supported cases of discontinuous change in my defense.

On the isolated island of Mauritius, former home of the dodo, two genera of boid snakes (a large group that includes pythons and boa constrictors) share a feature present in no other terrestrial vertebrate: the maxillary bone of the upper jaw is split into front and rear halves, connected by a movable joint. In 1970, my friend Tom Frazzetta published a paper entitled “From Hopeful Monsters to Bony-reine Snakes?” (American Naturalist, vol. 104). He considered every preadaptive possibility he could imagine and rejected them in favor of discontinuous transition. How can a jawbone be half broken?

Many rodents have cheek pouches for storing food. These internal pouches connect to the pharynx and probably evolved gradually under selective pressure for holding more and more food in the mouth. But the Geomyidae (pocket gophers) and Heteromyidae (kangaroo rats and pocket mice) have invaginated their cheeks to form external fur-lined pouches with no connection to the mouth or pharynx. What good is an incipient groove or furrow on the outside? Did such hypothetical ancestors run about three-legged while holding a few scraps of food in an imperfect crease with their fourth leg? Charles A. Long (American Naturalist, 1976), has recently considered a suite of preadaptive possibilities (external grooves in burrowing animals to transport soil, for example) and rejected all of them in favor of discontinuous transition. These tales, in the “Just-So Stories” tradition of evolutionary natural history, do not prove anything. But the weight of these, and many similar cases, has dominated our faith in gradualism. More inventive minds may yet save it, but concepts salvaged only by facile speculation do not appeal much to me.

If we must accept many cases of discontinuous transition in macro-evolution, does Darwinism collapse to survive only as a theory of minor adaptive change within species? The essence of Darwinism lies in a single phrase: natural selection is the active force of evolutionary change. No one denies that natural selection will play a negative role in eliminating the unfit. Darwinian theory requires that it create the fit as well. Selection must do this by building upon aptations in a series of steps, progressing at each stage the advantage part in a random spectrum of generational variability. Selection must suspend the process of creation, not toss out the misfits after some other force suddenly produces a new species, fully formed in pristine perfection.

We can well imagine such a role in the Darwinian theory of discontinuous change—profound and abrupt genetic alteration luckily (now and then) making a new species all at once of new force suddenly produces a new species, fully formed in pristine perfection. What is the chance, even in the fullness of time, to produce Mine rather than a deformed monster? Major disruptions of entire genetic systems do not produce favorable—even viable—creatures.

But all theories of discontinuous change are not anti-Darwinian. Huxley pointed out nearly 120 years ago. Suppose that a discontinuous change in adult form arises from small genetic alteration. Problem: discordance with other members of the species do not arise, and the later favorable variant can spread through a population in Darwinian fashion. Suppose also that this large change does not produce a perfected form at once, but rather serves as a new adaptation to shift its posses into a new mode of life. Continual success in this new mode may require a large set of collateral alterations, morphological and behavioral; but may arise by a more traditional, gradual route once the key adaptations forces a profound shift in selective pressures.

Defenders of the modern synthesis have cast Goldschmidt as Goldst of linking his catchy phrase—“hopeful monster”—to non-Darwinian transitions of immediate perfection by found genetic change. But this is what Goldschmidt maintained. In fact, his mechanism of discontinuous change within species?
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in adult forms relied upon a notion of small underlying genetic change. Goldschmidt was a student of individual development. He spent most of his early career studying geographic variation in the gypsy moth, Lymantria dispar. He found that large differences in the color patterns of caterpillars resulted from small changes in the timing of development; the effects of a slight delay or enhancement of pigmentation early in growth were enlarged through ontogeny and led to profound differences among fully grown caterpillars.

Goldschmidt identified the genes responsible for these small changes in timing, and demonstrated that large final differences reflected the action of one or a few "rate genes" acting early in growth. He codified the notion of a rate gene in 1918 and wrote twenty years later:

The mutant gene produces its effect... by changing the rates of partial processes of development. These might be rates of growth or differentiation, rates of production of substances necessary for differentiation, rates of reactions leading to definite physical or chemical situations at definite times of development, rates of these processes which are responsible for segregating the embryonic potencies at definite times.

In his infamous book of 1940, Goldschmidt specifically invokes rate genes as the makers of hopeful monsters: "This basis is furnished by the existence of mutants producing monstrosities of the required type and the knowledge of embryonic determination, which permits a small rate change in early embryonic processes to produce a large effect embodying considerable parts of the organism."

In my own, strongly biased opinion, the problem of reconciling evident discontinuity in macroevolution with Darwinism is largely solved by the observation that small changes early in embryology accumulate through growth to yield profound differences among adults. Prolong the high prenatal rate of brain growth into early childhood and a monkey's brain moves toward human size. Delay the onset of metamorphosis and the axolotl of Lake Xochimilco reproduces as a tadpole with gills and never transforms into a salamander. (See my book Ontogeny and Phylogeny [Harvard University Press, 1971] for a compendium of examples, and pardon me for the unabashed plug.) As Long argues for the external cheek pouch: "A genetically controlled developmental inversion of the cheek pouch may have occurred, recur and persisted in some populations."

Such a morphological change would have been drastic in effect, turned the pockets 'wrong side out' (inside in), but nevertheless it would be a rather simple embryonic change.

Indeed, if we do not invoke discontinuous change by small alterations in rates of development, I do not how most major evolutionary transitions can be accomplished at all. If systems are more resistant to by change than the strongly differentiated, highly specified, complex adults of "higher" animal groups. How could we ever convert a rhinoceros or a mosquito into something fundamentally different. Yet transitions between major groups n have occurred in the history of life.

Sir D'Arcy Wentworth Thompson was a classical scholar, Victorian physicist, and glorious anachronism, a twentieth-century biologist, dealt with this dilemma in his classic treatise Growth and Form.

An algebraic curve has its fundum formula, which defines the family which it belongs. . . We never think of "transforming" a helicoid into an esdoid, or a circle into a frequency curve. So it is with the forms of animals. We cannot transform an invertebrate into a vertebrate, nor a coelenterate into a worm, by any simple and legitimate transformation. . . Nature proceeds from type to another. . . To seek for step stones across the gaps between is to sink in vain, forever.

D'Arcy Thompson's solution was same as Goldschmidt's: the transit must occur in simpler and more similar embryos of these highly divergent adults. No one would think of transforming a starfish into a mouse, the embryos of some echinoderms and protovertebrates are nearly identical.

The year 1854 will mark the 12 anniversary of Darwin's Origin, first major excuse for a celebrat since the centenary of 1959. I hope that our "new speaking" seven ye hence will be neither dogmat nor vious nonsense. If our entrenched priori preferences for gradual begin to fade by then, we may find begin to welcome the plurality of of nature's complexity pvides.

Stephen Jay Gould teaches biogeology, and the history of science Harvard University.
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Social Commentary from the Cemetery
by Edwin S. Dethlefsen and Kenneth Jensen

From colonial times to the present, gravestones have reflected American attitudes toward death, family, and society.

An old and popular New England tradition, for resident and visitor alike, is a relaxing walk through one of our historical cemeteries. In the relief-sculptured death's heads and winged cherubs that adorn eighteenth-century slate headstones, we may admire a fine old folk craft or the more energetic may attempt to decipher the sometimes imaginative epitaphs. With appreciation for the artistry of our colonial forebears may come a sense that the graveyard is an oasis of stability in a world that is otherwise changing at a rapid rate. Stable as it may appear, the old cemetery is a remarkably sensitive record of change, representing successive generations, each with its own distinctive set of values and ways of perceiving the environment.

Haphazard rows of slate tablets give way in time to simple marble tablets bearing urn and willow motifs. The latter in turn lose popularity to marble gravestones of a variety of sizes and shapes and often arranged in groups or family plots. The heyday of ornate marble memorials lasted into the 1920s, when measured rows of uniformly sized granite blocks replaced them. The most recent development in cemeteries has produced parks of rolling lawns, their necropolis smoothness scarcely broken by rows of slight indentations in the grass, where small bronze or concrete markers record the names and numbers of those who lie beneath.

Surely these are vast changes to have accrued within a mere few centuries. The differences among Egyptian, Greek, and Roman architecture are hardly more diverse, even though they involve millennia, as well as the cultures of different nations.

The early colonists saw and dealt with their world in specific ways. The winged death's head, the most popular motif before 1760, represented the mortal remains of the deceased and was followed by winged cherubs representative of the immortal soul. By 1800 the ethereal, but impersonal, urn and willow motif had replaced all other pictorial references to the deceased individual.

Epitaphs on these stones of the late Revolutionary and early Federalist periods tend to memorialize the living personality rather than to mark its demise. One typical epitaph of this period, from Shrewsbury, Massachusetts, reads:

In Memory of Mrs. Hannah, Wife of Mr. Simeon Ide, Who Died April ye 18th, 1792 in ye 22nd year of her age. Endear'd to her friends by those amiable Virtues, which dignify human nature, and renders it desirable, even with its miseries.

But many gravestones of the earlier, colonial days speak not at all of memories. Consider this one in Lee,

In colonial New England cemeteries, such as Boston's Granary Burying Ground, most gravestones are adorned with sculptured death's heads.

S Green-Armytage, Photo Researchers
IN GOD WE TRUST

DIED
SEPT. 6, 1856.
F. A. C.

Daniel Clark
As a model of terrace and finality:

Here lies ye body of Hanna Joannes Wife of Ebenezer Joannes. Ages 31 years & 5 mo Died May 4, 1745.

Although not all inscriptions of the kind were so short, many include more than vital statistics, with an occasional phrase to remind us that death awaits us all.

Such sentiments and attitudes can range so much in a few generations, we can hope to understand the views our ancestors held of worlds they lived in? Literary historians may explain the psychology of our predecessors by examining often descriptions and characterizations, but in doing so, they must be with or ignore the lurking suspicion that writers were almost always exploiting group whose words did not necessarily reflect the attitudes of the clan folk. On the other hand, evensone dies, and survivors of the deceased memorialize that event with gravestones and epitaphs reflecting attitudinal attitudes of the times.

The lack of individuality in our modern cemeteries, much to the regret of those of us seeking a return to unimposing or, perhaps, quaintness, signals the continuation of a process begun decades ago—this cens is in a statement about change in American culture. If evidence of folksy individualism has disappeared from the cemetery, along with the Edwardian volubleness of its marble memorials, there must be reason or a complexity of reasons for the disappearance.

There is more to a gravestone than design at the top. Many have distinctive shapes and arrangements of words on them, references to groups which the deceased was once a part of, and even differences in the materials of which they are constructed. Gravestone decorations may vary greatly; often they are incised, but they also come in the form of grave accompaniments such as borders around family or individual plots, planted flowers or shrubbery, plastic or cut flowers and their containers, toys, candles, seashells, and so on. Even the position of the name on the gravestone may be indicative of changing cultural concerns.

While it is esthetically intriguing to examine one gravestone at a time, each memorial is also an integral part of an entire cemetery. The most revealing hints about American culture are the cumulative impressions of the various time and style periods represented in the cemetery.

A colonial or early American gravestone, for example, usually represents only a single individual. Occasional exceptions were children, mother and child, or husband and wife, any of whom may have sometimes shared the same gravestone. In modern community cemeteries from Maine to Florida, however, more than half the gravestones erected since 1950 represent two or more people. Nor is the arrangement random within a family. In more than 90 percent of contemporary grave stones, the shared monument represents a husband and wife. In many instances one member of the couple is still living; in some cases neither spouse is deceased. One elderly cemetery keeper in Florida proudly showed us the plot and stone already engraved with his and his wife's names, which they had carefully selected for their resting place.

We have also observed that in most southern cemeteries, the wife's name on recent gravestones is usually on the right, while in the north the placement of names is quite variable. As a variation on this theme, in some central Massachusetts villages with populations of eastern European descent, wives' names on gravestones consistently occupy positions below those of their husbands. While these observations are so obvious as to have gone largely unnoticed, they are of interest because they represent certain attitudes of contemporary Americans and, as such, demand explanations that may help us interpret evidence of the more distant past.

Colonial and early American husbands and wives were seemingly not greatly concerned about being buried side by side or about who was buried on which side of whom, but they did seem preoccupied with family solidarity, religious fervor, and wealth. This concern extended through the romantic Victorian and post-Victorian eras up to the 1920s.

Obelisks in countless family plots point out the heavenly resting places of those buried in them, with the individual graves marked by rows of simpler stones. Consider this simple, but intriguing, inscription on a large granite block in a Keene, New Hampshire, family plot:

Patrick Cooney 1845
Mary Cantwell his wife 1855
Lawrence Cooney 1871-1906
Mamie Cooney 1878-1885

While the significance of the arrangement of names on the stone is clear, the pattern of burials within a plot follows no rules. In family plots, husbands and wives rest in opposite corners just as frequently as side by side. Since a large proportion of burials, from colonial times through the 1920s, were in family groupings (more often identifiable as family plots, set off by a fence or border, in the nineteenth and twentieth centuries) there appears to have been a reasonable assurance that wherever one's remains were interred they would be in a friendly neighborhood. As often as not, children and other kin were buried between the remains of spouses, the burials arranged in the chronological order of death more often than according to specific familial relationships.

The appearance of formal family plots in the mid-nineteenth century suggests the social attitudes of the living community. The erection of ornate marble monuments in the family plots of upper-class families, as opposed to the simpler memorials erected by less wealthy people, may be an expression of the increasing social and economic stratification that occurred with the industrial expansion of the nineteenth century. It may also be a result of an increase in population density beyond the point where the deceased, buried at random in the
An

Here lies the body of

JOHN JACK,
A native of Africa who died
March 1773, aged about 60 years
Tho' born in a land of slavery,
He was born free,
Tho' he lived in a land of liberty,
He lived a slave,
Fif by his honest tho' stolen labors
He acquired the source of slavery,
Which gave him his freedom.
Tho' not long before,
Death the grand tyrant,
Gave him his final emancipation,
And set him on a footing with kings.
Tho' a slave to vice,
He practised these virtues
Without which kings are but slaves.
cemetery, had a reasonable expectation of lying among friends.

As burial patterns changed, so did gravestone materials. Gravestones of slate, so common during the colonial period, gave way by the mid-nineteenth century to marble. Slate, which consists of compacted layers of stone, is fine for engraving but not for elaborate sculpture. Also, because of slate’s physical structure, gravestones made of that material are necessarily tabular in form and cannot be easily quarried in blocks like marble. Dark in color, slate invited the traditional colonial death’s head and even cherub. But the urn and willow signs and epitaphs of the later period, which spoke of the eternal life of the soul, demanded a lighter-colored material that lent itself to new interpretations of death. Although the obelisk form of gravestone, wrought in marble, survived into the Victorian period, it was accompanied by increasing numbers of pulpit and obelisk forms, scrolls, crosses, and a variety of statuary, some imported from Europe by wealthier families. While family plot often included a large obelisk representative of the family as a whole, the individual grave was so marked by as decorative a stone as family finances and the importance the deceased would permit.

Epitaphs also changed over time. In contrast to the terse epitaphs of the colonial period, such as “He lived and died lamented,” those of the Victorian period are generally ei-

Most colonial epitaphs are terse accepting of death. The one left is unusual in a number of respects, not the least being that it was erected in memory of a slave. The death’s head colonial gravestones, top right, representative of humanity’s mortality, gave way in popularity to the more sentimental, immortal cherub. Center right, at the end of the eighteenth century, when the usefulness of Puritanism was diminishing. In the 1800s, the urn and willow replaced the cherub, continuing the attempt to accept death’s reality.
ther eulogistic of the deceased or worshipful of God. Following on the late stages of depersonalized death as exemplified by the urn and willow, the new stone forms and epitaphs appear to deny death altogether. Some typical ones are “Asleep in Jesus,” “At Rest,” “Not Dead but Sleeping,” and “In My Father’s House Are Many Mansions.” Also common are biographical statements about the deceased. Kin references to wife, son, daughter, and brother are also popular during this period, suggesting that family was taking greater ascendancy over community in the individual values and loyalties of the time.

During this period, references to God were more popular than in the eighteenth century, and the formerly omnipresent urn and willow now competed with lambs, doves, flowers, angels, crowns, crosses, heavenly gates, wreaths, and bibles, all in unprecedented variety. The Victorian era was a time of social and economic differentiation in America, an age of technological and intellectual exploration, and a period when practically any kind of behavior could be blamed on God.

Memorials to the successful are evident far beyond the cemetery as well as in it: witness the solidity and massiveness of public philanthropies of the industrial and economic giants of the time. The burial place of the man who had endowed the local library was usually marked by the biggest monument in the cemetery. The remarkable variety of the Victorian cemetery is itself an assurance that regimentation was not a characteristic of the time, but that competitiveness and creativity were prime virtues.

The 1920s marked the beginning of the modern period in cemetery change. Elaborately sculptured marble and flowery epitaphs rapidly faded in importance, ultimately to be replaced by stark and massive blocks of polished granite, whose impression of durability is far greater than that of either marble or slate. The time was further marked by the full bloom of assembly-line industry in place of handcrafting. It was marked, too, both by the decline of social Darwinism and by a movement toward egalitarianism that has continued its momentum up to the present. The wealthy no longer cared to call attention to their wealth. At the same time, the population of the United States climbed well beyond the hundred million mark. The combination of these last two elements perhaps prompted a general return toward simplicity and uniformity in the cemetery marker and plot. Granite headstones took the form of rectangular blocks inscribed either on their vertical faces, on their flat, slanted, or vaulted tops, or less commonly, on polished horizontal slabs.

Epitaphs are no longer common. When they exist at all, they are usually reduced to a few, remarkably unoriginal phrases such as “At Rest,” “In Memory of…” or “Gone but Not Forgotten.” References to God and heaven are rare. Their repetitiveness conveys the impression that they are employed as secularized formalities, rather than as expressions of primary values. We found one reverent but enterprising couple still living in Florida, however, who had the foresight to inscribe on their already erected gravestone the message, “To God With Love.”

Another contemporary type of gravestone is that provided for veterans by the United States government. This takes the form of a simple granite, marble, or bronze tablet and is a specific indicator of what we know to be an important aspect of cultural change in America—the increasing paternalism of government.

From cemetery evidence, we are tempted to suggest that the values of modern Americans have gone underground. The distinguishing aspects of the modern cemetery are the succinct gravestone inscriptions and the deliberate pairing of husbands’ and wives’ names. From the 1950s to the present these stones appear with such frequency that one wonders what has happened to the unmarried people. “Son” and “daughter” have all but disappeared from the cemetery. Infant and child mortality were all but eliminated during the second quarter of this century, so perhaps children simply moved away to establish families of their own.

A related side effect of twentieth-century cultural development has been a 30 to 40 percent increase in life expectancy, adding greatly to the number of married couples who, having lived into old age, spend their later years in childless homes. Consequential increase in the emotional importance of the wife—husband relationship is clearly visible in the high proportion of shared memorials. Nor can we entirely ignore implication that the devotion to, dependence upon, God so evident from the colonial period through the early nineteenth century and the portance of family in the Victorian period have been replaced in modern times by an emphasis on a strong, durable husband—wife bond.

Most of our historical community cemeteries are fully occupied, and remainders are nearly so. The era of community cemeteries that began with the Pilgrims is thus at an end. Few of us will be buried among our ancestors; this in itself represents a change in our view of death and associated emotions and rituals. Large numbers of people are now buried in memorial parks, where the successions of change in mortuary attitudes is again evident in the absence of denial of individuality. Instead, emphasis is on a peaceful, quiet environment, where the dead may rest in relative anonymity in egalitarian ranks of a multistoried mausoleum or in a memorial lawn, marked only by a flat tablet set at ground level to allow unimpeded passage of a lawn mower.

Because nostalgia is often a pleasant emotion, many of us deplore the passing of the historical cemetery. But progress and culture travel hand in hand. While the old common cemetery remains a quiet and pleasant place in which to meditate about the lives of those who went before us, the expansion of the memorial park is inevitable as was the replacement of marble by granite. The new cemetery is but another product of our cultural adjustment, and as such, future generations of strollers will find it, too, an absorbing place in which to look for, and think about, the lives of the predecessors.

The community cemetery is an entity of the past. As families have lost much of their geographic cohesiveness, modern gravestones have their geographic cohesiveness.
Monarch Migration
by Lincoln P. Brower

A butterfly weighing a fraction of an ounce flies thousands of miles to a recently discovered wintering spot in Mexico.

The monarch butterfly belongs to the Danaidae (or milkweed butterflies), a family that occurs throughout tropical regions of the world. Most of the species of this family lay their eggs only on milkweed plants. After hatching, a monarch caterpillar voraciously consumes the milkweed leaves, passes through five larval stages in about two weeks, undergoes metamorphosis into a chrysalid, and about one week later emerges as an adult butterfly. After about three days, adults are ready to mate and a new generation begins. The rate of development is temperature dependent, so that the number of generations varies from year to year.

During the past several million years, milkweeds underwent a remarkable evolutionary diversification in North America. Across the continent, including Mexico, there occur no less than 108 species in the genus Asclepias alone. This array of milkweeds represented a vast potential food supply for the danaid butterflies. However, these insects evolved in tropical climates, and no stage of any danaid butterfly—egg, larva, chrysalid, or adult—is known that can survive prolonged freezing temperatures such as those that occur in temperate North America. Breaking this climatic barrier was a major challenge, and the monarch, Danaus plexippus, is unique in being the only species in its family that has succeeded. Having evolved the ability to migrate, the monarch is able to exploit the North American summer food supply of milkweeds and then retreat southward to overwinter in areas free from excessive cold.

The migration of the monarch is very different from that of birds because the individual butterflies that fly south in the fall are several generations removed from their ancestors that flew north the previous spring. Their annual return to the overwintering grounds is thus a complex, inherited behavior pattern in which learning plays no role.

The monarch's migration strategy is highly successful; through several short-lived summer generations, of from three to five weeks each, the species builds its populations to immense numbers. Throughout the continent, as fall approaches, the last generation of adult butterflies begins congregating locally, and by mid-September, the monarch populations are in full migration. In the far west, the butterflies fly southward and westward toward coastal sanctuaries from north of San Francisco to Los Angeles. The butterflies congregate in moist groves of Monterey pines or eucalyptus trees far enough from the sea to avoid winter gales, but close enough to protect them from heavy winter frosts. The most famous California overwintering colony is in Pacific Grove, but scores of other sites exist.

Although migration routes and overwintering sites west of the Rocky Mountains are fairly well documented, a long-standing mystery enshrouded the fate of monarch popu-
ions eastward to the Atlantic coast. Small winter-breeding colonies occur in Florida, but it seemed unlikely that these could sustain and provide sufficient numbers of butterflies to migrate there again in the spring to repopulate the eastern half of the continent. Reports of large movements of monarchs along the Gulf Coast and eastward through Texas during the 1970s had long led scientists to suspect that the butterflies overwinter somewhere in Mexico.

During the winter of 1974, lepidopterist Kenneth Brugger, after a long search, finally solved the mystery at least one vast colony of overwintering monarchs occurs high in the mountains of central Mexico. I have long been interested in the monarch butterfly’s relationship to milkweeds from which it derives poisonous chemicals as well as sustenance. These poisons, cardiac glycosides, provide the butterfly with a considerable measure of protection against birds and probably other predators as well. If a bird eats a monarch that has fed on a poisonous milkweed, the bird will suffer a bout of debilitating. Although it soon recovers, the bird remembers its unpleasant experience and will not attack monarchs for a long period of time. In our research, my wife, Christine Moffitt, and I have found that not all monarchs are poisonous; those that are, vary in their toxicity to birds. In other words, there is a palatability spectrum in the monarch, which is determined by the milkweeds it eats during its caterpillar stage. Some milkweeds are not poisonous; others are slightly poisonous; still others extremely so.

Furthermore, most milkweed species have a characteristic array of cardiac glycosides, and it is possible to fingerprint captured wild monarchs by analyzing their chemical constituents, determine which species of milkweed they ingested as larvae in their natural habitats. Since we discovered this remarkable relationship in monarchs from the California overwintering areas, we predicted it would also be true of the butterflies in the Mexican colony. I was thus keen to visit the newly discovered site in Mexico.

In order to protect the overwintering site, in which millions of monarch butterflies cluster in a three- to four-acre area, the research team working there refused to divulge its location, even to other scientists. One of the researchers, Fred A. Urquhart of the University of Toronto, did publish a popular article in which he mentioned the altitude and general location of the site in a mountainous area of northern Michoacán. Armed with this information, and through a long, complicated, tedious, and frustrating piece of detective work involving a number of people, a member of our research team, William Calvert, located a massive overwintering colony on December 31, 1976, which he thought was the same one Brugger had discovered in 1974. Since we have been unable to ascertain whether the two sites are one and the same, we have designated our overwintering colony as “Site Alpha.” Our team immediately proceeded to Mexico, and with Calvert in the lead, we headed for the location where he had spotted the colony.

At first, we could not find the butterflies because the day was overcast, and they were inactive. But as we walked farther down a slope, I noticed changes in the patterns of light through the trees and realized that we were in the midst of the overwintering monarchs, occurring in such dense clusters that they vividly altered the appearance of the forest. Our first impressions were overwhelming, not only because of the incredible numbers of butterflies assembled in one location but also because of the profound biological implications of the phenomenon.

Although Site Alpha is more than 100 miles from the sea, its geographic location results in moderating climatic conditions, probably similar to those of the coastal overwintering areas in California. The colony is located in the trans-Mexico volcanic belt, close to the continental divide. The area, at an altitude of more than 9,000 feet, is moist and supports a mature forest community consisting mainly of firs, pines, cypress, and several smaller deciduous tree species. The firs dominate the forest in numbers and size and attain heights of at least 95 feet. Pines and then cypress are the next most abundant trees. The forest floor is carpeted with a lush layer of mosses, and the trees bear many mesic-loving lichens and ferns.

Even though overwintering occurs during the dry season, the area is high enough that clouds frequently roll across it, and in the evenings the humidity rises to 100 percent. This moisture is important because it protects the monarchs from desiccation when they are immobilized by low temperatures. Three other factors en-

Adult monarchs feed on nectar, but flowers, such as the lupine, above, are not plentiful at their overwintering site in Mexico. Fats, from nectar eaten in the fall, may sustain them.

George D. Lapp
hance the favorable moisture conditions of the colony: a cool exposure on a north-facing slope, a sheltered location about 200 feet downslope from the windy ridge crest, and proximity to the headwaters of a mountain stream.

We determined that the colony occupied an area of about 3.7 acres. We also estimated the number of butterflies at the site based on data from a study done in California. From autumn 1975 through the spring of 1976, my colleague Paul Tuskes utilized the mark, release, and recapture method in an overwintering grove at Santa Cruz and determined a peak abundance of 92,000 butterflies in February. The density of the butterflies on the trees at Site Alpha was at least ten times greater than at Santa Cruz, and the area was fifteen times as great. By multiplying this difference in area and butterfly density for Mexico by the number of butterflies at Santa Cruz, we obtained a value of 13.8 million butterflies at Site Alpha. This is a very conservative estimate, and we believe it is well within the realm of possibility that there are as many as 100 million butterflies overwintering in this one Mexican locality.

In California, most of the overwintering colonies occur in disturbed habitats with a rather uniform vegetation of either Monterey pine or introduced eucalyptus trees. In contrast, the natural community at Site Alpha has a diversity of tree species, which also vary in size. This provides different substrates for the butterflies and, in turn, results in a variety of cluster shapes, sizes, and organizations.

The scaly cypress leaves seemed to provide the best foothold; these trees were often so profusely covered with monarchs that it was nearly impossible to see the foliage. Some of the smaller trees were actually bowed over by the collective weight of the monarchs. On pines, the butterflies clustered among the needles in such numbers that whole branches seemed covered with jagged ornaments. The shorter needles of the firs provided less grasping surface, and many branches were transformed into surrealistic cylinders of butterflies. The trunks of many trees were also packed with butterflies, all aligned vertically and so close together that they obscured both the bark and the bases of dead branches, which protruded in a seemingly mysterious manner.

At night, early morning, late afternoon, and on overcast days the only movement in the clusters was that of the laden branches swaying gently in the breeze. During these times the monarchs clung tightly to the leaves, branches, and each other, and only the somber colors of their tightly oppressed wings were evident. Because butterflies are virtually dormant at low temperatures, cool periods are times of energy conservation for them.

Since the clustering behavior of the monarch is so controlled by temperature, we decided to study the relationship in more detail. During our stay we measured the temperature range in the center of the colony at heights of approximately 0, 16, and 33 feet. Even though two of the five days were brilliantly clear and three were partly to totally overcast, minimum temperatures ranged from only 42° to 48°F; maximum temperatures from only 56° to 60°. These findings indicated that the site is thermally quite stable and, equally important, that the maximum temperature was at the threshold at which monarchs can fly.

The critical nature of this temperature threshold was underscored one day by an unplanned, macabre incident that occurred when our guide, whom we had left in charge of our experimental equipment, built a fire under the trees. (As it turns out, the local people frequently bring their cattle to the site to feed on the monarchs. To facilitate this practice, the herdsmen build small fires beneath the clusters, and as the smoke rises

Clusters of overwintering monarchs, hung from the trees at Site Alpha in Michoacán, Mexico. Thirty to 100 million may be using the 3.7-acre area, and some clusters are so heavy that the tree branches bend and even break. Overleaf: Monarchs are packed so tightly against a cypress tree that only the outlines of a few branches are visible.
the monarchs release their grip and drop en masse to the ground.) I arrived on the scene to find a circle of forest floor, about forty-five feet in diameter, covered with layers of butterflies. This was late in the afternoon of a predominantly overcast day with the temperature about 55°. The butterflies flapped helplessly on the ground until they settled into a prolonged thermoregulatory shivering in an attempt to warm their thoracic wing muscles. Because the ambient temperature was too low, most of the butterflies could not attain the critical 59° to 61° that would have enabled them to fly back to a cluster. The next morning nearly all were found to have crawled from a few inches to about three or four feet up onto vertical faces of rocks or small plant stems.

We observed that the butterflies did not form clusters in the tops of the taller trees and reasoned that this decreases their chances of being blown down during cold periods. Another advantage in concentrating the clusters below the canopy became evident on the morning of January 23. In the clearing where we camped there was heavy frost on the ground, but beneath the butterfly trees in the forest the temperature was 42°. Thus, the tall trees not only act as a windbreak but also provide an umbrella against frost. Snowfall is another danger besetting butterflies that are dislodged from the clusters, since it would cover and totally immobilize them.

Although traumatic, our guide’s small fire provided valuable scientific information: since the butterflies are unable to return to their clusters if their thoracic temperature is less than about 55°, they are easy prey to mice and other mammalian predators. In fact, numerous dead butterflies were on the ground and looked as if they had been partially eaten by mammals, although hard evidence at Site Alpha has not yet been gathered. At a colony in Montaña de Oro State Park in California, I found several caches of wings beneath sticks and next to tree trunks adjacent to the overwintering trees—clear evidence of mammalian predation.

Monarchs are dislodged not only by storms and the possible breaking of branches, but also by birds attacking them or moving about in the trees while engaged in other activities. On
January 26, an overcast day, my assistant Lee Hedrick observed a small flock of Bullock's orioles fly into a fir tree that had no roosting monarchs. From this tree they flew singly to an adjacent fir laden with monarchs and, upon landing, displaced several butterflies, which either dropped to the ground or glided off into the forest. For about forty-five minutes, the birds dislodged occasional butterflies. Although we did not witness ingestion per se, one monarch wing floated down with a small piece of thoracic muscle still attached to it. We also heard the birds snapping their beaks while moving about in the vicinity of the clusters. A year earlier at Santa Cruz, we had observed western chickadees attacking and capturing several monarchs in the clusters.

Two other patterns of apparent bird predation occurred extensively along a logging cut that bordered one side of Site Alpha. We found numerous individual wings littering the forest floor and also saw many maimed, but still living, butterflies—some with one or more wings missing; others lacking their abdomens. One of the latter, in fact, fell out of the sky directly in front of me. I had noticed similar apparent predation in January and February 1974 at Santa Cruz and Montaña de Oro State Park.

Whether wild birds eat monarch butterflies was hotly debated earlier in this century. There is now no doubt that they do, and this raises the interesting question of how they cope with butterflies that contain emetic doses of cardiac glycosides obtained from milkweeds. My long-term assistant Susan Glazier and I have experimented with blue jays at Amherst College and have found that these birds learn to taste-discriminate the poisonous from the nonpoisonous monarchs and eat only the latter. It is tempting to hypothesize that the wild birds at Site Alpha and Santa Cruz were doing this, too, and the number of partly eaten butterflies on the ground would tend to support the hypothesis.

Over-all, natural mortality seemed to be low at Site Alpha. Upslope from the colony, however, dead butterflies littered the ground to such an extent that an odor of decomposition was strongly evident. This did not seem natural, and I wondered what had
caused it. Our guide provided the answer. On our third visit to the colony he brought a bag of salt, which he used as bait to lead cattle to the butterflies. Having previously shown us the effects of a small fire, he now shook the monarchs off several of the smaller trees. Because of the cold, the monarchs flapped helplessly on the ground, and the cattle ate them by the thousands and trampled countless others. Once inside the colony, the cattle bumped into smaller trees and dislodged large clusters of butterflies.

When Calvert first arrived at the site, the colony extended farther up the hill where the decomposing monarchs lay. We believe that the local herdsmen may have eradicated as much as 20 percent of the colony by smoking the butterflies out and shaking them off the trees for the cattle.

The general appearance of the majority of the monarchs at Site Alpha was of exceptionally high quality compared with butterflies from several overwintering sites in California that I have examined. Few butterflies were tattered, and the abdomens of most appeared robust, indicative of a healthy physiological state. In examining a number of collected specimens, I noticed a very high body moisture content; also that the gut was frequently filled with a watery fluid. Because of previous observations in California, where many monarchs fly out of the overwintering colonies on warm days and feed at flowers, my initial thought was that this was nectar.

We had hypothesized that the availability of nectar might well be an important factor in determining the location of overwintering sites in Mexico. Thus, one of our objectives at Site Alpha was to record the available nectar sources and the extent to which the butterflies utilize them. Several species of herbaceous plants were in flower, and we found monarchs nectaring on *Lupinus*, *Senecio*, *Stevia*, and *Bidens*. This is a montane coniferous community, however, and the flowers that normally occur here proved to be vastly outnumbered by the monarchs. Moreover, most of these plants were growing in open areas cleared by recent lumbering, and it soon became obvious that they could provide but a negligible amount of nectar for the butterflies.

On the second clear day at Site Alpha we determined the source of the monarchs' high moisture content. The butterflies appeared to be flying downhill along a draw on one side of the colony, so we followed them. A number of spring sites became evident, and wherever the sun shone upon moist areas, hundreds of butterflies were drinking. Still farther down, the draw intersected a creek where clouds of butterflies were flying about. Along the creek's edge and on rocks in its midst, thousands of monarchs were imbibing water.

Virtually all of these drinking butterflies were simultaneously basking. Since the shade temperature (56°F) was below the critical flight temperature (59° to 61°F), I reasoned that they were thermoregulating to assure their ability to escape from sudden shading, should it occur either because of clouds or the shifting angle of the sun. Late in the afternoon, observations on the hillside above the colony supported this hypothesis. At about 4:30 p.m., masses of monarchs passed eastward overhead and then veered to the north, back toward the clusters in the center of the colony.

During this return I watched the butterflies against the blue sky for about twenty minutes and noticed a peculiar pulsing in their numbers as they passed by. This, together with a definite patterning of their flight, suggested the ordered movement that one often sees in schooling fish. It seems likely that these oriented mass movements are based on some kind of an interindividual spacing mechanism. This could be visual, but it might also involve the following of aerial pheromone trails produced by the flying butterflies.

Butterflies at Site Alpha drink water from wet moss on the forest floor. A high body-moisture content is important to prevent desiccation. While drinking, the monarchs also bask, insuring that they will be warm enough to make the return flight to their clusters as evening and lower temperatures approach or when clouds shade the sun.

George D. Lapp
The migration of the monarchs, which culminates in the overwintering colonies, is controlled by seasonal changes. As fall approaches, the last generation of monarchs produced across the North American continent is subjected to decreasing day lengths and lowering temperatures. In a series of experimental studies, zoologists William Herman and John Barker of the University of Minnesota have found that these two factors in combination trigger the neuroendocrine system of the monarch to produce a juvenile hormone that represses gonadal maturation in adults. Although details of the control mechanism are not well understood, it is clear that monarchs of the fall generation are physiologically and behaviorally distinct from those of the summer generations in ways that make their southward migration possible. These differences include the repression of egg and sperm development, a nearly complete quelling of courtship and mating activities, a loss of oviposition response to milkweeds, the development of social nectaring assemblages, and the development of late afternoon aggregation behavior that results in temporary nocturnal cluster formation. As these behaviors emerge, they combine with a tendency for the butterflies to fly generally southward, and by mid-September the mass migration is under way.

The beak mark of an avian predator is clearly visible on a monarch wing, above. Birds feed on monarchs because there is a palatability spectrum in these butterflies. How palatable an individual is depends on the species of milkweed it fed on as a caterpillar. Some milkweeds carry no toxins, others are highly poisonous. This monarch probably escaped because the bird had learned to taste unpalatable butterflies from a previous experience and quickly released its catch. In a controlled experiment, sequence right, a bluejay with no experience with monarchs is fed a butterfly that was reared on a toxic milkweed. Shortly after ingesting its meal, the bluejay began to show signs of being uncomfortable. Vomiting spells followed. This bird thereafter refused to touch any monarchs that it was offered. In the wild, some birds apparently feed on monarchs until they ingest a poisonous one. Remembering the taste of the cardiac glycosides, the birds then avoid monarchs or immediately release poisonous individuals. Because some birds will attack them, monarchs are sensitive to their presence. At far right, a cluster of overwintering monarchs in California explodes into flight as birds approach.
Some of the butterflies at Site Alpha may fly in from the northernmost edges of their range, from northern Maine or Alberta, Canada, for example, a distance of at least 2,400 miles. If we assume that the mean distance flown by a monarch to Site Alpha is 1,500 miles and that the mean distance of the northward spring flight is another 1,000 miles, then the average Site Alpha monarch will have flown about 2,500 miles over its life-span. Now that we are certain of the massive overwintering in Mexico, this feat assumes awesome proportions.

We do not have much information on the return spring flight, but Urquhart and others before him have argued, probably correctly, that some may live on and disperse their eggs throughout the spring, thus surviving perhaps as long as nine months.

How can a butterfly, which weighs little more than half a gram (about one-fiftieth of an ounce) fuel its southward migration, survive several months with no significant access to nectar, and then perform the northward migration? Part of the answer is the energy obtained from the milkweed leaves eaten during the larval stage. This is conserved throughout metamorphosis into the adult butterfly where it is stored in the cells of an extensive abdominal organ known as the fat body. Fall migrants do have a high fat content, and in our earlier analyses of cardiac glycosides we noted that the abdomens of many migrating and overwintering monarchs were virtual butterballs. A previous study determined that, on the average, fat made up 34 percent of their dry weight.

Biologist L. A. Schroeder has reported that monarch larvae can convert as much as 81 percent of the carbohydrate present in milkweed leaves into lipids (fats). If we assume that a similar biosynthetic transformation can take place in the adults, nectaring aggregations during the fall flight may well be refueling stops of major importance to the successful overwintering in Mexico. This speculation is consistent with the results of a dissection sample of 111 females we obtained at Site Alpha. Seventy-five percent not only had well-developed fat bodies but also contained moderate to extensive amounts of free lipids, which oozed out as yellowish droplets when dissected under water. It would appear, then, that the fall migrants are well served by the great numbers of fall flower composites that occur between the Atlantic coast and the Rocky Mountains.

By dissecting the abdomen of a female under a microscope, it is possible to examine the ovaries and determine the extent of egg maturation. In our sample of 111 females, we found no indication of mature or maturing eggs. This sample also enabled us to determine the extent of sexual activity. We suspected that it was minimal because during our entire stay I observed less than a dozen mating pairs. In butterflies, mating results in the secretion of a distinctive spermatophore (a small sac of sperm) inside of a specialized female organ known as the bursa copulatrix. As the sperm are used up, the spermatophore collapses, but it has a neck that remains intact. It is therefore possible to determine the number of times each female has mated. We found that 85 percent of the 111 females were virgin, 11 percent had mated once, and 2 percent each had mated two and three times.

The lack of both egg development and mating activity indicated that the overwintering colony at Site Alpha was largely in a state of reproductive diapause at the end of the third week in January. The conclusion seems inescapable: reproductive diapause is an adaptation that results in the suspension of heavy, energy-demanding activities, thereby greatly increasing the chances of surviving the winter and executing a successful northward migration in the subsequent spring.

Experiments by Herman and Barker have demonstrated that egg development in the monarch is minimal to absent at day lengths of less than 11 to 12 hours and temperatures of less than 68°. Site Alpha is at approximately 20° north latitude, where on December 22 (the winter solstice) the day length is 10 hours and 48 minutes. At this latitude, the day length increases by 48 seconds per day, so that by February 1 it would be about 11.3 hours, with the stage set for mating to be triggered by the seasonally rising temperature. Thus, at the time of our visit to the colony, it is likely that the monarchs were primed for reproduction, as far as day length was concerned, but were repressed by the seasonally normal low temperature which reached a maximum of 60°.

The dual-control mechanism of day length and temperature seems ideally suited to promote the reproductive success of the overwintering monarchs. Since oogenesis occurs slowly at low temperatures and does not peak until 82°, the mated females are free to leave the colony and migrate northward, initially unencumbered with large numbers of eggs, but with an increasing rate of egg maturation as both seasonal temperature and day length increase.

It is unlikely that overwintering monarchs in the monarch butterfly in Mexico is geographically restricted as it now seems. I predict that, as is true in California, numerous Mexican overwintering colonies will be discovered at locations having ecological characteristics similar to those of Site Alpha. The principal reason for this contention is that roosting in a very limited area would make the species highly vulnerable to fire. Not only does the overwintering occur during the dry season, but this area is in the trans-Mexico volcanic belt. Past volcanic activity must have set man-made fires, and from our observations, large-scale fire could easily decimate an entire colony.

I concur with the original discoverers' desire that the precise location of Site Alpha not be made public until steps have been taken to protect it. This overwintering colony is certainly a prime example of one of the most spectacular natural phenomena in the world. Unfortunately, as is true of many important biological areas, Site Alpha is threatened by lumbering and cattle. A coordinated international effort should be mounted as soon as possible to protect this extraordinary site from what could be inevitable destruction in the not too distant future.

Monarchs in clusters will spread their wings and turn their wings to face sunlight. On cloudy days butterflies remain dormant thereby conserving their energy.
All an alligator wants is to bellow and head slap, engage in leisurely sex, and have a protective mother.

Two crocodilians live within the continental United States. The American crocodile (Crocodylus acutus), a widespread tropical New World species, has been reduced to about 200 individuals that inhabit some of the Florida Keys, Florida Bay, and areas in Everglades National Park. This species is threatened by the continuing loss of its coastal mangrove habitat and by human-caused mortality from automobiles on local roads and destruction of nests. The other species, the American alligator (Alligator mississippiensis), is endemic to ten southern states from Texas to North Carolina. Its fortunes have fluctuated in the last 200 years. Historically, alligators were either treated as vermin or exploited for their economic value. Young alligators were killed, stuffed, and sold as tourist curios, while shoes and handbags were manufactured in large quantities from the hides of adults. Sharp downturns in alligator numbers were noted by the turn of the century. During the next five decades the American alligator population decreased so dramatically that, in the late 1950s and early 1960s, some states passed protective legislation. In 1967 the American alligator was listed as an endangered species. Under state and federal protection the alligator began a slow but noticeable recovery in some areas. By 1972 the state of Louisiana, a front-runner in alligator research, management, and commerce, decided that the species had recovered its numbers sufficiently in three parishes (counties) to permit annual controlled hunting in early fall of several thousand alligators for their hides.

As of February 1977, the alligator was reclassified as “threatened” throughout most of its range. This establishes both the killing of alligators “in defense of human life” and the sale of hides obtained in this manner. The changes in federal regulation have been justified by census data collected by game commissioners in affected states. Although attempts have been made to standardize censusing among states, the danger that the loosely collected figures may be overestimates. Florida, for example, claims to be overrun with...
half-million alligators and is swamped with complaints from residents. In order to alleviate the pressure on harried Game and Fresh Water Fish Commission officers in the northern part of the state, Florida, with federal approval, will license hunters to shoot these “nuisance” alligators and to sell their hides with state cooperation. The problem is that humans have moved into alligator habitat, resulting in greater alligator-human contact.

Fortunately, the alligator’s plight simulated a serious research effort during the last two decades. Initially, management goals, directed primarily toward understanding alligator movements, feeding patterns, and reproduction, predominated. In contrast, our studies deal with alligator social life, and we have concentrated on systematically describing their social behaviors and organization. Most of our research took place at an alligator farm in south-central Florida where thirty-five adult alligators inhabit a medium-sized lake.

Biological studies of wild alligators in the Louisiana coastal marshes have determined what parts of a water body alligators use and when. By following adult alligators fitted with radio transmitters, biologists of the Louisiana Wildlife and Fisheries Commission found that adult males prefer artificial canals and other deepwater open channels year-round, and that females prefer open water during April and May, the courtship-mating period. After that, they stay near their nests and den sites. The most significant finding to come out of this work is that alligators form small breeding groups in open water during the spring.

Bellowing, usually an early-morning activity, is the most obvious signal of courtship and mating. We heard these booming roars in chorus nearly every morning until the middle of June. Apparently, bellowing attracts both sexes to a breeding group by advertising the location of potential mates. Only males were thought to bellow, but we found that females also do so, their roars often attracting courting males. However, when males approach other males, fights frequently result.

Head slapping is another display that we were able to study. In this display, an alligator slams its head into the water, creating a splash that can be heard at a distance of 200 yards above water, and probably much far-
Males and females take turns riding on each other's backs as part of their precopulatory ritual. Blowing bubbles and geyers of water through their nostrils is also a part of a courtship that may last for hours. The larger males establish breeding territories and mate with numerous females.

An alligator nest is composed locally available vegetation and earth. In early June we saw female alligators crawl out of the water at night and begin to shape, rework, and condition the nesting material into a mound about three feet in height and five or six feet across at the base, a process that took a week. For most of the construction they use both their limbs and forelimbs. The last deposit prior to egg laying is the formation of a conical egg chamber, extending about a foot or more below the apertures.

A female lays between 20 and 40 eggs, one every 45 seconds. As each egg leaves her body, she meets it with the underside of her hind limb, finally breaking the egg's shell and then positioning it in the nest. After the last egg is deposited, she covers the clutch with amazing control she grasps nesting material with the claws of her hind limbs and drops it on top of the eggs. Once the eggs are covered, the female reshapes the nest and packs it by crawling across it.

Nests usually are built in places above the high-water mark that summer rains will bring. Even so, some nests are flooded during severe storms. Release of water from canals into former parts of the Everglades and southern Florida during the rainy season regularly inundates and destroys many alligator nests.

Hatching success is determined by proper temperature and humidity.
Conditions in the nest, maternal protection against nest predators, and parental assistance at hatching. Temperatures within the egg chamber vary between 79° and 92°F during the sixty- to seventy-day incubation period. Moisture content in the nest is affected by rainfall and groundwater.

Raccoons and black bears are major predators of alligator eggs. Other studies have demonstrated that female alligators do guard and defend their nests against predators. From radio tracking studies and other observations, we know that females remain near the nest after laying. We often sighted females resting quietly at the edge of the lake near their nests; as we approached they lifted their heads and tails slightly out of the water. If we approached too close to a female, she swiftly charged toward us, driving us away from the nest.

Just prior to hatching, the outer shell of the egg cracks and falls away, and the tiny alligator slits the tough inner membrane with its egg tooth. Even before it takes its first breath of air outside of the egg, the hatchling is capable of vocalizing a high-pitched “erk” sound. By playing the tape-recorded grunts of a day-old alligator through remote audio speakers, we demonstrated that female alligators actually respond to the vocalizations of the young. A recently completed study by Gene Meyer and Myrna Watanabe, in the Okefenokee National Wildlife Refuge in Georgia, has produced conclusive evidence that female alligators excavate the nest, carry some hatchlings to water in their jaws, and lure the remaining offspring out of their natal tombs by vocalizations. But it is also known that in areas of heavy poaching or human disturbance females do not defend nests after laying and do not liberate the young at hatching. Given the heavy mortality on hatching alligators, such disturbance can cause a significant drain on alligator populations. Other crocodilians also defend their nests and liberate the hatchling from the nest, emphasizing the importance of maternal care.

Hatching alligators, probably from the same nest, live in groups, “pods,” near their mother’s den site. They often crawl about on the mother’s head and back where they bask and snap at insects. When we approached a brood the mother opened her mouth and hissed, then lunged and chased us from the area. When we grasped a hatchling it emitted a loud, repetitive “distress” ye that attracted adults to the sound. An experiment by Everglades National...
Alligator biologist James Kushlan demonstrated a female’s response to the distress calls of its young. Kushlan elicited such calls by holding a newly hatched alligator ten feet from its mother, which then rapidly crawled out of the water toward him. He then released the young one. The female picked up the hatching with the side of her mouth, retreated to the water, and released it. Inspecting the young in the mouth by females also has been documented in American, Morelet’s, and spectacled crocodiles, and in the spectacled man.

Toward the middle of their first year the young begin to swim alone. Several in a group we watched appeared to be leaders because they were followed by other individuals during their wanderings. While swimming, these leaders emit frequent grunts that probably help to maintain contact among all the members of the group and to alert others to the presence of food or predators. In spite of maternal care, young alligators are preyed upon heavily by racoons, otters, turtles, fish, and several species of heron. The toll taken by predators, when added to that taken by disease and other causes, probably reduces the original clutch by half within one year and 80 to 90 percent within three years. The remaining small alligators likely disperse away from the other by the second or third year, if this may be dependent upon the habitat. For example, in the Everglades, where alligators are restricted to "gator holes" during the dry season, young of three successive years have been seen near a female’s den. Crocodilians grow very rapidly, but mature late. Ranging from eight to ten inches at hatching, alligators grow roughly one foot during each of their first six years, eventually reaching an adult length of six to eight feet in males and ten to fourteen feet in females.

A diet of insects, snails, crabs, small fish, frogs, and small mammals supports such rapid growth. Larger prey such as gar and other fish, snakes, birds, raccoons, muskrats, and an occasional dog are also eaten as the alligator grows larger. Alligators are by no means finicky eaters—they will take live prey or scavenge for meals—but they feed less frequently than might be assumed for so large an animal. Nonfood items called gastroliths (stomach stones) are sought out, ingested, and retained in the stomach. Some biologists argue that these stones function as ballast, while others are of the opinion that they aid digestion.

Retention of gastroliths enabled us to feed adult alligators a small pseudogastrolith containing a radio transmitter that encoded stomach temperature. We wanted to know how the internal body temperature of this large ectotherm (ectotherms derive body heat from the environment, rather than from internal metabolism, as do birds and mammals) fluctuated in response to daily and seasonal changes in the environment and how an alligator’s behavior affected its body temperature. By simultaneously recording temperature and observing behavior, we demonstrated that an alligator can maintain its body temperature at about 89°F for
hours each day by basking in the sunlight on land or in the water. During the warmer months, when alligators bask infrequently and remain submerged for hours at a time, their body temperatures fluctuate by only a few degrees throughout the day.

In order to regulate their body temperatures alligators require a source of water deep enough to provide a temperature gradient and shelter from the sun, adequate vegetation on land and near the water for shade and shelter, and access to suitable land areas for basking.

Water, therefore, is the key to the alligator’s survival. Within a broader wetland mosaic, this semiaquatic reptile must locate suitable water for its food, social behavior, reproduction, and heat balance. However, wetland ecosystems are disappearing so rapidly that the American alligator’s survival cannot be guaranteed. For example, in 1972 biologist Jim Schortemeyer of the Florida Game and Fresh Water Fish Commission estimated that 23 percent of good alligator habitat was lost in the development of six south Florida counties.

A new life-history portrait of the American alligator is emerging, one that could save its existence. Alligators can be characterized as lacking predators (except humans) as adults, as suffering their major mortality prior to three or four years of age, as investing much time and energy in maternal care, as seasonal breeders possessing an intricate social organization and sophisticated communicatory behaviors, and as being long-lived in the wild. This is a very stable life-history pattern, one in which the alligator exploits a particular set of predictable environmental resources. For example, some female alligators show fidelity to nest sites year after year.

We have suggested how human alteration of the environment can disturb the alligator’s reproductive behavior and ecology. Such human disturbance as the flooding of nests is obviously detrimental. A less obvious but equally important human impact may also soon occur. Killing of large males in the Louisiana and Florida hunting programs should be avoided because removal of such individuals might disrupt the alligators’ male-dominated social structure during breeding and deprive the population of a potentially important genetic contribution.

Many important questions about the relationship between alligator behavior and ecology remain to be answered. One of these is whether habitat differences generate different social structure; that is, do alligators living in lakes or rivers have a different social structure from those in marshes. Despite gaps in knowledge, we now have enough information to formulate a coherent, habitat-centered survival plan for this ancient reptile.

Hatchling alligators float in a bed of swamp lettuce, below. At this stage of their lives, they feed mainly on insects, snails, frogs, and small fish. Raccoons are major predators on the young reptiles. When an alligator reaches the size of the one at right, however, the tables are turned and raccoons become the prey.
California Litter

Bruce E. Bechtol and Jerry R. Williams

In some instances, trash-laden beaches are more active than clean ones.

California beaches: Those words evoke visions of endless stretches of sand, warmed by perennial sunshine as frequented by bikini-clad sun worshippers and wet-suited surfers enjoying a casual life-style enhanced by occasional game of volleyball at beach party around a blazing fire.

The intensity of beach use in southern California sustains and magnifies the image. But another facet of this paradise is the increasing human impact on those beaches. Perhaps the most obvious result is litter; its volume is representative of the amount of refuse—a beach suffers. Intrigued by the dichotomy between use and abuse, we analyzed the accumulated litter on a beach in southern California over a two-year period.

Litter may well be the clearest indicator of the consumer-oriented, no deposit—no return society leaves to mark its passage. Wherever Americans travel, work, and play, and frequently, even where they live, their discarded objects pile up in an incredible variety of shapes, sizes, and materials. Beach litter is a potpourri of refuse—from newspapers and plastic eating utensils to disposable diapers and a myriad of other commonplace and exotic items haphazardly sorted and redistributed by the sea.

The scenic Pacific Coast Highway clings tenaciously to the steep, rocky cliffs of California. Occasionally, the roadway descends to sea level and skirts beaches built up by sea currents. The little ribbon of sandy beach that we observed stretches for about 300 yards along one of the coastal indentations, clasped to a sharp curve in this winding road just north of Malibu Beach. No signs warn visitors away from this small beach. There are no day use or parking fees, no rangers or lifeguards. Overnight camping is not discouraged, fires are not restricted, and animals can run free. This is one of those rapidly disappearing niches in southern California—a totally unsupervised and unmaintained recreational site on a segment of coastline that has somehow escaped development by commercial interests or government agencies.

Although much of the coastline south of this area is either publicly owned and maintained or fenced off by private landowners, this beach seems to be nobody’s concern. People seek it out to be free of any form of restriction on their activities. To insure that we did not interfere, we simply watched and, as unobtrusively as possible, collected litter.

Every two months over a two-year period, we picked up, counted, and disposed of all beverage containers in the area, but its over-all appearance remained much the same. We used the bottles and cans we retrieved as representative of all litter and left other trash to accumulate at its usual rate. During our study, we did not disturb the activities of beach users. In our conversations with many of them, we found that they perceived the beach as we did, as a heavily littered but unregulated recreational site. That it was unregulated was the beach’s greatest attraction and, at the same time, the source of its dismal appearance.

Beaches come and go with the seasons, reaching their maximum development by summer when human use and litter accumulations attain their highest levels. Between Memorial Day and Labor Day, the beaches are everybody’s playground as swimmers, sunbathers, people watchers, fishermen, and others crowd them. By summer’s end, the refuse of the previous months is quite evident. On the beach we studied, such lightweight items as paper cups, plates, napkins, food wrappers, and bags lined the base of the sea cliffs. Piles of refuse filled gullies and crevices, deposited there by people in half-hearted attempts to remove their trash. Remnants of fire pits, containing partially burned logs and garbage and surrounded by empty food and beverage containers, dotted the beach—mute testimony to the summer’s activities.

The winter beach is for hardy souls. Beachcombers, strollers, dog walkers, and fishermen are most common during this season and human pressure on the beach is minimal. But
even during the winter, the volume of discarded debris is sizable. As winds and waves scour the beach, much of the summer's trash is washed away. Shifting sands bury what is left, but this frequently reappears later as contemporary kitchen middens or 'buried treasure.' So long as the natural rhythm of the seasons is maintained, the sea coast will manage to purge itself of much of people's careless activity. Out of sight, however, is not always out of mind . . . everything has to go somewhere and the litter eroded from one location is usually deposited in another.

The natural cycle of seasonal beach change and human use is characteristic of almost all beaches, but human pressures are particularly noticeable on the coastal zone adjacent to large urban populations, such as those in southern California. On this particular beach, we were able to document a remarkable consistency in the volume of beverage cans and bottles thrown away during the same months each year. We could thus establish a discernible pattern of littering. Litter accumulation peaked in late summer when we collected more than 1,400 assorted beverage containers. The volume of litter as indicated by beverage containers declined in the winter months to fewer than 200 cans and bottles. By compiling the kinds of beverages and the brands, we gained insights into the nature of the people who frequented the area.

As might be expected, young people were the predominant users of the beach. We usually saw children and adolescents either with parents or in church and youth organizations. These groups camped for two or three days or used the beach for cookouts and picnics. On public beaches, some of these activities are prohibited and, where allowed, fees are required and strict supervision maintained.

On one occasion we tried to discourage a busload of cub scouts from unrolling their sleeping bags amid all the broken glass and debris. We suggested to the adults in charge that there would be less likelihood of cut feet if they camped at a nearby state park. Their reply was that there was a fee for using state facilities, while this one was free. They were aware of the hazards, having camped here before, but tolerated them in order to reduce their expenses.

We noticed that young people clearly demonstrated their impact through the number of soft-drink containers they left on the beach. These bottles and cans surpassed all other containers in total number and fluctuated markedly from season to season. After the end of each summer we collected more than 800 such containers. During the latter part of each winter, however, we found fewer than 100 of them.

Young adult consumers of alcoholic beverages were second in importance as contributors to the voluminous accumulations of trash. Beer drinkers were much in evidence during the summer. Of the more than thirty-five brands we found, Budweiser and Coors accounted for no less than 55 percent of the total. Beer drinkers typically congregated in groups of from two to six individuals and pursued activities ranging from sunbathing to overnight camping.

Hard liquor and wine bottles made up the smallest proportion of the litter that we recovered. Most were inexpensive brands of wine and rum. Their numbers remained low and constant. We observed that most of the wine and hard liquor was consumed by older adults, not the prime users of this beach.

An offshoot of our survey was the knowledge that the antilittering campaigns of the past several years were obviously not reaching young people. The very group that we naively expected to be most concerned about the environment turned out to be the chief litterers at this beach.

Although America's population is expanding, we are still an affluent society, with more leisure time, money, and mobility than we have ever had. One result of this generally fortuitous situation is increased pressure on recreational resources. In order to get the maximum use out of existing resources and to accommodate ever larger numbers of people, our society has moved increasingly toward computer-arranged, institutionalized recreation. Obtaining a campsite in a California state park, for example, requires making a reservation months in advance. This leads to additional bureaucracy, but it also results in better supervision and maintenance facilities. Use pressures are so great that without some such control the quality of outdoor recreational areas would rapidly deteriorate. Even many Americans object to such governmental regulations as an infringement on their liberty. Given such attitudes, many people are attracted to nonregulated areas. Paradoxically, with heavy use, unsupervised areas tend to suffer abuse because no one is ultimately accountable for them.

This open beach, which draws a wide range of people seeking escape from the metered tempo of metropolitan life, is a classic example of...
that can happen to an attractive recreational site when nobody has the responsibility to maintain it. There is a single litter receptacle in the vicinity; people seem to assume that a little bit of trash they leave behind will not make that much difference.

The volume of litter that accumulates on such a small section of beach is phenomenal. Over the two-year survey, we collected 6,702 beverage containers from this site. Other forms of litter, however, also continued to accrue, as evidenced by rusting cans, aluminum pull-tabs, rotting fruit, broken glass, half-burned garbage, and other miscellaneous trash. One would think that such an array would discourage use of the beach, but this was not the case. That parents let their children play amid all the trash, that dog owners run their animals free, and that swimmers and other water enthusiasts frequent the beach indicates that the strong attraction of an unregulated beach is one that is heavily littered. Most of the time, people were forced to clear away debris before they could establish a campsite, build a fire, or spread out a picnic lunch—but still they came. When we questioned them about their reactions to this mess, many voiced a preference for the better-maintained beaches in the vicinity, but said they were not permitted to run their dogs, build fires, or camp overnight on the cleaner, supervised beaches.

Inevitably, the people we interviewed decried the beach’s deplorable condition but maintained that they always took their trash with them when they left. They also frequently volunteered to give us their empty beverage containers. In two years, however, we did not observe a single individual or group removing any garbage or picking up any litter.

One can sympathize with those who oppose greater regulation of our personal lives. But as the population grows and as living space contracts and deteriorates in quality, individual and societal options decrease. In the case of this recreational site, a minimal response to the litter problem would be the placement of trash barrels at regular intervals near the beach. Unfortunately, this in itself solves nothing since someone or some agency has to be responsible for regularly picking up and removing the accumulated trash.

This is not as simple as it sounds. California has numerous examples of overflowing roadside trash containers and scenic landscapes cluttered with debris. As this one beach vividly illustrates, litter is an endemic problem of considerable magnitude in our society. If environmental quality in recreational areas is truly desirable to us as a nation, we must make some sacrifices, individually and collectively, whether it be through taxes or restrictions on personal liberties. At the very least, more attention must be given to minimal maintenance and supervision of intensively used recreational areas.
Lightning continues to puzzle the experts, and the process by which thunderclouds become electrified remains uncertain

Lightning strikes the earth about eight million times every day. During the period of one year, strikes in the United States alone kill some 150 persons, cause property damage in excess of $20 million, and set an estimated 10,000 forest fires that destroy $30 million worth of marketable timber. The cost of controlling these fires is approximately $100 million, or about one-third of the nation’s total annual fire-control expense. Lightning causes almost twice as many deaths as hurricanes and about the same number of fatalities and the same amount of property damage as tornadoes.

Not all lightning damage occurs on the ground. Some 60 to 70 percent of weather-related Air Force aircraft accidents are caused by lightning. Commercial airplanes are involved in lightning strikes about once in every 5,000 flying hours. In most instances, nothing untoward happens; the lightning simply flows over the outside shell of the plane, and when damage does occur, it is usually slight. But there have been several notable exceptions. A Boeing 707 was downed on December 8, 1963, near Elkton, Maryland, by lightning that ignited a gas tank. All persons aboard were killed. Those aboard a Boeing 727 in a holding pattern over Chicago’s O’Hare Airport on September 26, 1964, were more fortunate but will probably never forget the experience. Their plane was struck five separate times in twenty minutes but landed safely nonetheless.

Lightning is an electrical discharge—an enormous spark. It occurs mainly in towering cumulonimbus clouds, or thunderclouds, which are characterized by strong updrafts and downdrafts with velocities commonly from about 15 to 50 kilometers per hour (10 to 30 miles per hour) but that have been known to exceed 100 kph. A thunderstorm may have a diameter of about 1 to 2 kilometers and an altitude from cloud base to cloud top of 6½ to 8 km. In the mid-latitudes, the temperature at the base of the thundercloud is usually slightly warmer than freezing, although this depends on the geographic location of the storm; storm clouds in lower latitudes have correspondingly warmer bases.

Thunderclouds have a net positive charge in their upper regions and a net negative charge in their lower regions. This separation of opposite electric charges is known as a dipole. At least a dozen theories have been proposed to account for the polarity of the thundercloud, of which three are worth noting. Apparently, several charging mechanisms can occur simultaneously in a given thundercloud with the dominant one dependent on the storm’s location. The dominant mechanism in thunderstorms over mountains and in high latitudes may thus differ from that in tropical thunderstorms.

Ice particles are customarily found in the upper reaches of thunderclouds if the cloud tops are high enough. Clouds with altitudes of 7,500 to 9,000 meters (25,000 to 30,000 feet) may not exhibit lightning. But when the same clouds build up to 15,000 meters, lightning suddenly begins. Taking account of that observation, one explanation for the dipole structure of thunderclouds, proposed independently by researchers at the New Mexico Institute of Mining and Technology and the University of London, attributes it to a temperature differential in ice. According to this theory, when two ice particles come into contact and then separate, as in a bouncing collision, a charge will move from one ice surface to another; there is a temperature difference between the two surfaces. Laboratory experiments show that the warmer the two ice surfaces is left negatively charged; the colder surface is left with an equal and opposite positive charge.

It is believed that this process operates in two ways in a thundercloud. First, large, rough-surfaced hailstones, often produced in thunderclouds, fall through the cloud and collide with smaller and smoother crystals. In the collisions, the smoother-surfaced particles slide across the protruberances of the hailstones, causing frictional heating. The hailstones sustain a great amount of heat than the smooth smaller particles. The hailstones consequently acquire a negative charge and the smaller ice particles acquire a positive charge.

Secondly, hail or snow pellets that fall through a cloud may collide with supercooled water droplets—liquid water whose temperature is below freezing—which freeze on impact with the resultant latent heat release keeps the hail at a temperature above the freezing point of the smaller ice crystals with which the hail is colliding. The hail consequently receives a negative charge; it continues its fall toward the base of the thundercloud, while the smaller positively charged ice particles are carried on to the top of the cloud.
In the Northern Hemisphere, the incidence of thunderstorms is greatest between May and September. Most storms occur in the afternoon or early evening. Florida, where this picture was taken, is the most active lightning region of the United States.
Another explanation—and perhaps the most popular theory today—for electric charges in thunderclouds requires only that two liquid or solid particles undergo a bouncing collision while in the presence of the electric field of the cloud. Initially, the particles are electrically neutral. The effect causes positive charge to migrate on one side of a particle and negative charge to migrate to the other side of the same particle. When two particles collide, charge is exchanged and the particles separate with a net charge; the particle will be positively and the other negatively charged. Having acquired a net charge, the particles then experience the cloud’s electric field, gaining a greater transfer of charge when the next two particles collide within the field. This positive feedback mechanism for the separation of positive and negative charges will continue until lightning occurs.

A third theory is independent of whether the particles are water or ice and can occur in a cloud devoid of ice particles. The atmosphere typically contains a positive charge near the ground. This theory proposes that the positive charge is transported by convective currents to the upper part of a cloud. When positive and negative charges in the atmosphere around the cloud top are attracted by the cloud’s positive charge, become attached to the outside of the cloud, and are carried to the lower part by downdrafts along the cloud edge. Once again, intensification—or positive feedback—of the electric field will continue until lightning occurs.

Much controversy surrounds the preceding three theories and their applicability to thunderstorms. Nevertheless, it is well known that one or more charge-separation mechanisms produce a minimum of 20 to 30 coulombs of positive and negative charge in a thundercloud (a coulomb is the amount of charge transferred in one second by one ampere). By comparison, a 100-watt bulb uses about one coulomb per second. The mechanism also creates electric fields as high as 500,000 volts per meter and electric potentials with respect to the ground of 100 million to 1,000 million volts. When those conditions are fulfilled, lightning occurs.

The high voltage produced during thunderstorms has led to the suggestion that lightning might be harnessed to provide a useful source of energy. Unfortunately, the charge delivered to the earth’s surface in a lightning flash is only about 20 coulombs, enough to operate one 100-watt bulb for just over 20 seconds. Thus, the total charge available in a single active thunderstorm would not fill the energy needs of even one household.

The charge separated by one or more of the mechanisms discussed above resides on the solid or liquid particles in the cloud. When the accumulation of charged particles produces a high enough electric field, the insulation of the air surrounding the particles breaks down and electric charge flows from particle to particle in an avalanche of discharges constituting lightning.

There are several types of lightning named according to where the discharge takes place. Among them are intracloud lightning, by far the most common type, in which the flash occurs within the thundercloud; air-discharge lightning, in which the flash occurs between the cloud and the surrounding air; and cloud-to-ground lightning, in which the discharge takes place between the cloud and the ground.

The last type is mostly obstructed by the thundercloud and is therefore widely studied even though it represents only about 20 percent of lightning flashes. A cloud-to-ground flash is composed of one or more shorter-lived discharges known as strokes. The first stroke begins in the base of the cloud and proceeds toward the ground in regular and distinct steps of 50-meter length at intervals of 50 microseconds. Called a “stepped leader,” this process, which begins as a faint luminosity, creates a downward-branching pattern. As it moves toward the ground, it also produces a pipe-like channel within the cloud. Carrying an average current of a few hundred amperes—enough to run several hundred TV sets for a few milliseconds—the stepped leader propagates at a typical velocity of 150,000 meters per second, or about one two-thousandth the speed of light. Near the ground, peak currents of a few thousand amperes have been reported by a research team at the University of Arizona. The stepped process deposits approximately 5 coulombs of charge on the channel, inducing an opposite charge on the ground and increasing the electric field between the leader and the point of impact.

As the faintly luminous leader comes within about 50 meters of the surface of the ground, an upward discharge jumps from the target object to meet it. At the moment of junction, the cloud is short-circuited to the ground and a brilliantly luminous, upward return stroke of high current occurs. Because the return stroke is much brighter than the preceding leader, its intense light is typically what we first see as lightning. Stepped leaders that have not reached the ground become the branches of the return stroke, and charge on these branches flows into the lightning channel.

The 5 coulombs of charge deposited on the channel by the initial stepped leader flow to the ground in a few hundred microseconds to produce peak currents on the order of 30,000 amperes but which may exceed 200,000 amperes. Studies of the rapidly changing electromagnetic field made at the University of Florida indicate that these peak currents are reached within 1 to 3 microseconds of the initiation of the return stroke. Peak lightning temperatures measured by the author in the channel were observed to be about 30,000°K, or five times hotter than the surface of the sun.

As the charge streams toward the ground, the luminous return stroke moves upward toward the cloud base.
at speeds of about 100 million meters per second, approximately one-tenth to one-half the speed of light. In the rapid passage from ground to cloud, the luminous return stroke pauses at points where the branches join the channel, and the channel brightens as charge from the branch flows into it. The stroke then continues its upward motion, reaching the cloud base in about 70 microseconds to complete a return trip that took the stepped leader 20 milliseconds on its downward journey.

With the completion of one return stroke, the flash may be over. On the other hand, if there are subsequent strokes, about 30 to 50 milliseconds will pass before a dart of light perhaps 50 meters long, called a dart leader, moves down the channel of the return stroke. Carrying a current of 1,000 amperes at a speed of 2 million meters per second, the dart leader will once again short-circuit the cloud to the ground and a second return stroke will occur. This sequence of leaders and return strokes usually takes place three to four times within a given flash but has been recorded a maximum of twenty-six times in a flash that lasted for two seconds.

The tapping of electric charge by subsequent strokes in a flash was once thought to be initiated in vertically aligned charge centers located higher and higher in the thundercloud. However, studies at the New Mexico Institute of Mining and Technology and Rice University in Houston indicate that charge centers in multistroke flashes tend to be aligned horizontally. Furthermore, research on thunder has produced maps of the lightning channel within the thundercloud that show it to be horizontal. These findings are significant in suggesting that a mixture of ice and supercooled water particles is probably present in the charged regions of the thundercloud. Higher elevations would be characterized by the dominant presence of ice, the lower regions by the dominant presence of water. Perhaps the mixture of ice and water is a prerequisite for the build up of the charge centers in these clouds.

Cloud-to-ground discharges are not the only kind of lightning that involves the ground. Studies carried out at New York City’s Empire State Building in the late 1930s revealed that lightning sometimes begins on the ground and moves upward toward the cloud. A detailed investigation of such discharges, known as “triggered lightning” because they occur only in the presence of human-made objects, has recently been completed at the Mount San Salvatore Lightning Observatory, near Lugano, Switzerland. The 70-meter towers above Lake Lugano are involved in more than 100 flashes each year, more than 80 percent of which are triggered lightning. The remainder are the normal cloud-to-ground discharges.

Triggered lightning begins with a stepped leader that flows from the tower top upward toward the thundercloud. On reaching the cloud base, an increase in the channel luminosity occurs but no return stroke follows. If there is a subsequent lightning stroke, it is initiated by a dart leader that begins in the cloud and moves down the old channel to the tower. A normal dart-leader/return-stroke sequence then takes place in all subsequent strokes. A curious feature of these flashes is that they are occasionally the only ones that occur during a “thunderstorm” over Mount San Salvatore, which suggests that in the absence of the towers on the mountain, there might not have been any lightning at all.

Intracloud lightning, the most frequent kind of flash, begins with a leader that moves between charge centers in one direction only and produces a more or less continuous, but flickering, luminosity for approximately 0.2 second. During this time, the amount of charge transferred is probably similar to the amount involved in a ground discharge. Studies of strikes to instrumented aircraft that fly through thunderclouds indicate peak currents of only a few thousand amperes, an order of magnitude less than the currents in cloud-to-ground return strokes. Intracloud discharges illuminate a cloud without the lightning channel being visible. The cloud takes on the brief appearance of a white sheet, hence this type of discharge is popularly referred to as sheet lightning.

Flashes that take place between a cloud and the surrounding air are called air discharges. These occur when a flash moving toward the ground fails to reach it or when intra-

cloud discharges extend into the surrounding atmosphere.

Other types of lightning with similar names as forked, stroke, heat, hot, cold, ribbon, and bead will all be explained in terms of cloud-ground discharges.

Forked lightning refers to a multibranched cloud-to-ground lightning stroke. A discharge without branch is called streak lightning.

Heat lightning is a distant cloud ground or intracloud discharge flashes on sultry summer evenings. As a result of the great distance to discharge, a preponderance of the light is scattered from the discharge and the flash is characterized by a faint orange light, the cause of the distance to the flash. Thunder is usually not heard in conjunction with heat lightning.

The terms hot and cold light refer to those ground discharges caused by forest fires and those that are not. Flashes composed of streaks with currents of a few hundred amperes that last for at least a tenth a second after their greatest intensity are capable of starting forest fires and are consequently called hot lightning. Flashes with shorter-lived currents cause only explosive damage to trees and are known as cold lightning.

Less frequent than the types of lightning already discussed are forked and bead lightning, additive forms of ground discharges. A strong wind is blowing perpendicular to the line of sight during a multistroke flash, the lightning channel may be blown sideways and subsequent strokes will be displaced. In the residual image on the retina of the eye, the flash may resemble a ribbon composed of several strokes.

Bead lightning is even less common than ribbon lightning. In this type of discharge the main channel breaks into luminous sections, known as beads, as the light intensity of channel decays. Some sections of the channel remain luminous longer than other sections either because they viewed end-on or because they have a larger diameter and therefore take longer to cool.

Ball lightning is the name given to the mobile luminous spheres that have been observed during thunderstorms. They are often the size of an orange or grapefruit, have a lifeti
few seconds, and are usually red, green, or yellow. The balls generally move horizontally at a velocity of a few meters per second. Many do rise, as a sphere of gas might be expected to do. Unfortunately, there is no adequate theory to explain ball lightning.

Almost all types of lightning discharge are followed by thunder. The powerful flow of current in a lightning flash heats the surrounding air, which expands rapidly forming a shock wave. Initially, the air expands at a rate faster than the speed of sound (1,100 feet per second) but the shock wave quickly decays to a sound wave and is then heard as thunder.

You can estimate the distance to a lightning flash by counting the seconds between seeing the flash and hearing the thunder. For every second you count, add about 300 meters (approximately 1,000 feet). For example, if it takes five seconds for the thunder to reach you, the lightning was one mile away. I am often asked if I am ever afraid of close lightning strikes when doing experiments in thunderstorms. My answer is, not if I hear the thunder. If the lightning is so close that you cannot hear the thunder, you are a part of the strike.

In view of the extent of the damage caused annually by lightning and of the gaps in our knowledge about it, many scientists have turned to the study of lightning and thunderstorms. Seventy investigators from more than twenty universities and government agencies are currently midway through a three-year program called the Thunderstorm Research International Program (TRIP). Based at the Kennedy Space Center in Florida, TRIP makes use of sophisticated research equipment, including radar and aircraft. Among the questions the scientists hope to answer is, Just how does a thunderstorm work? Studies by many of us in the past have been performed singly to determine the physical properties of the lightning flash. Yet prediction and control can only come after we gain an understanding of the complicated meteorological patterns of air flow and precipitation that are associated with the build up of the charged regions in thunderclouds. This requires a large, coordinated scientific effort using the latest technological advances to investigate all aspects of the thunderstorm simultaneously. In the end, we hope that our effort will bring the goal of lightning prediction, and perhaps limited control, within the realm of applied technology.

Ribbon lightning, a relatively infrequent type of discharge, is named for the effect created when strong winds blow across the point of observation and displace the successive strikes in a flash.
Letters

Tobacco Row

"The Unnatural History of Tobacco" (April 1977) should be required reading for every grammar, high school, and college student.

C. H. McKechnie
Cambridge, Massachusetts

Erik Eckholm’s article, “The Natural History of Tobacco,” suffers from an imprecision uncharacteristic of your publication. Built on a premise that is grossly generalized, the article is a house of cards. The premise, repeatedly stated, is that the "medical case against tobacco" is "a some," "airtight," "conclusive," "growing," and "massive." Such terminology begs definition and substantiation. A "medical case" more than accusations and non sequiturs.

There is an essential distinction not made in the article, between a hypothesis suggested by statistical association and the sum of the laboratory, clinical, and epidemiologic evidence necessary to establish scientific proof. The fact is that there is conclusive laboratory or clinical evidence that cigarettes cause human diseases with which they have been statistically related. So we left with statistical associations. Responsible epidemiologist says that statistical associations alone cannot establish cause and effect. The best such statistics can do is to suggest hypothesis, and that’s the prime basis for the medical case against tobacco: a hypothesis based on statistics.

Dr. Carl Seltzer of Harvard examined the statistics concerning heart disease and found some curious anomalies. For one thing, he found that the attack rates of coronary heart disease (CHD) were lower for smokers who had stopped smoking than for people who never smoked. Following the conventional hypothesis, he said, it would be best to smoke and then stop than never to smoke at all. He rejected the notion of course, but said the anomaly upsets any causal hypothesis.

In a paper in the American Journal of Public Health (July 1975), Dr. Seltzer...
risk
For Philip Burt and sis, the Explore-a-hed, "...''


With questionable laboratory evidence, disputed statistics, and a number of other hypotheses, the indictment of cigarettes is hardly "airtight." Eckholm then asserts that ambient cigarette smoke harms non-smokers. A physician who reviewed the research in the same issue concluded that the complaints might be psychogenic in origin.

Even those who have been vocal against smoking agree there is no proven harm to the nonsmoker. Dr. Ernst Wynder of The American Health Foundation said recently that cigarette smoke can be "disagreeable," but added, "it has no influence on the health." Last September, Dr. Gio Gori of the National Cancer Institute said, "If you want to remain with fact and not with fiction, there is little danger of disease to people that stay in the room, say, where people smoke."

During the past twenty years, most of the publicly supported research on the diseases blamed on cigarettes has been started with the predetermined conviction that cigarettes would be proven guilty. This approach violates a cardinal principle of scientific investigation and usually is unproductive or worse. There still is not acceptable evidence on which to convict cigarettes.

During the same period, the tobacco industry has contributed more than $60 million for independent re-
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search on smoking and health, with no strings attached. This amount is far more than all the voluntary health agencies combined, the same agencies that indiet cigarettes in their public appeals for funds.

The industry's long-standing position is that the truth will be found in the laboratory, not in polemics. Eckholm has delivered seven pages of opinions, all on one side, without a single indication that contrary opinions exist. It is thus not surprising that he concludes by advocating the "vibrant, systematic use of all possible educational channels, advertising restrictions, prominent warnings on cigarette packages, tax disincentives, and so on."

Demurrers aside, those are subtle and, in the case of "tax disincentives," not so subtle forms of coercion to modify behavior.

Also not so subtle is Eckholm's statement that the federal government spends $50 million a year "supporting the tobacco industry." The implication is that there is a subsidy for the cigarette manufacturers, while in reality the government support program is designed to stabilize tobacco leaf production and assure fair prices to the growers. Since its establishment by the Congress, the program has cost little more, in 43 years, than what Eckholm claimed for one year. No other farm commodity price-support program has fared so well or cost the taxpayers so little. Under mandated acreage and poundage limits, it assures a good portion of America's farmers families a just return on investment.

Within the past month, the Secretary of Agriculture told a House committee that ending tobacco price supports would put 600,000 to 800,000 families on the welfare rolls.

Eckholm questions the inclusion of export tobacco under Public Law 480, a program of concessional agricultural sales to needy countries. But through such trade promotion, overseas sales of this American farm product now contribute more than $1.2 billion a year to the over-all U.S. trade balance.

The economics of tobacco should by no means be equated with any alleged health effects. But a truly objective chronicle of America's first industry should, in addition to delving with open mind into the medical literature, have addressed tobacco's importance to present economic well-being.
does not mention the editorial that inspired the British Medical Journal of August 21, 1976. Burch, Journal observed, "must be vir- 
ily alone... in asserting that the 
al hypothesis [that smoking pro-
ites lung cancer] is 'a catastrophic 
crucial warning.'" 
Kornegay quotes from Dr. Joseph 
Framen, Jr., and Dr. Gio B. Gori 
the National Cancer Institute as 
hough their views contradicted 
e. I doubt this, however, since by 
incidence both of these distin-
ished researchers had reviewed and 
entially agreed with my draft man-
ripts on smoking and cancer. The 
Cancer Institute's valuable 
estimations of geographic varia-
s in cancer rates will likely help 
cover industrial carcinogens but in 
way contradict the evidence that 
king is the principal cause of lung 
er. To suggest otherwise is to 
tort badly the meaning of Dr. Fra-
ni's statement.

For obvious ethical reasons, the 
of long-term, controlled study of 
ans that might provide the final, 
mal "proof" of smoking's haz-
s will never be carried out. Thus, 
can expect those with a financial 

Ah, Kiwi

I look forward to Raymond Sokolov's witty and civilized articles on rare foods, and "Strange Fruits" (March 1977) was no exception. It also brought back memories of my first taste of kiwifruit. I had the good 
fortune to enjoy a rest leave in New 
Zealand during World War II. The 
name kiwifruit may have been adopted in New Zealand as early as 1906, but in 1944 I was introduced 
to the fruit as Chinese gooseberry and its 
taste has stayed with me through the years. I recently saw my fondly 
remembered Chinese gooseberry at a 
fruitarian's and bought one, looking 
forward to recapturing the taste of 
New Zealand after 33 years. What 
disappointment! Ripened in the crate 
is not ripened on the vine. Or has my 
memory played tricks with my taste 
buds?

I was surprised that Sokolov did 
not mention the passion fruit, which 
I also enjoyed in New Zealand. As I 

remember, it was the size of an Italian 
plum, its hard rind was broken 
away at the top and the fruit scooped 
out of the rind with a demitasse spoon 
as one would eat a boiled egg. The 
small, soft seeds were covered with 
the flesh of the fruit much as a pome-
granate, but the seeds, being small 
and soft, were eaten with the meat. 

To trust my memory, the taste was 
delicate and exotic, like no fruit I 
have eaten before or since. Where, oh where for a vine-ripened kiwifruit or 

passion fruit?

PHILIP WINOGRAD 
Yonkers, New York

Reading the article "Strange 
Fruits," by Raymond Sokolov, I was 
surprised to learn that kiwi isn't 
grown in this country. In this area 
there are many acres of kiwi grown, 
with associations for growers. A 
problem with the vine is the initial 
cost of planting, so most people have 
small plantings of five acres or less. 

If Sokolov wants kiwi so badly, 
perhaps he should come here in late 
summer. He could gorge himself at 
that time.

MARY ANNE HAYRE 
Marysville, California

This fascinating book gives us the world of archeology with an intimacy I have rarely experienced...taking us into fabled lands and fabulous fields of human endeavor." 
—Leon Edel

SIR AUREL STEIN 
Archaeological Explorer 
by Jeannette Mirsky

In his day, Sir Aurel Stein (1862-1943) was continually in the limelight, through his own writings and lectures and through newspaper dispatches about his exotic travels and spectacular finds in Central Asia. Rediscovery 
of the ancient Silk Route between China and the West; recovery of the 
library at Tun-huang (comparable to that of the Dead Sea Scrolls); 
evacuations of long-buried sites at Turfan, Niya, Miran, and other places 
important in revealing how Christian and Buddhist influences moved 
east and how Indian, Persian, and Chinese cultures impinged on the 
West—these are just a few of Stein's prodigious achievements which 
were described by Sir Leonard Woolley as "the most daring and 
adventurous raid upon the ancient world that any archeologist 
has ever attempted."

This exciting biography will awaken a whole new generation of 
readers to the way Stein's discoveries expanded our intellectual 
horizons. 
Illustrated $17.50 
University of Chicago Press
KONRAD LORENZ: A BIOGRAPHY, by Alec Nisbett. Harcourt Brace Jovanovich, $10.00; 240 pp., illus.

Few figures in twentieth-century biology have been as controversial as Konrad Lorenz, founder of the modern discipline of ethology (the study of animal behavior) and recipient, with Nicolaas Tinbergen and Karl von Frisch, of the 1973 Nobel Prize for Physiology or Medicine. Alec Nisbett’s biography makes it clear why Lorenz became involved in one controversy after another. Throughout his career Lorenz chose to focus his attention, not on trivial questions, but on the most fundamental issue of animal social life: the origin of behavior. No topic could involve more potential controversy. Among biologists it raised again the old dichotomy of “nature vs. nurture”; among nonbiologists it questioned the whole method of extrapolating from animal to human behavior. Coming down as distinctly as he did on the side of the innateness of much animal behavior, Lorenz was bound to stir more than a few hackles.

In the introduction, Nisbett explains that his purpose is “to indicate a way through the thicket of what are sometimes densely interwoven, and at others only half-related, ideas that one man has launched in a lifetime’s industry. To see best how these fit together demands some understanding of the man himself, and his own personal history: my aim is to provide this in a sympathetic but critical biography.” Sympathetic it is, but critical it is not.

Nisbett traces Lorenz’s career from his birth and early childhood in Altenberg, Austria, through his gymnasium and medical education (M.D. from the University of Vienna in 1928), to his entrance into the field of natural history with studies of the behavior of jackdaws (1928-31), and somewhat later, careful observations of nesting behavior in the greylag goose. From there Nisbett chronicles Lorenz’s work on behavior in a variety of other species (mostly fowl), which, for lack of a regular academic appointment, he carried out at his family home in Altenberg. In 1940 Lorenz received his first university assignment, as professor of psychology at Albertus University in Königsberg (now Kaliningrad). Pressed into medical service during the war, Lorenz returned to Austria in 1945 without a job and accepted an appointment with the newly reorganized Max Planck Institute (formerly the Kaiser Wilhelm Institute).

Throughout this chronology an unassuming picture of Lorenz emerges. On the one hand, he is portrayed as the relaxed naturalist who likes nothing better than to be left alone to spend countless hours peering through bullrushes at a family of ducks watching patiently the courtship...
or of some greylags in his gar-
for reading and writing in his
ery at Altenberg, bothered only by
occasional visit of one of the
domesticated birds that freely
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here can be little doubt that
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, Robert M. Yerkes, and William
ougall. Lorenz was dismayed at
ack of detailed observational data
hich these authors had based
-scale generalizations about
ans as well as animals. Lorenz
en interested in natural history
child, and brought to the study
pecies-specific behavior the skills
n exceptional observer. Among
earlyst observations was the phe-

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The fact of Lorenz's theories and explicit espousal of Nazi ideology, Nisbett does not try to hide the fact that Lorenz had certain sympathies for the Nazi cause, or that Lorenz wrote at least one infamous paper in 1940 ("Disorders Caused by the Domestication of Species-Specific Behavior"), which was not only racist in import but was couched in Nazi terminology. In discussing this paper, Nisbett argues in the most contorted vein that Lorenz was politically naive; that only recognized the evils of Nazism in 1943 when he saw a group of Gypsies being carted off to a concentration camp; and that the topic of domestication of races was for Lorenz a "purely scientific" issue in 1940.

The length to which Nisbett will go to apologize for Lorenz is seen in his attempt to minimize the serious racist implications of the article. In his 1940 paper, Lorenz argued that in domesticated animals degenerative mutations result in the loss of innate, species-specific releaser mechanisms governing mating patterns. These mating patterns are necessary for maintaining the purity of the stock. If allowed to mate at random, most domesticated strains would soon revert to their wild-type ancestry. In humans, who have also become "domesticated" by their civilization, random mating would yield similar results: the loss of pure "types." Under more natural conditions each human type (read, "race") has an "innate esthetic mating sense"—people of "higher types" being naturally repulsed by the physical appearance of people of "lower types." The biologically determined esthetic sense helps maintain purity of type or race. The breakdown of this system through overcivilization has resulted in racial degeneracy in Europe—only the state, by controlled breeding, can stop the decline toward degeneracy. (Lorenz made this argument less than five years after the passage of the infamous Nuremberg Laws, which made marriage between Jews and Gentiles illegal in Germany!)

Nisbett goes out of his way to downplay the racist overtones in this argument. First, he makes a huge furor over a small semantic point: Lorenz claimed that he was mistranslated by one of his American critics (Leon Eisenberg) in a highly critical paper published in Science in 1972. In a controversial passage of Lorenz's original, in which he describes how superior people are esthetically repulsed by inferior people, Eisenberg translates the phrase Messen des anderen Geschlechts as "more another race," whereas Lorenz claims he meant "people of one sex." But fine points of etymology are not the issue here. The overall tone of the 1940 paper is so all that Nazi terminology and ideology, he is so overtly racist, that to argue the use of a single word serves to distract the reader from the point.

Second, Nisbett argues that Lorenz is no more a racist in describing certain human groups as "degenerated" than he is in describing the domesticated goose as a degenerate "race" of greylag. But elsewhere in his writing Lorenz makes it clear that he "likes" domesticated forms far more than their wild ancestral types. This idea could be closer to the Nazi ideology of superiority of the Nordrassen "type," the progenitor from which all other races have degenerated. As third, Nisbett claims that Lorenz, writing his 1940 paper, was "creating" Nazi ideology, by asking for a scientific reexamination of ideas that had already been filled in orthodox Nazi "philosophy." He evidently hoped by a little clever manipulation to get his own ideas excepted into Nazism.

All of these rationalizations for the 1940 paper are weakened by the picture of Lorenz that Nisbett himself paints. Personally, Lorenz seems always to have been a compromiser—a sellout if one wants to less kind. For example, when his Ph.D. orals, Lorenz sensed that one of the examiners stood on the opposite side of a particular controvert from himself. Accordingly, Nisbett tells us, Lorenz gave answers to the examiner would find "acceptable" even though he himself believed differently.

More important, Lorenz was naïve about the social and political implications of his theories. Nis-This shows us that Lorenz took every portunity to draw connections tween animal and human social behavior. In On Aggression and a host of popular articles and books, Loren repeatedly made the same points, stripped of Nazi terminology as found in his 1940 paper. Furthermore, Lorenz did not object, exce in a few instances, to the widespread popularization of his ideas about ritoriality or aggression in the jo
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nalistic writing of Robert Ardrey (The Territorial Imperative), Desmond Morris (The Naked Ape), or the team of Robin Fox and Lionel Tiger (The Imperial Animal). With a general world view that held that much of human behavior, and thus social worth, is innate, Lorenz helped create and maintain the ideological foundation on which the Nazis could build their myths of Aryan superiority and anti-Semitism. In the long run it matters relatively little that Lorenz wrote an explicitly Nazi paper. The damage was done, and continued to be done, through the more customary channels of strictly "scientific" literature both before and after 1940.

But the worst part of Nisbett's approach is his lack of understanding of the real forces that affect the development and use of scientific ideas. Historically speaking, it is important to analyze the forces behind the immense publicity given during the 1920s and 1930s to theories of biological (genetic and evolutionary) determinants of social behavior, of which Lorenz's ideas of instinct and innate aggression are only one example. This was the period during which eugenicists in the United States, Great Britain, Scandinavia, and Germany were espousing a genetic cause for all sorts of human behavioral and personality traits (alcoholism, feeblemindedness, prostitution, unemployment, and so on). Hereditary arguments were given widespread publicity by wealthy interests at a time when capitalist economy was entering its most severe period of decline in the twentieth century (the Great Depression). Racism was on the rise and was given substantial justification by a variety of theories that claimed that social behavior was a product of innate, rather than environmental, factors.

Nisbett's failure to consider the over-all scientific and social context of this period has caused him to miss the main point to be learned from a study of Lorenz's work. Scientists can play a powerful role in society—more powerful, sometimes, than they or the public are willing to admit. Ideas can become deadly weapons when they provide a supposedly objective and rational description for human social behaviors. Scientists need to understand the role their work can play in a social system where the control of the flow of ideas lies in the hands of those elite who have their own social aims in mind. Lorenz's case exemplifies this point dramatically. From his notions that man's behavior is innate and humans have an instinct for preserving the "purity of type," all else his system follows. Lorenz respected scientist whose views adversely or not, could be used to legitimize a brutal genocidal philosophy. In killing Jews, Aryans only "doing what comes natural."

It makes little difference for an analysis of history to argue who Lorenz saw the implications of work in this direction or not. Study of history is not concerned with individual motivations, but with behavior of large groups—class who behave in accordance with derailing social, political, and nomic forces. Lorenz contributed and was used by, one class (the man ruling class, eventually represented by the Nazis) in its vain attempt to maintain control over a wildly deteriorating social and nomic system.

The historical lessons to be learned from an analysis of Lorenz's career are all the more important for today, when "doing what comes naturally" is rapidly becoming a holy hold term. Our own era has seen the rise of similar theories of biologically determinants for social behavior. Arthur Jensen and William Shley's notion that blacks are genetically inferior to whites in I.Q. E.O. Wilson's Sociobiology: New Synthesis, a monograph maintains that many human social behaviors, especially sex roles, are ethically determined and have been selected for during evolution. Neil Jensen and Shockley not Wilson's any more evidence that Lorenz the innateness of such human social behaviors. Yet the immense power that these recent theories have ceived is no less startling in our than was that which Lorenz received in his. Lorenz's case ought to help see that the prevalence of such theories (not just one theory, many of similar ilk) can pave the way for a holocaust. It is not a perversity of history to try and learn from past. Books like Nisbett's could potentially make an enormous contribution in that direction. That a pretent biography does not is a great appointment. 

Garland E. Allen is an associate, fessor of biology at Washington vercity, Saint Louis, Missouri.
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A Matter of Taste

Oranges and Their Cous

The great success of citrus fruits in America has turned the exotic into the ordinary

Driving through Bradenton, Florida, this winter, just after the frost had laid waste thousands of fruits in the commercial orange groves and sent local prices climbing, I thought of another cold day fourteen years ago in London. My wife, who was writing a paper on Paolo Uccello, and I had come to look at one of the painter's famous battle scenes in the National Gallery. As it happened, the picture was being restored, and so, after addressing ourselves to the appropriate authorities, we were ushered backstage, as it were, to a large yet still-cluttered room where, hard by Rembrandt's Polish Rider, we found our Uccello, partly cleaned, but visibly in need of more work. The restorer had, however, already earned his keep. In the background of the stylized affray we knew from reproductions, he had uncovered orange trees: bright, luxuriant, fruiting orange trees.

They are the only instant oranges I have ever come across. My surprise and delight at seeing them were probably irrelevant reactions to the painter's intentions, but Uccello must have put them in to add an exotic, rich strain as a symbolic counterpart to the choreographed havoc that was his main subject.

Oranges and their citrus cousins always, until quite recent times, brought a warm, bright, comfortable whiff of the semitropics to people who ate them in northern climes. Seventeenth-century Dutch painters of luxurious still lifes liked to place elegant spirals of citrus peel among high-priced crystal and gold objects. As recently as 1923, Wallace Stevens wrote deliciously of "complacencies of the peignoir, and late coffee and oranges in a sunny chair."

Since then, oranges and lemons, limes and grapefruits have lost their aura for Americans. Botanists may once have compared oranges to the golden apples of the Hesperides, but the enormously successful citrus industries of Florida and California have turned wonder into routine. United States is the leading citrus producer in the world. This, combined with easy transport, artificial ripening with ethylene gas, and clever methods of propagation through grafting and budding, has made citrus fruits and juices a cheap and fact of American life. Frenchmen may still regard orange juice to be as an unusual indulgence (as might consider freshly squeezed mango juice), but for most of orange juice is simply O.J., something we take with breakfast don't think twice about.

While passing through all that varied, spoiled fruit, I thought perhaps the inevitable rise in price will remind people that oranges are important. Perhaps some who now settle for truly banal juice made from artificially "balanced" concentrate will go back to squeezing their own oranges. Others may even revert to peeling whole oranges. That could lead to a wave of citrus connoisseurs ship now limited to those Florida residents and northern fanatics who in

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fresh, naturally ripened fruit on for its taste and texture. Despite the freezing temperatures, any marketed oranges, grapefruits, and tangerines in Florida this winter dramatically outclassed any fruit I have eaten at any time north. I found myself gobbling tangerines, which are sour but delectable morsels eaten peel and all. And at the time—I well spent—to peel albedo-laden tangelos.

The classic method is a bit messy but laborious, but it pays off, for ages as well as tangelos. You cut the peel in a thin, curving strip, plug with a small knife just deep enough so that all the white albedo of inner peel comes away with the red outer flavedo. This peel contains aromatic oil glands, which impart flavor to cocktails when they leaped all these specialized berries, or hesperidia, into the subdivision Citreae of the family Rutaceae. The Citreae are further divided into three subtribes, of which the true citrus group is the one that includes oranges et al.

Actually, the true citrus group includes six genera. Three are of no practical interest and are limited to Australia, New Guinea, and the island of New Ireland in the Bismarck Archipelago. Poncirus is the genus of the trifoliata orange, whose hard rootstock hybridizes conveniently with grafts and buds from other citrus. Kumquats have the Fortunella genus pretty much to themselves. And last, but obviously not least, the genus Citrus contains all the other edible citrus fruits.

Thorny shrubs, white flowers, compound leaves, hesperidial fruit (in sections encased in membranes and housing easily ruptured juice vesicles), juice rich in organic acids (notably ascorbic acid, or vitamin C) and carotene (vitamin A)—these are the common traits of the citrus plants we know and eat. They mutate frequently and hybridize easily among each other. Their seeds are either zygotic (genetic mixtures of male and female parents) or nucellar embryos, which contain only the genetic information of a single female plant. Nucellar seeds will produce plants identical to the ones that they grew on, an advantage usually limited to plants grown from grafts or buds on a host rootstock or by other vegetative means.

Modern citrus growers rejoice in this state of affairs, which has made

with a luscious pile of orange sections on one side and a heap of membranes on the other. After squeezing the residual juice out of the membranes into a glass, you have only to rinse off your hands and eat the fruit.

This procedure will work with nearly all citrus fruits (although it is essentially unnecessary with tangerines and other "zipperskins"), graphic proof that they are relatives. Taxonomists looked to this similarity when they lumped all these specialized berries, or hesperidia, into the subdivision Citreae of the family Rutaceae. The Citreae are further divided into three subtribes, of which the true citrus group is the one that includes oranges et al.

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Modern citrus growers rejoice in this state of affairs, which has made
genetic engineering with citrus trees comparatively easy. They can either graft disparate species onto each other with ease or they can grow seedlings without the risk of unsuccessful variation that threatens seed propagation in many other plants.

But citrus men have also inherited a complex legacy from less scientific millennia, during which citrus genes blended and intertwined to produce a thicket of varieties too tangled to sort out cleanly in the greenhouse or in the field. Indeed, horticulturists have sometimes reproduced hybrids that had already appeared in nature, while for most species it has been impossible to locate wild progenitors.

The citrus diaspora began in prehistoric times in northeast India. By 136 B.C., Simon the Maccabee was ordering that citrons replace cedar cones in the Jewish harvest-festival ritual. Palestinian Greeks then conflated the two objects and kept the old name, which is why all citrus plants are now named after cedars (kedros). The citron (Citrus medica) was the first such fruit to reach Europe. This happened in Hellenistic times, after Alexander had opened up good lines of communication with the East. Eventually, it fell to Columbus, on his second voyage in 1493, to close the circle by transporting orange, lemon, and citron seeds to Hispaniola.

The West Indies have ever since been a rich ground for citrus evolution. A certain Captain Shaddock introduced the largest of all citrus fruits, Citrus grandis, to Barbados in 1696. Now known as the shaddock, or pummelo, its flesh has not won many adherents. But during the eighteenth century, shaddocks mutated into a more delectable fruit that grew in clusters like grapes and was therefore dubbed the grapefruit in Jamaica. The name stuck, despite efforts on the part of horticulturists to rename it “pomelo.” The grapefruit (C. paradisi) reached the United States in 1823, when a French settler, Odette Philippe, planted seeds or seedlings from the Bahamas near Safety Harbor on Tampa Bay. All modern American varieties are said to descend from this original planting (red and pink varieties are mutations). And since this country now produces 90 percent of the world’s grapefruit crop, Dr. Philippe deserves an important place in the pantheon of American economic botany.

Mandarins are the zipperskin family of tangerines, and because they are genetically easier to graft, they are the most popular citrus. But citrus men have also inherited a complex legacy from less scientific millennia, during which citrus genes blended and intertwined to produce a thicket of varieties too tangled to sort out cleanly in the greenhouse or in the field. Indeed, horticulturists have sometimes reproduced hybrids that had already appeared in nature, while for most species it has been impossible to locate wild progenitors.

The citrus diaspora began in prehistoric times in northeast India. By 136 B.C., Simon the Maccabee was ordering that citrons replace cedar cones in the Jewish harvest-festival ritual. Palestinian Greeks then conflated the two objects and kept the old name, which is why all citrus plants are now named after cedars (kedros). The citron (Citrus medica) was the first such fruit to reach Europe. This happened in Hellenistic times, after Alexander had opened up good lines of communication with the East. Eventually, it fell to Columbus, on his second voyage in 1493, to close the circle by transporting orange, lemon, and citron seeds to Hispaniola.

The West Indies have ever since been a rich ground for citrus evolution. A certain Captain Shaddock introduced the largest of all citrus fruits, Citrus grandis, to Barbados in 1696. Now known as the shaddock, or pummelo, its flesh has not won many adherents. But during the eighteenth century, shaddocks mutated into a more delectable fruit that grew in clusters like grapes and was therefore dubbed the grapefruit in Jamaica. The name stuck, despite efforts on the part of horticulturists to rename it “pomelo.” The grapefruit (C. paradisi) reached the United States in 1823, when a French settler, Odette Philippe, planted seeds or seedlings from the Bahamas near Safety Harbor on Tampa Bay. All modern American varieties are said to descend from this original planting (red and pink varieties are mutations). And since this country now produces 90 percent of the world’s grapefruit crop, Dr. Philippe deserves an important place in the pantheon of American economic botany.
Colombian Orange Puffs

The Dumpling Cookbook, by
Polushkin. Workman Publishing Co.

1. Prepare a cookie dough crust (pâte sablée) with the flour, 7 tablespoons of the sugar, 5 tablespoons of the butter, and the shortening. Blend the butter and shortening quickly with your fingertips or a pastry blender or two forks, until the dough reminds you of oatmeal. Blend in the egg and gather the dough up into a ball. Press it in a long smear across the work surface with the heel of your hand. Re-form the ball and refrigerate in a plastic bag for several hours, until firm.

2. Just before you are ready to roll out the dough, preheat the oven to 300 degrees, grease the surface of a cookie sheet and prepare the filling for the tart: grind the almonds in a nut grinder or whirl in the blender, turning the machine off and on several times to minimize the release of oil from the nuts. With a vegetable peeler, cut away the yellow part of the lemon peels; chop this lemon zest as finely as you can. Beat together the remaining sugar and remaining butter. Then beat in the egg yolks, the ground almond, and the chopped lemon zest.

3. Roll out the crust until it is a circle about 14 inches in diameter. Put a greased 10-inch flan ring on the cookie sheet. Place the dough over the ring and push it snugly against the inner sides of the ring. Run a rolling pin across the top of the ring to cut away excess dough (which can be reserved to make cookies). Push the dough up over the top of the ring all around to about ¼ inch above the ring. Press with the back of a knife against the rim.

4. Pour the almond/egg/lemon filling into the tart shell. It should come about three-quarters of the way up the side of the shell. Bake until the crust browns nicely and the filling has set, about 40 minutes.

5. When the tart is done, lift off the ring (cut it loose with a thin knife if necessary) and slide the tart onto a serving dish. Let cool before serving.

Yield: 4 to 6 servings.

Tarte au Citron

(tart as prepared at the Midi- nut Restaurant, Lyon)

1¼ cups blanched almonds
Peel of 2 large lemons
3 egg yolks

1. Sift 2 cups flour into a medium bowl, sift together ½ cup sugar, and 1 cup salt. Add the butter, orange juice, and orange peel and mix to form a stiff dough, dialing extra flour if necessary.

2. Move the dough to a floured board and knead for about 10 minutes or until the dough feels smooth and satiny. Cover and let stand half an hour.

3. Roll the dough as thin as possible. Use one or several cookie cutters to cut out shapes you like. Coat the vegetable oil to 360 degrees.

4. Roll the dough pieces into the hot oil and fry for 3 minutes or until golden brown. Fry no more than 4 to 6 fritters at one time.

5. Remove with a slotted spoon and drain on absorbent paper. Repeat until all are done.

6. Sprinkle with confectioner’s sugar and serve.

Yield: 4 to 6 servings.

Raymond Sokolov’s most recent cookbook is The Saucier’s Apprentice, a guide to French sauces.

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EAST COAST SOUTH AMERICA

Nov. 19. (27 days) Sail south from Rio de Janeiro to Buenos Aires. Visit the Falklands (Islas Malvinas) and Punta Arenas. Chile returns to Ushuaia, southernmost town in Argentina.

2 ANTARCTIC ADVENTURES

Cemeteries (p. 32)


Monarch Butterflies (p. 40)


Alligators (p. 54)

Edward A. McIlhenny's personal account of Louisiana alligators, Alligator's Life History (Boston: Christopher Publishing House, 1935), contains many observations that later research has proved to be inaccurate. A 1976 reprint edition of this work may be obtained from Publishing Section, Society for the Study of Amphibians and Reptiles, Department of Zoology, Miami University, Oxford, Ohio 45056, at the cost of $12 (paperback) or $15 (hardcover). A useful overview of both extinct and living crocodilians is Wilfred T. Neill's The Last of the Ruling Reptiles: Alligators, Crocodiles, and Their Kin (New York:...
Rickenbacker Causeway, Miami, Florida 33149. An annotated bibliography on man's recreational impact on natural resources is available from Wildland Recreation Research Project, Pacific Northwest Forest and Range Experiment Station, U.S. Department of Agriculture Forest Service, 4507 University Way NE, Seattle, Washington 98105. Bruce E. Bechtol and Jerry R. Williams have written two other articles on litter: "The Litter Census as a Tool in Geographic Education" (Journal of Geography, November 1972, pp. 468–72) and "Is the Aluminum Container a Viable Alternative to Oregon-Style Legislation?" (Modern Brewery Age, May 31, 1976, pp. 22–23), which describes littering patterns at twenty-three California sites.

Lightning (p. 66)


Pamela Haas

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Celestial Events
by Thomas D. Nicholson

Sun and Moon  The sun moves from the constellation Taurus into Gemini on June 20 and arrives at the summer solstice on June 21. It continues eastward in Gemini into July, passing south of Castor and Pollux about the 15th, finally entering Leo on August 10. A few days later, on August 13, it passes the planet Saturn. Now in the most northerly part of its apparent sidereal path, the sun spends nearly 14½ hours above the horizon daily.

Expect a morning moon during the first half of June, July, and August and an evening moon during the last half, with new moon occurring about mid-month and full moon near month’s end. Phases in June are last-quarter on the 8th, new on the 16th, first-quarter on the 24th, and full on the 30th. In July: last-quarter on the 7th, new moon on the 16th, first-quarter on the 23rd, and full moon on the 30th. Last-quarter will occur again on August 6, new moon on August 14. Perigee moon is on June 1, June 29, July 27; apogee on June 14, July 12, August 8.

Stars and Planets  There are no planets on the Star Map this month, because none are above the horizon at map times. Mercury is an evening star for July, but sets too early for good observing. Saturn is also in the evening sky through August 13, low in the west for several hours after sunset in June and early July, but poorly placed after that.

The morning planets are better located. Venus is dominant in the east for several hours before sunrise and quite brilliant (although dimmer than it was in May, it is better positioned for viewing). In early June, Mars will be near the brighter Venus. Look on the morning of June 12, when the late crescent moon will pass by them. Jupiter will show up as a morning star by early July, low in the east before sunrise, below Venus. The distance between these two planets will decrease until the end of July, when they are quite close; it will then increase slowly in August. Jupiter, Venus, and the crescent moon will be impressive on the morning of July 13 and again on August 11.

June 3: Venus is in conjunction with Mars.
June 4: Jupiter, in conjunction with the sun, enters the morning sky.
June 13: Earliest sunrise of the year.
June 15: Venus is at its greatest distance from the sun in the morning sky.
June 20: Saturn is near the moon tonight.
June 21: Solstice. Summer in the Northern Hemisphere begins at 7:14 A.M., EST.
June 28: Latest sunset of the year.
June 29: Mercury enters the evening sky.
July 5: Earth is at aphelion, farthest from sun (94,500,000 miles).
July 11–12: The late crescent moon passes Mars and Venus in the morning sky.
July 13: Jupiter is near the moon this morning, below Venus.
July 29: Maximum of the Delta Aquarid meteor shower.
July 30: Venus is in conjunction with Jupiter, separating thereafter to the east (below Jupiter).
August 8: Mercury is at greatest elongation in the evening sky.
August 9–10–11: The moon passes Mars, Jupiter, and Venus in the morning sky, coming closest to each on successive mornings.
August 12: The rich, impressive Perseid meteor shower reaches maximum.
August 13: Saturn, in conjunction with the sun, becomes a morning star.

★ Hold the Star Map so the compass direction you face is at the bottom; then match the stars in the lower half of the map with those in the sky near the horizon. The map is for 1:15 A.M. on June 1; 12:20 A.M. on June 15; 11:25 P.M. on June 30; 10:25 P.M. on July 15; 9:20 P.M. on July 31; and 8:20 P.M. on August 15; but it can also be used for an hour before and after those times.
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Announcements

The Aeolian Chamber Players will give two concerts, one for children and the other for adults, in the Museum's Auditorium during the weekend of June 11 and 12. This ensemble, founded in 1961, has a wide repertoire of contemporary and classical selections that are rarely performed. The group is noted for its unorthodox, imaginative playing techniques; for example, in their frequent rendering of "The Voice of the Whale," from George Crumb's Vox Balurnae, the flutist sings into the flute and the pianist strokes the piano strings with a chisel. The ensemble also plays works of other contemporary composers, such as David Burge's "Aeolian Music," Arnold Schoenberg's chamber symphony No. 9, and William Bolcom's "Whisper Moon." The concert for children, June 11 at 11:00 A.M., will emphasize pieces based on folk music and is free to all participating and donor members of the Museum. Associate members and the public will be charged $0.50 cents per ticket. The second concert will be on June 12 at 3:00 P.M. Tickets, available by mail order or at the second floor information desk, are $3.00 for participating and donor members, and $4.00 for associate members and the public.

More than 100 specimens of Cones and Cowries, two colorful shell types favored by collectors, will make up an exhibit in the Roosevelt Rotunda. A short time ago, the Museum was given two unusual shells: one a species of cone shell, Gloria maris, or glory of the sea; the other, a species of cowrie, Cytraea valenti. These two specimens form the basis of the exhibit, which will run from June 15 through August.

A photo exhibit honoring Margaret Mead, curator emeritus of ethnology at the American Museum, will continue throughout the summer in the Akeley Gallery on the second floor. The display includes photographs of Mead as a child, as a student, as a young anthropologist interviewing South Pacific islanders, and more recently, as a well-known lecturer and panelist. The display consists of both black-and-white prints and projected color transparencies.

An exhibition of Maps—Their Science and Their Arts, in Gallery 77 on the first floor of the Museum, explains map scale and projection, the use of latitude and longitude, and the kinds of instruments used in map making. Many of the maps are of New York City: some are historical, showing the growth of the city, while others explain the city's different aspects—school districts, water supply routes, topography. Also displayed are maps used by other societies. Examples are a reproduction of an Aztec codex and a birch bark map used by American Indians. Most of the maps are on loan from the Museum's various departments and from such institutions as the American Geographical Society and the U.S. Geological Survey.
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by Aynsley
4 Authors

8 Letters

22 The Biology of Aging Leonard Hayflick
   For an animal to develop, its cells must contain "death clocks."

34 This View of Life Stephen Jay Gould
   Our Allotted Lifetimes

45 Prizewinning Photographs
   From the 1977 Natural History Photographic Competition, a colorful
   look at life.

64 Botanicas: Puerto Rican Folk Pharmacies Mary Ann Borrello
   and Elizabeth Mathias, photographs by Marcia Keegan
   For sale: potions, herbs, candles, and colorful statues of Buddha, Jesus
   Christ, African gods, the Madonna, saints, and cigar-store Indians.

74 The Great Grizzly Grapple Christopher Cauble
   Is there room on earth—and in the human psyche—for a free,
   magnificent, and dangerous bear?

82 Celestial Events Thomas D. Nicholson

84 A Naturalist at Large Bernard Nietschmann
   The Bambi Factor

88 Sky Reporter Stephen P. Maran
   Rings Around Uranus

94 Book Review Alain Y. Dessaint
   The Chinese Way of Eating

104 A Conjugation of Snails photographs by Hans Pfletschinger
   Like minisized Cupids, land snails start courtship by shooting darts
   into each other.

108 A Matter of Taste Raymond Sokolov
   Up from Catsup

114 The Market

116 Additional Reading

118 Announcements

Cover: Charles B. Krebs's photograph of an anhinga, taken in Everglades
   National Park, Florida, won First Prize in the Natural World category
   in the 1977 Natural History Photographic Competition. A 17-page display
   of other contest winners begins on page 47.
A leading figure in the technique of culturing human cells, microbiologist Leonard Hayflick is affiliated with the Children's Hospital Medical Center, Bruce Lyon Memorial Research Laboratory, Oakland, California. He has served in the past at the Wistar Institute in Philadelphia and worked and taught at Stanford University School of Medicine in California. Hayflick received his Ph.D. in medical microbiology and chemistry from the University of Pennsylvania in 1956. His research plans include a project involving the reconstruction of human cells from isolated nuclei and cytoplasms.

Elizabeth Mathias, right, is associate professor of anthropology at Saint John's University in New York City's borough of Queens. Her work has centered on Italian-American folk religion in south Philadelphia, and on life in a Sardinian shepherd village. Sister Mary Ann Borrello, left, of the Dominican order of Our Lady of the Rosary, is assistant professor of sociology and anthropology at Suffolk County Community College on Long Island, New York. While teaching in the South Bronx, in 1960s, Borrello first became aware of spiritism's pervasiveness among New York's predominantly Roman Catholic Puerto Rican community when she asked her Puerto Rican grade school students what the mothers did when the children were ill. In 1975, one of Mathias's college students invited her to a spiritist ceremony. Borrello went along, and a joint study of botanicas and Puerto Ricans' dual religiosity began.

“For the past two years I have been, in a sense, a migrant worker,” writes Christopher Cauble. In the summertime he worked for the National Park Service in Alaska; winters he settled in the mountains of Montana to pursue free-lance writing. Cauble's interest in grizzlies became firmly entrenched in 1972 when, alone on a backpacking trip in Mount McKinley National Park, a sow grizzly attempted to sink her teeth into a selected part of his anatomy. He has encountered more than a hundred grizzlies in the backcountry of Mount McKinley, Glacier, and Yellowstone national parks, and at Katmai National Monument in Alaska. Cauble is working for the National Park Service in Katmai this summer.
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A report on how the forest industry is working to get twice as much wood from America's commercial forests. Year after year. Forever.

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But while world demand for wood is increasing, the amount of land available for commercial forests is shrinking. Some of it has been set aside for parks and wilderness areas. Much of it has been turned into farms, freeways and new developments.

The chart above shows that U.S. consumption of all wood and paper products will double in less than 50 years. Thus the reason behind Operation Double Tree—the forest industry's name for intensive forest management that can double the amount of wood grown on a given piece of land. And do it in such a way that the forest remains a valuable part of the ecosystem.

Double Tree is ambitious and is already working.

All across the U.S., forest product companies are working to double forest yield. In Oregon and Washington, forest product companies are predicting triple growth with genetically superior trees planted in prime forestlands.

Through thinning efforts alone, some companies in the Great Lakes States have increased diameters of remaining trees enough to double wood volume per acre over a 35-year period.

Today's intensive forest management is rooted in nature's own ecological cycles. Harvesting begins with the harvest. Slower growing trees are thinned at peak growth. Others are harvested at peak growth.

The two Douglas firs to the right grew in the forests of the Cascade Mountains of Washington State. Both were harvested when they were 25 years old. The difference is, the larger one grew in an Operation Double Tree area, while the smaller one did not.

Double Tree isn't limited to large-trial tree farms. Individual wood owners from Maine to Georgia are turning idle lands to work, creating belts that offer the twin payoffs of increased harvest and eternal forest resources.

That may sound like a paradox. But to a forest manager, eating a cake and having it, too. Like oil or coal, wood is one naturally available source that is renewable. And as a result, forestry has found ways to make Nature more productive.
Dedicated to using every last part of the tree: tops, limbs and bark.

New Forest.

But the real key is in the new forest, the new trees. In some areas, foresters plant new plants by machine, or by hand. Helicopters are also used to re-seed. When seedlings go in, the forest often gets a five-year head start over natural regeneration in the same area. Many of them are of genetically superior stock, the result of years of selective "breeding." Seedlings by the hundreds of millions are grown in special nurseries. They're healthier, faster growing, mature faster and can be harvested sooner.

In some forestlands, such as in the Northeast and some states, are Mother Nature because natural regeneration does a better job.

Soil studies determine prime growing areas. When necessary, nutrients are added. And the young trees are protected from destructive insects, fires and natural enemies.

The result is a better quality forest, one that can be at least twice as productive.

Who Owns The American Forests?

Significantly, the principles of Operation Double Tree are being used on only a small portion of America's forestland. And good as Double Tree is, it might not be enough. Too much of the American forest is still under-utilized and under-productive.

Overall, industrial forestlands are working the hardest. Industry owns only 13 percent of the commercial forestland, but it provides almost 30 percent of the total harvest. Some 4 million private individuals own 60 percent. Government owns about 27 percent.

All of which means we must join to make the most productive use of our remaining commercial forestland. Industry has invested millions to make the concept a reality. But money isn't enough. Leaders and landowners alike must understand the problem. And, more important, the solution.

For more information, write for our free booklet "Managing the Great American Forest," American Forest Institute, P.O. Box 873, Springfield, VA 22150.
A Turtle Vanishes

Jim Cooper’s article “Vest-pocket Turtle” (April 1977) stimulated us into a weekend field trip to photograph *Kinosternon flavescens spooneri*, its habitat, and other eastern Iowa sand prairie fauna on Muscatine Island.

Hopeful and anxious to locate a live Illinois mud turtle, we were disappointed. A careful search of the first pond we encountered revealed the remains of seven dead *spooneri*. At the second pond, we discovered that some disaster had also befallen its chelonian population. Walking one-third of this larger pond’s shoreline, we counted fifty dead turtles representing four species, including one more *spooneri*. The area we surveyed was small, so hopefully there are other ponds harboring *spooneri* which did not meet the same fate.

The cause of the turtles’ death is not known to us. The very severe winter combined with a low water level in the ponds could have caused many turtles to freeze. A chemical plant nearby may be using the ponds for waste disposal. In any case, “the largest known population of the Illinois mud turtle” is in trouble, if not destroyed.

If a viable population of *spooneri* survives on Muscatine Island, the future may be no brighter than the present. The northern end of Big Sand Mound is owned by a large chemical company, and the rest has just been purchased by an electric company as a site for a generating plant. Though the power company has proposed setting aside some unused acres as a “nature preserve” when construction starts this fall, the needs of a generating plant and a rare semiaquatic turtle may not coincide. Where there is a clash, it’s doubtful that the power facility would be modified to preserve turtles.

All populations of the Illinois mud turtle should probably be listed as endangered by the Office of Endangered Species, U.S. Fish and Wildlife Service. Federal endangered status would not only protect individual turtles, but such listing would allow “critical habitat” designation for Muscatine Island and similar areas. This type of protection would preserve not only the “vest-pocket turtle,” but the entire sand prairie fauna.

John C. Murph
Plainfield, Ill.
Michael J. Coyle
Grayslake, Ill.

Animal Traffic

Jean-Yves Domalain’s “Commissions of an Animal Trafficker” (May 1977) correctly describes how trade in illegal wild animals can occur because of the disinterest of some government officials and bribery of others, and how some callous dealers grossly mistreat animals, but it incorrectly reports many other aspects of the international trade in live animals. The author is only partly accurate in detailing the collection/shaping end of the animal trade that exists in parts of Southeast Asia, it is frequently inaccurate when describing the purchasing/receiving end of the trade in Europe.

Far and away the greatest number of live wild animals sold internationally or domestically go to the pet market, not to zoos and circuses. For example, U.S. Fish and Wildlife Service records for 1970 and 1971 indicate that 95 percent of the wild birds imported into the United States were for sale as pets to private citizens. About 4 percent were sold for medical research and less than 1 percent were destined for zoos. The remainder were imported by wildlife agencies and other special interests. At the same time, about 44 percent of the imported wild mammals were sold as pets, 54 percent went to medical research, and less than 2 percent to zoos and aquariums, with the remaining fraction for wildlife and agricultural purposes. Wild bird imports for 1973 and 1974 were roughly similar, with 98 percent destined for pets and less than 2 percent for zoos.
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In 1973, only 30 percent of the animals were imported for sale as pets, while 60 percent were brought into biomedical research. Approximately 4 percent went to zoos at aquariums.

Domalain knows that the majority of live wild animals are sold to private pet keepers, but he chose to downplay that fact in favor of attacking the more conspicuous zoos. And his customers were primarily French institutions, possibly the least knowledgeable and/or least humane of all zoos on the European continent.

A good many North Americans view European zoos as among the enthusiastic supporters of efforts to eliminate commercial trade in endangered or legal wildlife, by participating in voluntary boycotts prior to enactment of endangered species laws, pressing for passage of the U.S. Endangered Species acts, and actively participating in the drafting of the Convention on International Trade in Endangered Species of Wild Fauna and Flora and the domestic legislation that implements this treaty in the more than 30 nations that have ratified it to date. Several zoological societies have global programs aimed at conserving wild animals in their natural habitats.

In summary, author Domalain's experiences in trafficking in wild animals in Southeast Asia and selling them primarily to French buyers, include some badly operated French zoos, has given him a biased understanding of actual world trade in wild animals and of professional zoo operation.

F. Wayne Keeney
Director of Zoology
Conservancy
New York Zoological Society

Less Litter

I hope you follow up “California Litter” (June-July) with another article on the same problem.

We have found here in this small corner of the Hudson Valley that our annual “Litter Days” well-publicized locally, do help. We make piles out of them, ending a three-hour litter-picking with a two-hour picnic with songs. The total volume of litter has slowly but steadily gone down.

Our Clearwater “sloop club” keeps a watchful eye on a small state park beach and a municipal waterfront. At the latter we have torn down the insulting “No Littering $5 Fine” sign, which no one, including police, paid much attention to.

(Please turn to page)
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put up colorful hand-painted “Welcome” signs with information about the area.

It is obviously impossible to regulate and supervise every acre of public land. It is possible to examine other industrialized nations of the world, and learn from them.

Peter Seeger
Beacon, NY

Bechtol and Williams’s concern over the amount of litter on California beaches and other recreational areas is shared by many in our country.

The major portion of this trash consists of beverage bottles and cans, their research revealed. (A glance alongside most roads in the nation will reinforce this conclusion.)

I say “most roads” because here in Vermont a person is hard pressed to find bottles or cans along roadsides, on the beaches, in the woods . . . anywhere.

This is a result of our beverage container deposit law, which requires that a deposit be paid on soft drink and beer bottles and cans (usually 10 cents) and which is refunded when the empty containers are returned.

“Flip-top” cans with metal tops that are removed to open the can are prohibited.

This law has drastically reduced the amount of litter in our state.

Few people will throw away nickel, and for those who will, there are many more who will pick it up (Had they been Vermont bottles, Bechtol and Williams’s collection would have brought a tidy $335.10). A. J. Shelly Rutland, Vermont

Every independent study I have seen shows that metal beverage containers are distinctly in the minority as a percentage of litter. We aren’t particularly happy about this as we wish people wouldn’t litter anything at all. But banning the can will not solve the problem.

While we don’t have a ready answer to the very real over-all litter problem, we are making exception in getting aluminum cans out of the litter. They are worth about $400 a ton, and in 1976 alone the aluminum industry recycled 4.9 billion of them, including about 1.5 billion from the state of California. At we’ll do better in 1977?

Blair R. Gett
Aluminum Company of America Pittsburgh, Pennsylvania
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Normal human cells seem to have a limited capacity for replication. Before the limit is reached, aging sets in and death approaches.

There is probably no other area of scientific inquiry that abounds with as many untested or untestable theories as does the biology of aging. Three of the most tenable hypotheses on which most other theories ultimately rest are based on modern understanding of the molecular biology of genetics. Several considerations, not the least of which is the constancy of the life-span within each animal species, lead to the conclusion that the probable cause of senescent change is somehow contained in the genetic message.

The first of the three generalized possibilities now au courant is that the manifestations of senescent changes are the result of actions by the genetic program, which contains specific "aging genes" that code for the senile changes presaging the death of the organism. All developmental changes result from a preexisting genetic program played out over time. Consider, for instance, the inevitability of the menopause and the graying of hair, two examples of predictable biological events that occur late in life and that are probably genetically based.

Advocates of the theory of a prewritten genetic program conjecture that aging results from this kind of mechanism. They argue further that the survival of a species depends upon the ability of its members to live long enough to reach the age of procreation and that what occurs after that is essentially irrelevant. The biological changes that occur during this irrelevant period we recognize as senescence.

This reasoning postulates that profound clinical manifestations of aging occur only in humans and in their domestic or zoo animals. Wild animals that have not learned to cope with disease and predators do not live long enough to exhibit senescent changes to the degree observed in humans or those species we choose to protect. Old animals in the wild are simply culled by predators and disease well before real aging becomes manifest. Thus the profound senile changes seen in humans are inadvertently unmasked because of man's success in controlling his environment.

The second hypothesis involving the genetic apparatus has many of the features of the preceding argument, except that it does not include specific aging genes; instead, it proposes that the organism simply runs out of genetic information, resulting in those biological changes we recognize as senescence.

The third hypothesis of aging maintains that the genetic information system, although programmed for sequential biological events, eventually acquires inaccuracies and produces misspecified proteins. Loss of accurate information occurs from an accumulation of random events that damage essential information-containing molecules. When threshold of "hits," "damage insults," or "errors" is reached, normal biological activities stop at signs of aging occur. The nature of damage to such essential molecule is not clearly understood, but the fact of its occurrence is known.

Some gerontologists believe that the reason for the known redundance of identical message units in human DNA, for example, is that it provides insurance against the vulnerability damage inherent in this system, as that the presence of duplicated information serves to lengthen the time before hits and errors accumulate in sufficient number to confound the genetic message.

A specialized case of this last general theory has been described in which errors are postulated to occur in those molecules that synthesize enzymes. A faulty enzyme could very quickly produce a batch of faulty even lethal misspecified proteins, very much as a single faulty machine tool would quickly produce hundred of faulty parts. A search for these misspecified proteins in aging cells...
On Photographing the Invisible

To the naked eye, it was a Swedish 80-ore postage stamp. A rarity, and very valuable.

The camera, however, told quite another story. The stamp was a counterfeit.

Faint traces of tampering that were hidden to the naked eye were revealed by the camera. Someone, somewhere, had ingeniously altered the stamp by chemically removing a surprint. The stamp was worthless.

What manner of exotic camera was this that could "see" the invisible?

The lens: one of the 20 in the Hasselblad arsenal, the 105mm Zeiss UV-Sonnar f4.3. Designed for photography within the ultraviolet portion of the electromagnetic spectrum, its costly quartz elements can detect radiations that are unseen by the human eye.

It has peered at objects in outer space, examined forgeries, laid bare the secrets of counterfeit money. Not a lens for everyone, obviously, but an indication of just how awesomely comprehensive the Hasselblad System is.

The camera: an otherwise perfectly standard Hasselblad 500C/M, normally fitted with an 80mm Zeiss Planar f2.8 multi-coated lens.

This is the basic model that allows you to tap into the vast Hasselblad System. It is one of the most bewilderingly versatile cameras the world has ever known. Yet so marvelously simple to operate that it often plays the part of the family snapshot camera.

A True System.
The Hasselblad System is a prodigious array of 4 cameras, 20 lenses, 8 viewfinders, 9 film magazines, and over 300 other accessories. Choose the right pieces, and your 500C/M would be equipped for sports, aerial, architectural, and fashion photography.

And portrait, landscape, medical, underwater, and news photography.

And wildlife, laboratory, industrial, and child photography.

And you would always have the right film in the camera at the right time. You can shift from color to black-and-white and back again to color—and resume shooting at precisely the right frame—by popping in the protective dark slide and switching film backs.

The Camera with Nine Backs.

There is a small button on the film back of every Hasselblad 500C/M. Slide it sideways with your thumb and the back will come away in your hand.

The standard back holds 12 exposures. Each frame of film is 2 1/4 inches square, almost four times the area of a 35mm frame (See box, below, right, for actual size.)

This is only the beginning. There are eight other backs available: Backs that let you change to a 6 x 4.5cm format—or a 4.5 x 4.5cm superslide format for showing in any 35mm projector. Backs that give you a choice of 1, 12, 16, 24, 70, or 500 exposures. A back that is a sheet-film adapter.

Even two backs for Polaroid film, so you can check composition, lighting, and exposure ahead of time.

You begin to realize why eight out of ten top commercial photographers surveyed name Hasselblad as the medium-format camera used in their work.

Retained Value vs. Obsolescence.

In an age when machines spew out cameras in the tens and hundreds of thousands, when flashy new models thrust last year's marvels into early obsolescence, Hasselblad goes its own way.

Planned obsolescence is taboo at Hasselblad. All but two of the accessories for the 500C/M will fit every Hasselblad made since 1957 (except the Super Wide Cl) ... and will fit every future Hasselblad.

The greater part of a year is spent on building each camera, much of it crafted by hand. And fully one quarter of the work force devotes its time to nothing but quality control.

Little wonder, then, that a pre-owned Hasselblad commands such a high price... if its owner can be persuaded to part with it at all.

Hasselblad 500C/M.

A lavish brochure is available free if you write:
Braun North America, Dept. 0000, 55 Cambridge Parkway, Cambridge, Mass. 02142
Braun North America is a division of The Gillene Company and exclusive marketer of Hasselblad cameras in the U.S.
If you think an economy car would put you in a compromising position, look again.

With a Volkswagen you could actually wind up with more room and comfort than you have now.

Our Dasher, for example, comes in a beautifully appointed 2-door hatchback or 4-door sedan, with fully reclining bucket seats, plush carpeting, and enough room for five passengers.

In fact, the Dasher beats just about every car in its class in combined interior room and trunk space. And in a wagon, it has more cargo area than any car in its class.*

Then there’s our Rabbit, which has been catching everyone by surprise. Even Detroit. To start with, it takes off like a shot.

With acceleration from 0 to 50 mph in amazing 7.7 seconds. (That’s faster than Triumph Spitfire.) And with front-wheel drive that literally pulls you around corners.

It also has more room.

ple than 25 other cars you could (including Monza, Mustang II, Pinto, Celica, and Datsun B-210). And the room for luggage than 53 other cars. 

That is, would you believe, with the rear seat folded in it can hold 21 bags of groceries. And the seat folded up it still has more trunk room for luggage than a Cadillac Seville.

Finally, we come to Scirocco, our true car that gives you extravagance and a good sense at the same time.

Last year Scirocco was the Trans Am winner for cars under 2 liters. And speaking of economy, the Scirocco was just named one of the "25 best-designed factory-made products available in America today" by Fortune magazine.**

It also gives you something few sports cars can offer: room for four and more trunk space than a Ford LTD II. Yet (amazingly!) a Scirocco has the same economy as a Rabbit. Both Scirocco and Rabbit get 29 mpg on the highway and 22 mpg in the city. Dasher gets 36 mpg highway, 24 mpg city. (Of course, these are EPA estimates with standard transmissions. Your mileage may vary depending on how and where you drive, optional equipment and your car's condition.)

With all this going for our Volkswagens, we suggest you stop in to your Volkswagen dealer for a test sit.

It's one way to get through the energy crisis without getting bent out of shape.

Economy without sacrifice.

June, May 1977.
now the object of considerable research. Since no system works flawlessly, what causes these defects to occur initially? Is it chance or programming by aging genes, which, with clocklike precision, assures that the genetic program functions accurately up to a point and then specifies its ending?

Whether any of the aforementioned notions, alone or in combination, will ultimately explain the biology of senescence cannot now be determined. Nevertheless, most gerontologists would argue that the fundamental events that orchestrate age-related changes are likely to be found in the genetic machinery.

In addition to hypotheses rooted in genetic mechanisms, several theories of aging currently under study involve events occurring at a higher organizational level than the gene or enzyme. These theories include such things as immunological mechanisms, a mechanism based on the age-accelerating effect of radiation energy, and changes in the chemistry of connective tissues. Yet these latter considerations involve events occurring at levels of biological complexity that either do not apply to all animals that age or are secondary or tertiary changes caused by more fundamental events occurring at the gene level.

After reaching sexual maturity, individual members of a species eventually accumulate physiological losses that lead to an increase in their chances of dying. In fact, the actuarial data for humans, first analyzed by the English actuary Gompertz in 1825, reveal that the likelihood of dying doubles every seven years after the age of thirty. A variety of human physiological functions decline at a rate of about 0.8 to 0.9 percent per year of the functional capacity present at age thirty.

The notion that aging occurs in animals that reach a fixed size after maturity is beyond dispute, but is the inevitability of the aging and death of individual cells composing that organism predetermined? A superficial consideration of this thought may provoke disbelief since it is intuitively obvious that a dead or aging organism must consist of dead or aging cells. Research shows that whatever causes aging and death in the whole organism does not produce similar changes, and at the same rate, in each cell composing the organism. If the rates of aging vary among organs, tissues, and their constituent cells, then one might argue that the root causes of aging may occur as a consequence of losses in some few cell types where the rate is fastest and the effects greatest. Let us explore the notion that normal somatic, or body, cells as opposed to germ, or sex, cells are destined to undergo irreversible functional declines that may presage aging in the whole organism.

There are at least two ways in which this question has been tested. First, vertebrate cells have been grown and studied in cell culture, and second, cells have been serially transplanted in laboratory animals. The goals of such studies have been directed toward answering this fundamental question: Can vertebrate cells, functioning and replicating under ideal conditions, escape from the inevitability of aging and death, which is universally characteristic of the whole animals from which they were derived?

In respect to those studies undertaken in cell culture, one investigation stands out as the classic response to this intriguing question. In the early part of this century Alexis Carrel, a noted cell culturist, described experiments purporting to show that cells derived from chick heart tissue could divide indefinitely. The culture was voluntarily terminated after thirty-four years. This experiment is important to gerontologists because if cells, released from controls by the animal, can divide and function normally in culture for periods in excess of the life-span of the species, then either the type of cells cultured plays no role in the aging phenomenon or aging is the result of changes that occur only in whole organs. The inference would be that aging per se is not the result of events occurring in the cells.

Following Carrel's observation, support for his experiments seemed to be forthcoming from other laboratories in which it was noted that cultured cell populations, derived from many tissues of a variety of animal species and from humans, had the striking ability to replicate apparently indefinitely. These cell populations, which arise spontaneously, number in the hundreds and are best known by the prototype cell lines HeLa (derived from a human cervical carcinoma in 1951) and L cells (derived from mouse connective tissue in 1943). They continue to flourish to this day in cell culture laboratories throughout the world. Nevertheless, what seemed to be incontrovertible evidence for the potential immortality of vertebrate cells soon fell to new insights and a preponderance of opposing evidence.

Of central importance to the question is whether the cell populations studied in vitro are composed of normal or abnormal cells. Clearly aging of animals occurs in normal populations and if we are to equate the behavior of normal cells in vitro with similar cells in vivo, then the latter must also be shown to be normal.

It is for this reason that the "immortal" cell lines described above which the HeLa and L cell populations are prototypes, must be excluded from consideration because they are abnormal cells. For example, most immortal cell lines do not have either the exact number or the precise morphology of chromosomes characteristic of the cells composing the tissue from which they originally descended. Many such cell lines give rise to tumors when inoculated in laboratory animals, and some reveal biochemical properties uncharacteristic of the cells composing the tissue of origin. The widespread use, by cell lines for a variety of research purposes in laboratories throughout the world is subject to criticism that, in most cases, they are not characteristic of any cell type found in human or animal tissue.

However, cell populations entirely typical of normal cells found in vivo can be cultured, and in respect to gerontological inquiry, the findings are profoundly different from the behavior of abnormal cell lines.

Some fifteen years ago, Paul Macleod, a geneticist now at the University of Pennsylvania Medical School and I found that cultured normal human embryonic cells underwent a finite number of population doublings in vitro and then died. We found that when such cells were grown under the most favorable conditions, death was inevitable after about fifty population doublings. We also showed that death of cultured normal cells was an inherent property of the cells themselves. That observation has now been confirmed in hundreds of laboratories.

Since normal cell strains have a limited doubling potential in vitro, studies on any single strain would be severely curtailed were it not possible to preserve these cells at subzero temperatures for apparently indefinite periods of time. The reconstitution of
Pruning as a means to more nearly perfect wines.

To us, pruning — the cutting off of parts of the grapevine during the winter dormant period — is the single most important practice in the entire culture of grapes. It is a complex and highly judgmental operation that not only controls the amount of crop our vines will bear, but also controls the quality of the ultimate contribution that crop will make to our wines.

That is why, we do not consider a man thoroughly experienced until he has been pruning for at least three years.

Why We Prune

The whole purpose of pruning is to direct our vines to grow fewer but better grapes — grapes of optimum maturity and with the full potential of their variety. Vines which produce too many grapes — a condition called overcrowpping — can lead to a thin, watery wine.

A carefully pruned vine will produce grapes that have acid and sugar contents in perfect balance, and their wine will be full-bodied, deep and brilliant in color, and with a bouquet that is true to the grape.

Our Unique Next Step

Sometimes, despite judicious pruning, a vine will overproduce anyway — perhaps because of optimum conditions for exceptional fruitfulness, or because it did not produce as much as it should have in the previous year.

In such a case, we resort to thinning. Thinning involves the actual removal of whole grape clusters from the vine — the sacrificing of a part of our crop in order to ensure the quality of the rest.

Sometimes this can mean removing as much as one-third the crop from an overproducing vine in order to maintain vine vigor. Or all of it, if we wish to give the vine a rest to regain its vigor.

Gallo, we might point out, is one of the very few wineries to practice this costly technique of thinning in order to produce only the best possible wine grapes.

How We Prune

Pruning is basically an art. And over the years we have developed techniques that we believe provide the best possible results of that art.

We began researching and establishing our pruning practices in the 1940's. At that time, every single variety of grape was given its own program to determine the best method of pruning for that particular vine.

As a result of our tests, we have established some general rules.

One is that on each spur — that part of the new wood which remains after pruning — we never leave more than two buds for future growth. This ensures optimum grape quality.

We do, however, vary the number of spurs on each vine. This depends on the variety.

For example, the Chenin Blanc and Ruby Cabernet vines are allowed not more than twelve spurs, the French Colombard fourteen, and the Barbera ten.

In general, the varieties having larger grapes and grape clusters are left with fewer spurs so as not to tax them beyond their capacities, and the varieties having smaller grapes and grape clusters are left with more.

Who Prunes

Because so much depends on the judgment of our pruners — in addition to how much to cut, at what angle, and which wood — we treat their training very seriously.

At first, a beginner is only allowed to watch. Then he is permitted to work only when an experienced man is watching him. And finally, before working independently, he must work under a foreman.

That is why, as mentioned earlier, it is usually three years before we consider him a thoroughly experienced pruner.

Our Goal

Obviously, the reason we here at the Gallo Vineyards are so particular about pruning is the direct relationship it has with wine quality.

Our experience is that excellent wines can only be made from excellent grapes, and that perfect wines require perfect grapes.

Therefore, because our goal is to make the finest wines possible — to give you pleasure by bringing you only the fullest perfection of flavor, taste and bouquet — we are totally committed to growing and using only the best quality grapes.

That insistence on perfection, really, is the basic principle to which we have dedicated our wine-making lives.

Gallo Vineyards, Modesto, California
Fill out this coupon and save the children

Just by completing this simple questionnaire, you can befriend a needy child through Save the Children Federation. For only fifty-two cents a day, your money, combined with that of other sponsors, can breathe new life into an impoverished village… help hard-working people in their fight for dignity… turn despair into hope for a child who has known only disaster. Fifty-two cents may not buy much where you live. But for the poorest of the poor where the need is so desperate, it can work miracles.

NH 8/7

My Name is: __________________________________________
Address _________________________________________________________________________________________________________________________
City __________________________ State __________ Zip __________

Tell us how you want to help, by answering these questions:

1. What geographical area are you interested in?
   Urgent need exists in all the areas listed below. Select an area, or let us assign a child where the need is greatest.
   ☐ Where the need is greatest
   ☐ Appalachia (U.S.) ☐ Angola (U.S.) ☐ Bangladesh
   ☐ Chico (U.S.) ☐ Colombia (U.S.)
   ☐ Dominican Republic ☐ Honduras ☐ Indian Republic
   ☐ Inner Cities (U.S.) ☐ Israel ☐ Korea
   ☐ Latin American Islands ☐ Lebanon ☐ Mexico
   ☐ Indian Islands ☐ Rural South (U.S.)

2. Any sex or age preference?
   If so, our personnel who are familiar with conditions in the area you have chosen will select a child in accordance with your wishes.
   ☐ Boy ☐ Girl ☐ No preference
   Age ☐ 4 to 7 ☐ 8 to 12 ☐ No preference

3. Would you like a picture of your sponsored child?
   Shortly after assignment is made, we can send you a photograph and brief personal history, if you desire.
   ☐ Yes ☐ No

4. Would you like to correspond with your sponsored child?
   If desired, correspondence can help build a meaningful one-to-one relationship. Translations, where necessary, are supplied by Save the Children Federation.
   ☐ Yes ☐ No

5. Would you like information about the child’s community?
   Several times a year you can receive detailed reports on the activities and projects being undertaken in the community to benefit your sponsored child. These community reports show how your money is being used most effectively for permanent improvements to the child’s environment—for health care, education, food production, nutrition, and community training. Would you like to receive such information?
   ☐ Yes ☐ No

6. How do you wish to send your payment?
   ☐ Monthly, $16 ☐ Quarterly, $48 ☐ Semi-annually, $96
   ☐ Annually, $192
   Enclosed is my first payment: _______________________

7. Do you wish verification of Save the Children Federation credentials?
   Save the Children is indeed proud of the handling of its funds. An exceptionally large percentage (78.1%) of each tax-deductible dollar you donate is used for direct aid and supporting program services. Due to volunteered time, labor, and materials, the donation provides your sponsored child with benefits worth many times your total gift. An informative annual report and audit statement are available upon request.
   ☐ Annual Report ☐ Yes ☐ No
   ☐ Audit Statement ☐ Yes ☐ No

8. Would you rather make a contribution than become a sponsor of an individual child at this time?
   ☐ Yes, enclosed is my contribution of $ ________________
   ☐ Check here for general information about our unique programs for aiding impoverished children.

Mail to:
SAVE THE CHILDREN FEDERATION®
48 Willton Road, Westport, Connecticut 06880

God bless you for caring enough!

Member of the International Union for Child Welfare and the American Council of Voluntary Agencies for Foreign Service.
YOUR SPONSORSHIP PAYMENTS AND CONTRIBUTIONS ARE U.S. INCOME TAX DEDUCTIBLE.
blings (40 to 60) than those derived from adults as a group (10 to 30). More recently, others have not only confirmed my earlier report but have shown a direct correlation between donor age and the number of doublings cultured cells will undergo.

A phenomenon that is fundamental to our understanding of the biology of aging is that variations in life-spans between different species are far greater than individual differences within a given species. A fruit fly is ancient in 40 days, a mouse at 3 years, a horse at 30, a man at 100, and some tortoise species not until about 150 years.

Although the data are fragmentary, the population doubling potential of normal cells derived from the embryonic tissue of a variety of animal species seems to be proportional to the mean maximum life-span for those species. If such a correlation is ultimately proved, a significant finding will have been made. It would then be possible to determine the life-span for any animal species simply by assessing the number of population doublings of which their cultured normal embryonic cells are capable.

If the concept of the finite lifetime, or senescence, of cells grown in vitro is related to aging in the whole animal, then it will be most important to know whether normal cells have the capacity to proliferate indefinitely in vivo. If all of the multitude of animal cell types were continually renewed, without loss of function or capacity for self-renewal, we would expect that organs composed of such normal cells would function indefinitely and that their host would live on forever. Unhappily, however, renewal cell populations do not occur in most tissues and when they do, a finite limit to their proliferation occurs.

The important question is, Is it possible to circumvent the death of normal animal cells that results from the death of the “host” by serially transferring marked cells—that is, cells that can be distinguished from those of the host—to younger animals?

The question can be answered by serial transplantation of normal tissue to new, young animals each time the recipient approaches old age. Under these conditions would transplanted normal cells proliferate indefinitely?

Data from four different laboratories in which mammary tissue, skin, and blood cells were employed indicate that these normal cells, serially transplanted to animals, do not survive indefinitely. It is well known that under similar conditions of tissue transplantation, cancer cell populations can be serially passed indefinitely. The implications may be that acquisition of the potential for unlimited cell division or escape from senescent changes by mammalian cells in vitro or in vivo can only be achieved by cells that have acquired some or all of the properties of cancer cells or germ (sex) cells. Paradoxically, this leads to the conclusion that for mammalian somatic cells to become biologically immortal they must first be induced to a cancerous state either in vivo or in vitro. They can then be subcultivated or transplanted indefinitely.

The possibility that animals age because one or more important cell populations lose their proliferative capacity is unlikely. I would suggest instead that normal cells have a finite capacity for replication and that this finite limit is rarely, if ever, reached by cells in vivo but is, of course, demonstrable in vitro. I would further suggest that other functional losses, which occur in cells prior to their loss of ability to divide, produce age changes in animals long before these normal cells have reached their maximum division limit. Indeed, we now know of many functional losses that take place in cultured normal human cells that are expressed well before the cells stop dividing. We believe that these decrements, which herald the approach of loss of division capacity, play a greater role in the expression of aging long before these cells fail to divide.

However, the measurement of loss of proliferative capacity is, after all, one of many cell functions that can be studied. If the manifestations of age changes are due to the loss of some cell function other than the loss of cell division, as I believe likely, then in vitro systems are all the more important as model systems. We must not forget that cell division itself is one of a number of functional losses that occur as normal cells proliferate in vitro.

The death of cells and the destruction of tissues and organs is a normal part of the developmental sequence in animals. It is the common method of eliminating organs and tissues that are useful only in the larval or embryonic stages of many organisms. Examples of such tissues are the primitive kidney of higher vertebrates, the tail and gills of tadpoles, larval insect organs, and in many cases, thymus. During the development vertebrate limbs, cell death and sorption shape the digits and the upper-arm contours. In the list of vertebrates, cell death clock operates on schedule. Loss of function leading to cell death is thus an intrinsic part of development.

The control of human aging has recently gained much attention. This field is rife with suggestions. Most approaches are derived from animal studies and are based on slowing down processes rather than circumventing it. Although some animal studies have slowed aging, none of these approaches has yet been tried in humans. Animal studies that used the technique of reducing body temperature showed that a reduction of only a few degrees resulted in a significant increase in the longevity of fruit flies, rotifers, and fish. In human beings, it is thought that a reduction in body temperature of two to three degrees Celsius would result in an extended life-span by approximate twenty years.

Another approach involves the inhibition of highly reactive molecule known as free radicals. Their presence, it is believed, may accelerate the process of aging. If so, the use of chemicals such as antioxidant which bind free radicals and thus inhibit their reactions, might ameliorate the aging phenomenon. Work on mice that have been fed antioxidant has been interpreted as showing a 20 to 40 percent increase in mean life span.

Perhaps the most practical approach to increasing human longevity might be based on experiments which rats were underfed by providing them with a very low caloric intake. The result was a 50 percent increase in longevity. Similar results have been shown to occur in rotifers, silkworms, fruit flies, bees, chickens, and other animals. The effect, however, is most pronounced if the low-caloric diet is started when the animals are very young. This results in a stretching out of the developmental program over a longer than normal period of time. Infancy, puberty, maturity, adulthood, and aging simply occur at later than usual points, with no particular period seeming to lengthen more than the others. If this approach should be practical for humans, the question would be: Which is more important, the quantity of life or its quality?
"Any talk about one exclusive form of energy is just irresponsible nonsense. This country will need all the energy it can get from all sources to meet the challenge that confronts us."

"We’re not running out of gas. We’re running out of cheap, readily available gas. That’s an important distinction."

Are We Running Out of the Fuel of the Future?

No, say the experts. Despite recent shortages, clean, efficient natural gas will play a significant role well into the 21st century. The truth is, we simply cannot do without our most modern form of energy.

Hugh Downs interviews Robert E. Seymour, Chairman of the Board, Consolidated Natural Gas Co., and Chairman, American Gas Association.

Hugh Downs:
Last winter the U.S. experienced severe and disruptive shortages of natural gas. We are now officially in the middle of an energy crisis that President Carter has said requires waging the moral equivalent of war. Yet you have stated that you’re optimistic about the future of gas energy.

Robert Seymour:
I’m indeed optimistic. Let’s look at the facts. Geological experts estimate that we have at least 35 and possibly as much as 60 years of supply from conventional sources, and that figure rises steeply when you add the gas from supplemental and non-conventional sources. So there is cause for optimism as far as the future of gas energy is concerned. Gas is certain to play a major role in the U.S. energy picture well into the 21st century. I consider that good news, because there is simply no other form of energy that could take over the load gas is carrying today.

Hugh Downs: Just what is that load?

Robert Seymour:
Gas supplies over half of the energy users in the residential-commercial sector, and the largest share of energy consumed by industry. You get an even better perspective by looking at it this way: the gas industry supplies almost three times as much energy per year as the electric industry.

Hugh Downs:
That’s something most people aren’t aware of, I suspect.

Robert Seymour:
I’m afraid you’re right. President Carter has called natural gas our most precious fuel, and I suspect that in addition to its high-energy content his assessment was due to the fact that natural gas just doesn’t pollute air, land, or water. Far from being old-fashioned, natural gas is really our most modern, most timely fuel.

Hugh Downs:
The critical question, it seems to me, is how does the cost of our “most precious,” “most modern” fuel compare with other energy forms, let’s say electricity?

Robert Seymour:
In terms of energy bought by residential users, electricity

<table>
<thead>
<tr>
<th>Types of Users</th>
<th>Gas Customers</th>
<th>Gas Consumption</th>
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<tbody>
<tr>
<td>Residential</td>
<td>44,753,000</td>
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<tr>
<td>Commercial</td>
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<td>Total</td>
<td>44,933,000</td>
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*Includes gas used for electric generation. Excluding transportation, gas provides 35.9% of all energy consumed in the U.S.
The Queen's Great Pacific & Orient Cruise.

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On January 16, 1978 the Queen Elizabeth II embarks on a fantastic voyage to the other side of the world. She'll travel 35,798 miles and visit 27 ports. Join her for all or part of her 90-day cruise. Choose from 33 Pan Am fly/cruise segments, starting at 14 days. Whatever you do—go!

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Shore excursions include 3 days in the People's Republic of China during The Queen's stop at Hong Kong. Visit Canton or, for a limited group, Peking and the Great Wall.

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Leave from N.Y., Fla., or L.A.

Sail from New York for 90 days on January 16; from Fort Lauderdale for 86 days on January 18; or from Los Angeles for 62 days on January 30. Full 90 days: $8,900 to $35,000 per person, double occupancy. See your travel agent or write Vaughan Rickard at Cunard, Dept. NH 555 Fifth Avenue, New York, New York 10017.

Queen Elizabeth II

Great Ships of British Registry since 1840

Our Allotted Lifetimes

During an average life, all mammals have nearly the same number of breaths and heartbeats.

Meeting with Henry Ford in E. L. Doctorow's Ragtime, J. P. Morgan praises the assembly line as a faithful translation of nature's wisdom:

Has it occurred to you that your assembly line is not merely a stroke of industrial genius but a projection of organic truth? After all, the interchangeability of parts is a rule of nature. . . . All mammals reproduce in the same way and share the same designs of self-nourishment, with digestive and circulatory systems that are recognizably the same, and they enjoy the same senses. . . . Shared design is what allows taxonomists to classify mammals as mammals.

An imperious whom should not be met with equivocation; nonetheless, I can only reply "yes, and no" to Morgan's pronouncement. Morgan was wrong if he thought that large mammals are geometric replicas of small ones. Elephants have relatively smaller brains and thicker legs than mice, and these differences record a general rule of mammalian design, not the idiosyncrasies of particular animals.

Morgan was right in arguing that large animals are essentially similar to small members of their group. The similarity, however, does not lie in a constant shape. As I have argued in several columns, the basic laws of geometry dictate that animals must change their shape in order to perform the same function at different sizes. I remind readers of the classical example, first discussed by Galileo in 1638: the strength of an animal's leg is a function of its cross-sectional area (length × length); the weight that the leg must support varies as the animal's volume (length × length × length). If a mammal did not alter the relative thickness of its legs as it got larger, it would soon collapse since body weight would increase much faster than the supporting strength of limbs. Instead, large mammals have relatively thicker leg bones than small mammals. To remain the same function, animals must change the form.

The study of these changes in form is called "scaling theory." Scalar theory has uncovered a remarkable regularity of changing shape over a 25-millionfold range of mammalian weight from shrew to blue whale. We plot brain weight versus body weight for all mammals on the so-called mouse-to-elephant (or shrew-to-whale) curve, very few species deviate far from a single line expressing the general rule: brain weight increases only two-thirds as fast body weight as we move from small to large mammals. (We share with bottle-nosed dolphins the honor of greatest deviation from the curve.)

We can often predict these regularities from the physical behavior of objects. The heart, for example, is a pump. Since all mammalian hearts are similar in function, small heart will pump considerably faster than the large ones (imagine how much fast you could work a finger-sized toy before it was forced to stop by the giant model that fueled the blacksmith's large forge). On the mouse-to-elephant curve for mammals, the length of a heartbeat increases between one-fourth and one-third as fast as body weight as we move from small to large mammal. The generality of this conclusion has been affirmed in an interesting study by J. E. Carrel and R. I. Heathcote on the scaling of heart rate in spiders. They used a cool laser beam to illuminate the heart of a spider and drew a spider-tarantula curve for eighteen species spanning nearly a thousandfold range of body weight. Again, scaling very regular with heart rate increasing four-tenths as fast as body weight.
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Animals have rhythm in their life, and this rhythm is clear in large and small mammals. Small animals, like the gerbil, have a shorter life span than larger animals like the whale. But the rate of these two is similar in that they both breathe more frequently and have a higher metabolic rate.

The rate of breathing and heartbeats in mammals can be measured through experiments. For example, the heartbeat of a mouse is 500 beats per minute, while a whale's heartbeat is only 20 beats per minute. This difference is due to the size and weight of the animal.

The concept of neoteny, or the retention of juvenile characteristics into adulthood, plays a role in the development of these animals. Humans, like other primates, have retained some juvenile characteristics, such as the ability to use tools and the ability to learn from the environment.

The concept of time is also important in understanding the behavior of these animals. In the case of the humpback whale, the length of their song can be measured in minutes, and this helps to understand their communication.

The concept of the minimum and maximum respiratory rate (R/R) is important in understanding the behavior of these animals. The R/R of the humpback whale is 1:1, which means that their respiratory rate is constant. This is important in understanding their communication and behavior.

The concept of the length of breath is important in understanding the behavior of these animals. The length of breath is given in minutes, and this helps to understand their communication and behavior.

The concept of the length of breath is important in understanding the behavior of these animals. The length of breath is given in minutes, and this helps to understand their communication and behavior.
Traveling this far, you don’t want to end up in a bush league hotel. The Nairobi Hilton, a self-contained oasis of luxury accommodations sparked with East African authenticities, is an ideal departure point for the safari of a lifetime.

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the Nairobi Hilton is a lively spot by day and night. For a sample of the wildlife adventure awaiting, Nairobi

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Six miles away is Salt Lick Lodge, constructed on stilts, connected by elevated walkways. You’ll get breathtaking close-ups of the menagerie of animals parading before your eyes as they water at Salt Lick. In a recent month guests sighted 2,160 elephants, 5,182 buffalo, 69 rhinos and 24 lions.

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For reservations call your travel agent or Hilton Reservation Service.

Hilton International
The results of the Buick Opel 5-Car Showdown are in!
Opel finishes...uh...2nd.

A lot of car makers compare their car to other cars.
We compared our car with other cars.
In a daring, fender-to-fender competition called The Buick Opel 5-Car Showdown. In it, we pitted our Opel against four better known competitors in point-by-point, side-by-side, independently supervised tests of acceleration, cornering flatness, parking lot maneuverability, pulling power, gradability, and a few other areas. In short, some of the things you'd like to know when you go out to shop for a car.

It was a bold move. After all, what if we didn't win?
Well, to make a long story short—we didn't. When all the tests were completed and all the figures tallied up, Opel finished second, right behind VW Rabbit. You can imagine how thrilled we were. But look at it this way: in order to finish second overall, we had to beat Toyota Corolla, Datsun B-210, and Subaru DL in a number of instances. (And in some areas, we beat VW, too, as you'll see.)

Which is a victory. And not just a moral one.
You see, we know Opel is a little dynamo of a car. But apparently no one else did. Because it seemed that whenever anyone went out looking for a practical little import, they looked real hard at the other cars in the Showdown. But hardly ever at ours.

So we wanted to show that Opel could hold its own against its famous competitors. That it should definitely be considered when you wander out to shop.
In other words, we were confident Opel was good enough to take on this competition.

Opel announces 4-doors.

Then we went one step further. And made Opel good enough to take on your family. By offering you our new, just-introduced-in-this-country Opel 4-door Sedan.
After all, if you've got a family (or maybe some friends you like taking along on spirited spins around the countryside), you need to carefully examine a car's ins and outs. So we gave you two more. Easy come, Easy go.

| Final Test Results | VW Rabbit | Buick | Toyota Corolla | Subaru DL | (Showdown Point Summary) |
|--------------------|----------|-------|----------------|-----------|
| Interior Noise     | 5 5 5 5 2 | 9     | 9              | 9         |
| EPA Interior Road Estimates | 9 | 9 | 9 | 9 |
| EPA Tread Capacity Estimates | 3 | 5 | 4 | 4 | 1 |
| Pulling Power      | 3 5 4 4 4 | 4    | 4              | 4         |
| (55mph 3rd gear)   | (55mph 4th gear) | (30mph 3rd gear) | (30mph 4th gear) |
| Parking Lot Maneuverability | 3 5 | 4 | 2 | 1 |
| EPA Mileage Estimates | 3 2 4 4 5 | 4    | 5              | 4         |
| Estimated Range    | 3 5 4 4 4 | 4    | 5              | 4         |
| Maintenance Stops* | 5 3 4 2 4 | 4    | 5              | 4         |
| (Recommended)      |          |      |                |           |
| Acceleration       | 3 4 3 2 1 | 1    | 1              | 1         |
| (0-55mph; 20-35mph) | (0-70mph) | (30-70mph) | (55-60mph) |
| Gradability**      | 3 4 3 3 2 | 2    | 1              | 1         |
| (55mph 3rd gear)   | (55mph 4th gear) | (65mph 3rd gear) | (65mph 4th gear) |
| Cornering Flatness*| 4 5 3 4 5 | 5    | 5              | 4         |
| Steering Quickness | 5 5 5 5 5 | 5    | 5              | 5         |
| Grand Total        | 56 47 46 39 35 | 35   | 35             | 35        |

*The less frequent the number of visits over 37,500 miles of normal driving, the higher the score. The number and type of inspections, adjustments and replacements would vary by visit.

**Based on opinion that less lean is preferable to more lean.

In California, Opel placed second on an overall basis. Individual test results vary from those shown above.
See your Buick Opel dealer for complete details.
Opel makes sense.

You can learn a lot from a test drive.

Or even a test-sit.
That will let you experience our odly-contoured vinyl seats. Seats tailored for comfort and good lateral support. With seatbacks that adjust.

Opel performs.

Indeed it does. As the 5-Car Showdown will testify. First of all, in tests of cornering flatness and steering quickness, none of the competitors out-ran Opel. And in tests of acceleration and gradability, only the VW Rabbit (a car much-ballyhooed for its fuel-injected engine) was able to nose out our Opel for top honors.

Opel's strong showing in these areas isn't surprising when you consider its own accoutrements. Like the dynamic overhead-cam, 4-cylinder hemi engine. Four-coil-spring-suspension. Front stabilizer bar. Rear track bar. Floor-mounted, full-synchronized, short-throw, 4-speed manual transmission (with 5-speed and automatic available). Rack-and-pinion steering. And lots more.

Nevertheless, it still may surprise you. But then, up to this point, maybe you haven't considered Opel. Maybe you should.

More than just mileage: range.

When you do consider Opel, you'll find it quite considerate of you. With EPA mileage estimates of 36 mpg on the highway and 23 mpg in the city. (The actual mileage you get will vary depending on the type of driving you do, your driving habits, your car's condition and available equipment. Estimates lower in California.) But don't stop there.

You won't have to. Because with Opel's 13.7-gallon gas tank (largest of any of the cars in the Showdown, by the way), it's estimated range is about 550 miles.

(By the way, this range estimate is a function of both gas tank capacity and miles per gallon, and is based on multiplying the EPA combined estimate, which is 27 mpg, by gas tank capacity. Actual range may vary.)

The best news of all.

If by now our intrepid little Opel is beginning to sound like an intriguing proposition, let us suggest you hurry to your Buick Opel dealer for further consultation.

Not only will he give you a brochure with complete details on the 5-Car Showdown, he'll be happy to provide you with one of those revealing test-drives we mentioned.

And, of course, he'll show you how very affordable Opel is to buy. Come on, now. Any car with this much going for it is at least worth considering, isn't it?

BUICK OPEL
Behind every new Minolta SR-T, there's experience and know-how that have satisfied more than three million owners.

And to satisfy that many people, a camera has to do a lot of things right.

Let's take a look at what's behind the Minolta SR-T's popularity.

It's easy to use, for one thing. With Minolta's patented through-the-lens metering system, you get perfect exposures just by lining up two needles in the big, bright viewfinder.

Interchangeable lenses, for another. All Minolta SR-T models accept all of the nearly forty Rokkor-X and Celtic lenses made by Minolta. So you can get all kinds of photographs—from fisheye wide-angle shots to close-up pictures of faraway subjects with a super-telephoto lens—using just one camera.

And the lenses are easy to change, with the unique Minolta bayonet mount that requires only a quick turn to put a lens on or take one off.

Should you buy the good used camera? Yes. Especially now that it's easier to own one than ever before. For more information, see your photo dealer or write Minolta Corporation, 101 Williams Drive, Ramsey, N.J. 07446.

MINOLTA

More than three million people own a Minolta SR-T.
Prizewinning photographs from the 1977 Natural History Photographic Competition

The successful entrants in the 1977 Natural History Photographic Competition might have taken a cue from Colette, the French novelist. Her great word was egarde! before the beauty disappears. This she learned from her mother, who could not comprehend city life, a world of constant change. Our contestants wanted to capture and preserve what they saw in their gardens, but the end could only bear witness to the ephemeral character of the natural world. Like Colette, they had to recognize that all things change constantly and irrevocably. Of our winners’ work, no picture illustrates the photographer’s dilemma more poignantly than Martha Cooper’s sequence.

A free-lance photographer who, thanks to a father who owned a camera store, has been taking pictures since nursery school, Cooper passed a Maryland farm day en route to a temporary job in Baltimore. “I didn’t conceive the series as a sequence—it evolved naturally. The first picture I shot just because the farm looked so picturesque; the subsequent ones because I was saddened by its transformation.” She moved to New York, and a year later, returned briefly to Baltimore and recorded the former farm’s subdivision into lots—an all-too-frequent event in nature.

Two prizewinners were similar examples of sharp eyes paired with feet heading elsewhere. Willard Colburn passed the young robins in their traffic-light nest—nature adapting reasonably well to technology—every day for two weeks. Finally, one Saturday morning, the sun broke through the Oregon rains, giving him enough light to photograph. Arthur Swoger, a professional who does every kind of work, especially nature photography, took the subway to Jamaica Bay Wildlife Sanctuary in New York City’s borough of Queens. As he left the train, he spotted dozens of grasshoppers, ranging in color from pea green to deep brown, in a clump of tall grass alongside the station.

Sometimes, a photographer—as an apprentice in looking—must combine contemplation with careful planning, patience, and ingenuity. Karin Furlow had always found her two-year-old grandson’s short, fat feet amusing, but to convey their charm, she had to persuade him to pose with a mirror. Dale Sarver, who is earning a Ph.D. in marine biology at the University of Hawaii, ran into unforeseen difficulties using a movie camera to photograph a snail devouring a sea cucumber—a minute-long process. The snail, which normally appears only at night, buried its head in the sand to avoid the floodlights. Using a still camera, Sarver needed extra film; the animal would stop eating when it saw the camera’s flash.

To watch a caterpillar hatch from its egg and change into a giant moth with a ten-inch wingspan, Jack De Coningh, an industrial designer, built a breeding box and created an ecosystem in his New York City apartment, experimenting with half a dozen different species of moths and butterflies. The moth’s metamorphosis took five months, and De Coningh had to stay up for twenty-eight hours to photograph the caterpillar spinning its cocoon. Born in Indonesia, where he discovered early that the natural world was “a constant source of interest, beauty, and mystery,” he is especially pleased that his granddaughter’s class of urban first-graders wants to visit his breeding boxes. His pictures are his means of passing on to the young his urgent concern about environmental destruction.

Microphotography may be the ultimate expression of the photographer’s admiration for his subject, no matter
how small, how overlooked. Since he discovered microphotography three years ago, Michael Siegel, a microbiologist, is prepared to take a second look at everything. "It's practically the only kind of photography I've done since." He found that certain crystals, when subjected to polarized light, will break into masses of color and design. His winning picture is of a melted sheet of polyethylene, normally used for plastic bags.

The possibilities of dirt—not the clarity of crystals—drew Sharon Geyer to microphotography. Five years ago, working as a darkroom technician on blood and liver cell research, she discovered, "Though dirt ruined microscopic slides for what I was really after, it can be beautiful in a purely esthetic sense." When I realized this, I decided to add my own dirt." Her prize winner, which one judge wanted to title "Mother and Child," is a dried solution of DL-methionine, ferric sulfate, and water. "All of my slides are a witches' brew of chemicals, dust, lint, whatever, and a dissolvent such as water or benzene. Very unscientific. This slide was concocted almost a year earlier, a fairly normal length of drying time."

Other photographs did not require elaborate technology, but the photographers did have to be born watchers: vigilant, patient, philosophical about mistakes and missed opportunities. Charles Krebs, a school bus contractor, spent a week alone in the Everglades—"you can't take the family"—waiting for late afternoon sunlight and a female anhinga with the turquoise eye coloring peculiar to the breeding season. Richard Smith waited for a very early October morning to photograph his mysterious island in a northeast Minnesota lake. To describe the day, he sent us part of Sigurd F. Olson's The Singing Wilderness: "It was before dawn, that period of dusk before the birds had begun to sing. The lake was breathing softly as in sleep; rising and falling, it seemed to me to absorb like a great sponge all the sounds of the earth. It was a time of quiet—no wind rustling the leaves, no lapping of the water, no calling of animals or birds."

At dawn on the other side of the world, about ten miles west of Shiraz, Iran, an energetic sales pitch allowed Carol Bier the fly-on-the-wall invisibility every documentary photographer seeks. Bier and her husband spent last year doing archeological research in Iran, traveling to and from ruins in the province of Fars. En route, they were able to spend time with pastoral nomads of the Qashgai confederation of tribes, at both their summer and winter encampments, and to observe the fall and spring migrations to and from the camps. In her photograph, the merchant squatting at left has come out from Shiraz, the provincial capital, to barter the cones of sugar before him for the migrants' goats, sheep, milk products, or coins. "The merchant and his family were so absorbed in bargaining and gossip that they were unaware of me."

Other winners were blessed with luck, what Stephen Diehl modestly called, "just one of those rare moments of being in the right place at the right time with the right equipment." Diehl, whose luck carried over from last year's contest, in which he won an honorable mention for his study of an apple leaf, took his deliciuos picture of fall foliage practically holding its breath on hardwood trees in New York State's Adirondack Mountains. "My wife and I were overtaken by a virtual storm. Rain and wind blasted the mountainsides. Photography impossible that Saturday. Next morning we awoke to find that the rain had changed to snow. The winter storm had passed leaving clinging snow or ice everywhere."

William Holmes happened to be photographing in his garden when he saw a fly land on an orange poppy. The fly's alert profile reminded him of "a miniature B58 Hustler ready to take off." Lee Rentz is getting a master's degree at Utah State University in Cache Valley, an agricultural region where the clouds are particularly beautiful in May. "I often look at the sky, grab a camera, and go out into a storm. If the clouds are interesting or if rain is falling somewhere in the distance, chances are I can take some dramatic photographs." On this occasion, he was struck by the contrast between his wife's red shirt and grasses bending in eerie storm light.

Some winners took a serendipitous shot and were surprised to discover what they had. Michael Neff saw a coot on a Swiss lake, where a late afternoon sky and reflections from a nearby building produced a "psychedelic effect" he liked on the waves. But he considered the photograph, "the worst of the three pictures I sent you." Fred Darvill was hiking in early morning fog. "Both my small daughter and I stopped rest. She was one switchback ahead of me. Without much thought or planning, I snapped the one picture only and we went on. I really did not realize how good the photograph was until it was returned or I certainly would have taken more."

Some lookers, perhaps the most enterprising, pay
attention in unexotic spots, settings that border on the banal. On a photography safari to Mount Kilimanjaro, Ted Schiffman found a Masai woman in a model tribal village maintained for tourists. Renato Caselli, a Mississippi farmer, liked the tail he saw on a hippo in the Jackson zoo. And Everett Johnson was killing time in the Frankfurt zoo, waiting for a plane home on a chilly October day, when he found the meerkats enjoying a heat lamp. There was no question about his prize; the animals' irresistibly corny quality made the judges laugh out loud.

Our three judges were struck by the high quality of the 400 slides and photographs winnowed for their viewing from 30,000 entries that arrived from all over the world. The 1977 finalists' virtue was so consistent that one judge said his choices could only be considered capricious. In the end, the three judges concurred amicably on which pictures belonged at the top of the heap.

Although not all the judges had met previously, their careers had crossed or intersected. Milton Glaser, the influential graphic designer, is founder of Push Pin Studios and designer of New York magazine. John Dominis, now picture editor of People magazine, was formerly a staff photographer at Life, as was Ken Heyman, now a free-lancer. Some of Heyman's most familiar work appeared in the collection "The Family of Man. Working with Margaret Mead, he has illustrated two books: Family, published by Macmillan in 1965, and World Enough: Rethinking the Future, published by Little, Brown in 1975.

The 1977 Grand Prize was a round-trip for two to Peru. First Prize in each category was $500, Honorable Mention $100. Special awards—Humor in Nature, Urban Wildlife, and the Willoughby Prize, presented by Willoughby's Camera Stores—were each $200. All prizewinning photographs will be displayed in a special exhibition at the American Museum of Natural History in September 1977.

For the 1978 Natural History Photographic Competition, the categories will be: The Natural World; A Sequence of an Event in Nature; Macro/Microphotography (including pictures with a scanning electron microscope); and The Human Environment. There will be special awards for Humor in Nature and Urban Wildlife. Details concerning the rules, the prizes, and the deadlines will be announced early next year.

Ann Marie Cunningham
FIRST PRIZE
The Human Family
Qashqai nomads bartering
Fars Province, Iran
Carol Manson Bier
FIRST PRIZE
Humor in Nature
Meerkats
Frankfurt Zoo, West Germany
Everett C. Johnson
FIRST PRIZE
A Sequence of an Event in Nature
A farm is sold
Owings Mills, Maryland
Martha Cooper
Honorable Mention
Mention
Metamorphosis of the giant moth
New York, New York
Jack DeConingh

SPECIAL AWARD
Willoughby Prize
Two-year-old boy’s feet
San Jose, California
Karin J. Furlow
Honorable Mention
Snail devours a sea cucumber
Honolulu, Hawaii
Dale Sarver

Honorable Mention
Ford Island and reeds in mist
Burnside Lake, Minnesota
Richard Smith
Honorable Mention
Spur-throated grasshoppers
Queens, New York City
Arthur Swoger

Honorable Mention
Hippopotamus tail
Zoo—Jackson, Mississippi
Renato Caselli

Honorable Mention
Fly on poppy
Toronto, Ohio
William A. Holmes
Honorable Mention
Snow on hardwood trees
Adirondack Mountains, New York
Stephen J. Diehl

Honorable Mention
Masai woman
Kenya
Ted Schiffman

Honorable Mention
Melted polyethylene sheet
Photographed at 400X
Michael Siegel

Overleaf
GRAND PRIZE
On the trail to Cascade Pass
North Cascades National Park, Washington
Fred T. Darvill, Jr.
Botanicas: Puerto Rican Folk Pharmacies
by Mary Ann Borrello and Elizabeth Mathias
photographs by Marcia Keegan

In New York City, small shops selling articulos religioso are the only outward sign of Puerto Ricans' spiritist beliefs and practices.

In New York City's Puerto Rican neighborhoods, life is very much the same as in Puerto Rico itself: the language is unchanged, and community institutions, such as bodegas, social clubs, and botanicas, or religious supply shops, are not very different. A botanica's front window is usually a jumble of conventional gift store items, crucifixes, highly colored plaster statues of the Madonna, angels, and saints—including such foreign transplants as the Infant of Prague and the Italian favorites Saint Francis of Assisi and Saint Rocco—plus African gods, Buddhas, and cigar-store Indians. A passerby who peers beyond the statues or ventures inside the botanica will find shelves of yellow, white, red, black, and maroon candles and bead necklaces in similar colors; books on dream interpretation, Chinese proverbs, and numerology stacked alongside the Bible and Roman Catholic prayer books; jars of incense and herbs; bottles of Florida water, commercial toilet water, and herbal lotions; oils and soaps; aerosol sprays; lodestones and cowrie shells; Latin music tapes and records with saints on their covers and titles like 'The Seven Powers' and 'The Most Powerful Hand.' Some botanicas stock various plants and such ani-

Left, in La Marqueta, Spanish Harlem's open-air market, a stall offers beads, herbs, and lotions that promise good luck and health. Above, Otto Chicas is one of the market's largest botanicas. Flowers, used for home altars, are sold outside.
The botanica is the economic manifestation—and to an outsider, the only visible evidence—of the bifurcated religious system of most Puerto Ricans, who since the 1950s have been settling in El Barrio, or Spanish Harlem, New York's major Puerto Rican neighborhood. Other pockets of settlement are found on Manhattan's West Side and Lower East Side; in parts of Brooklyn, the Bronx, and Queens; in nearby New Jersey and Long Island. Most Puerto Ricans are Roman Catholics, but for many—regardless of income, social class, age, or education—orthodox religious affiliation pales beside their involvement with espiritismo, or spiritism. At botanicas, Puerto Ricans buy the formidable variety of objects and goods they need for spiritist observances. The botanica's seemingly unrelated items all have symbolic meaning and order in the spiritist world view. And throngs of customers at flourishing botanicas attest to spiritism's thousands of followers.

To these faithful, daily life is surrounded by an invisible universe of good and evil spirits, with powers to affect the course of human affairs. Spiritist teaching consists of ways to contact the spirits, to enlist their aid or escape their ire. In Dan Wakefield's Island in the City, one of the first books about Puerto Rican culture in the urban United States, a Puerto Rican is quoted as saying, "If you ever talk to a Puerto Rican who says he doesn't believe in spirits, you know what that means? It means you haven't talked to him long enough."

For an immigrant community under considerable stress, spiritism is a solace: it puts names on fears and supplies reasons why things go wrong. It also provides the possibility of relief or change if the unseen powers are courted by a person who has developed his or her facultades, the innate abilities to intercede with spirits.

In its Puerto Rican incarnation, spiritism is a mélange of Roman Catholicism, Yoruba religion brought to the Caribbean in the seventeenth century by African slaves from western Nigeria, and the teaching of Hippolyte Rival, a French spiritist philosopher who saw no conflict between spiritism and Scripture, and who published in the 1850s and 1860s under the name Allan Kardec. (Most botanicas carry Kardec's seven books, basic theology for any spiritist, as well as pictures of Kardec, which are used in spiritist centers or home shrines.) His fame seems to have reached Puerto Rico on publication, for séances were already being conducted at parties there in 1856.

Before Kardec arrived in book form, Puerto Ricans were already familiar with santeria, a type of spiritism that exists throughout the Caribbean and Central and South America. In one of its forms, santeria syncretizes Roman Catholicism with Yoruba religion. The Catholic clergy made strenuous efforts to convert slaves upon their arrival in the New World, but the Africans actually absorbed Catholicism into their own religion. They recognized their familiar gods and goddesses in the new figures of Christ, the Madonna, and the saints. Chango, for example, the most virile and sexual Yoruba deity, the warrior god who controls thunder, lightning, and fire, is syncretized with Saint Barbara, virgin martyr, protector of soldiers, whose father was struck by lightning after he beheaded her. Like all santeria deities, Chango/Saint Barbara has a favorite color (red), claims certain animals and plants with magical and medicinal uses (sarsaparilla, among others), is invoked for particular reasons (protection against enemies), and responds favorably to favorite offerings (fruit, rum, and cigars). Oshun, the affectionate Yoruba goddess of rivers, love, and gold, is syncretized with La Caridad del Cobre, a Cuban virgin who watches over fishermen. Eleggua, Yoruba guardian of the highway and the home, is seen as Saint Anthony of Padua and the guardian angel. In the Puerto Rican community, members frequently
have special devotions to individual gods. Each saint must be venerated with amulets, oils, and lotions, as well as candles, bead necklaces, and incense in his or her favorite color, all purchasable at a botanica.

The botanica's busiest day is Saturday, when crowds of customers, mostly women, line up. Each has a slip of white paper in hand and consults it frequently while making purchases. Friday evening is the night when most spiritist meetings are held in centros, or spiritist religious centers. In the spring of 1975, thanks to an invitation from a Puerto Rican student, we visited a centro in the Bronx, and observed how the intimate relationship between botanicas and the spiritist religion works.

This particular centro ceremony incorporated elements of both spiritism and santeria. In this centro, the presiding medium was called madrina, which is a santeria term. At most spiritist services, the leader is known as a medium. The ceremony was to begin at nine on a Friday night, but we arrived early to consult with the madrina, or medium. A medium has developed her facultades and has been trained in spiritist ritual by means of a long and expensive initiation, involving many botanica expenditures. She can communicate with the spirit world and can call spirits into her own body or those of the faithful. She can also see past, present, and future events in visions and hence can prescribe prayers and ceremonial rites to solve problems.

The centro we visited was the presiding madrina's home, an ordinary two-story frame house in a working class neighborhood. On the lawn near the centro's basement entrance were two shrines, one enclosing a statue of Saint Barbara, with fruit offerings at her feet. (Santeria gods must be fed their favorite foods; many seem to have sweet teeth, preferring fruit and candy.) The other niche held a statue of an American Indian chief, a protective figure representing a syncretism of spiritism and Indian healing lore. The statue was bedecked with beaded necklaces in the god's colors to ward off evil, and its base was surrounded by fruit and cowrie shells and coconuts (used to foretell the future).

The centro's sanctuary room measured about thirty by eighteen feet. Folding chairs faced a free space about the size of a small dance floor. The room was dimly lit, and along the wall at the far end was a water font filled with pennies and nickels meant by means of sympathetic magic, to attract more money. Behind the font was a three-foot statue of La Caridad del Cobre, with a boat at her feet. She wore yellow. Oshun's favorite color. Large statues of other saints and African gods, accompanied by their favorite offerings, lined the walls of the room. To the font's right was a five-foot statue of Saint Barbara with a dish of fruit. Next to her stood a smaller statue of Saint Martin de Porres with a candy offering. Farther on was an open grass hut, a shrine to Concilio Congo, an African deity, whose offerings included the familiar coconut shells, strings of beads, and cowrie shells, as well as black dolls used for magical spells.

The centro's congregation celebrates its presiding madrina's anniversary as a medium and the birthday of one of her personal spirits. Dancing to the Afro-Cuban band, two teen-age girls, left and below, receive spirits and go into ecstatic trances. Below, a boy too young to go into trance watches.
In the wall at the room's near end was a deep niche fronted by a glass case, which doubled as a counter. There was the centro's botanica, run by the madrina to serve the more immediate needs of this particular religious community. Opposite, a door led to the madrina's consulting room.

The few Hispanic men, women, and children—women outnumbered men two to one—who had arrived early for consultations or for socializing sat on folding chairs near the consulting room's entrance. A man wearing a white shirt and trousers came forward, and our student-presented himself. He was the padrino, the madrina's husband and assistant. He told us in Spanish that the madrina would be with us shortly and would see us individually. For us, she would permit an exception to usual procedure: our student-interpreter could accompany each of us.

The madrina, a tall, light-brown-skinned woman in her late thirties, appeared and warmly encouraged us to come into her consulting room. Inside, the only uncluttered area was her sacred white table. The walls were decorated with scarves in colors associated with each god and saint, pictures of Chango, Yemaya, (goddess of the sea, syncretized with Our Lady of Regla, a Cuban madonna), Saint Lazarus (paired with Babalu-Aye, god of the sick), and Saint Barbara. Clustered on the floor were coconut shells, black dolls of several sizes, and roses of Jericho, curious dried plants that open and turn grayish green when placed in water. (Santeria's African roots give it animistic elements. As good luck plants, roses of Jericho are frequently fed honey or sugar water.)

The madrina briefly ignites her hands and passses them before the faces of the faithful waiting to go into trance. Once in that state, they can depend on their friends to assist them.
The madrina opens centro ceremonies by welcoming the congregation. As spiritual leader of the centro, located in her basement, she is godmother to many of the attending faithful.

The room smelled strongly of garlic, which had been burned to discourage evil spirits. A plate on a small stool contained the dollar bills left as payment by consultees who had preceded us.

The madrina indicated that each of us, in turn, should take a seat near her table. The first consultee was Elizabeth and after looking closely into her face for thirty seconds or so, the madrina turned to the table and took a handful of cowrie shells out of a drawer. She tossed the shells onto the table and, after studying the pattern they made, went into trance. In Spanish, she gave her evaluation of Elizabeth’s personal life and problems. Then, coming out of trance, she spoke further about Elizabeth’s particular problems and determined that her bad luck was the direct result of an evil spell that had been cast ten years before. A jealous person had stuck nails in an onion, tied it with black ribbon, and had buried it. (The ten-year-old spell the madrina envisioned coincided with a somewhat difficult period in Elizabeth’s life.)

The madrina assured Elizabeth that with proper ritual, this old curse could be neutralized. Mary Anne was told that she had a strong spirit on her side, but that she had been a bit distracted and forgetful lately. For each of us, the madrina wrote on pieces of white paper lists of items we were to buy. Upon our return she would use our purchases to perform special rites to remove the evil influences plaguing our lives. Mary Anne’s list included a white pigeon, forty-six pennies, four coconuts, a bottle of honey, Florida water for purification defense against evil, and four pieces of magnus rock. These lodestones, and nails or filings that have touched them, are thought to be alive and receive prayers and offerings.

Elizabeth’s list was more complicated and expensive, calling for a black chicken, a white pigeon, Florida water, three coconuts, and four pieces of magnus rock. The madrina herself could supply the chicken and pigeons for a fee. According to our student, a chicken usually costs $10, while a baby goat, sometimes needed for very serious problems, might run as high as $15.

By 9:30 P.M., preparations for services had begun. We joined the congregation of about thirty people and removed our shoes to avoid polluting the sacred area. The madrina padrino, and three helpers, dressed in white, went to the altar. Latin music, meant to draw spirits, flooded the room. Moving with the music’s tempo, the madrina and padrino ignited coconuts doused with Florida water, and using their fee rolled the flaming spheres around the room to purify it. Members of the congregation then approached the altar one by one, and the madrina assisted each into trance by passing her flaming hands, which she had lit, over the coconuts, before the individual’s face for a few seconds. She then turned the person around three times, releasing him on the third turn whereupon helpers came forward to guide his movements. The trance state lasts from a few seconds to several minutes, and may be mild to extremely agitated, depending on the type of spirit entering the person’s body. Possessed faithful may fall to the floor in a frenzied state or speak in tongues.

Finally, after all who wished to go into trance—the majority of the congregation—had recovered and returned to their chairs, the madrina’s turn arrived. This was the peak moment of the service. One by one, three spirits took possession of her, including her personal spirit, which had appeared to her in a dream or vision as the spirit of the saddle. When this spirit arrived, the madrina moved to the back of the room and placed her foot upon a saddle standing in the corner.

Of the three visiting spirits, one was aloof, avoiding contact with humans. Another, known to be a childlike and especially loving spirit, invited contact. To communicate with this spirit, the congregation, ourselves included, lined up in front of the madrina, who, whispering words of affection, embraced and presented each with a flower. The service ended about 1:00 a.m., when the madrina, exhausted by her activi-
and by spirit possession, was led way by the padrino and two assisting mediums.

What we experienced at the centro presents only one of the many richnesses of spiritist services. On Saturdays, those who have consulted mediums proceed to botanicas armed with shopping lists. However, since mediums offer consultations at any all times, botanica business continues steadily throughout the week, as botanicas have their own small consulting room with a medium in attendance, who may charge little or nothing. Clients are expected, however, to patronize the botanica after their sessions.

The botanica functions as a folk pharmacy, through which the medium ministers to the physical and spiritual health of the community. Faithful consult the medium for life’s every problem—unemployment, ill health, marriage, love, and family difficulties—as well as dream interpretation and exorcism. Some health professionals recognize the medium’s role as a folk psychotherapist: in the South Bronx, community mental health centers regularly refer Puerto Rican patients to mediums and botanicas, especially for psychosomatic complaints.

Although nothing—except perhaps the psychological influence—adequately explains how the medium’s intervention works, we have seen many cases in which she has definitely helped. During one session at another centro, a woman complained of head pains. She had been X-rayed, but doctors had found no evidence of tumors. In this case, another member of the congregation, who had been developing his own facultades, had a vision of a woman whose head had been crushed by a car. The client exclaimed that her sister had died in such a manner. The group concluded that the dead woman’s spirit was causing her sister’s headaches and tried to communicate with the spirit to discover its motives. The medium and the client then proceeded with private consultations and ritual to drive away the spirit.

As spiritism’s mediator, the medium provides channels, in private sessions and communal ritual, through which individuals may gain the protection, encouragement, and support of their fellows, as well as of spirits or saints and of deceased members of their own families. Through the medium’s intervention, a congregation member can cast off evil and feel the presence of friendly spirits. The medium interprets and analyzes problems, provides explanations for personal misfortunes, and prescribes guaranteed remedies: rituals only she can perform or supplies available only at a botanica.

The remedies always cost money: botanicas, botanica wholesalers, and spiritism in general are big business in the Puerto Rican community. Spiritism’s devout followers go to bo-

At the centro, top, the madrina guides a group of young people learning to develop their facultades, abilities to communicate with spirits. Bottom, a flaming coconut, used to purify the centro, rolls past a shrine to Ellegua, guardian of entrances. The coconut will be kicked outdoors, extinguished, and smashed to ward off evil.
Santería not only to fill the medium's prescriptions but also to buy herbs (which purportedly can cure most ailments), and statues for home shrines, as well as various other supplies that honor personal gods, induce good luck for family and friends, or inflict bad luck on enemies. Statues can be considerable investments. In Spanish Harlem, we have seen five-foot plaster statues of Saint Barbara priced at $495. More modest statuary starts at $9.95. Two or three dollars buys lotions, soaps, and aerosol sprays with powers to remove jinxes, bless a house, attract a lover, bring luck in gambling, or invoke the Seven African Powers, a particularly potent group of santería deities.

As the medium is apt to prescribe Catholic prayers and attendance at Mass along with santería rituals, so botánica products call on African gods and Catholic saints and Jesus Christ. One label on a bottle of Seven African Powers lotion reads:

Do you have problems? Call the Seven Saints to your aid. Humble yourself when you need assistance. Ask for help in the name of Jesus Christ with your problems, financial, health and love. These Seven African Powers will offer you concentration power.

The same cross fertilization is obvious in the botánica's stock of religious jewelry: Catholic medals and scapulars, spiritist amulets shaped like small rosary beads, or miniature black hands. When a Puerto Rican baby is baptized, the family will often ask the priest to bless the baby's medal and amulet, both worn on one chain. Some priests bless both objects without comment. Others attempt to convince the family that the bead or hand has no part in Catholicism. Puerto Ricans generally see little sense in this argument; they consider both objects necessary to protect the infant from evil.

Although candles are burned to honor the gods and achieve good health and happiness, they also have destructive uses. A woman who wants to destroy a marriage might buy three black candles, two shaped like nude females and one like a nude male. (Black, the most powerful color, may cause death; red will result in a lesser injury.) At home, she writes the names of the husband and wife she wants to separate on two slips of paper. If she wishes to become the man's new lover, she writes her own name on a third slip. She then turns two candles, representing a man and a woman, back to back, and places the husband's or wife's name under the appropriate figure. She puts her own name under the other female candle and places it facing the male. She lights all three candles and recites special prayers. Within the week to ten days the candles take to burn down, the marriage should be destroyed and the man attracted to his new lover.

Even smaller purchases like these candles represent considerable investments for people hampered by chronic shortages of cash. Nevertheless, the market for botánicas shows no signs of drying up. Besides serving as community therapy, spiritism also represents a colorful alternative to the relatively inexpressive Roman Catholic ceremonies. In and around the New York area, the traditional attitudes and beliefs of spiritism receive continual reinforcement from Puerto Rico. Followers take advantage of inexpensive weekend flights to migrate back and forth to their home island.

In New York, as in Puerto Rico, when crowds line up outside botánicas on Saturday mornings, they demonstrate that a minority subculture has managed to maintain a substantial level of ethnic and spiritual unity. Spiritism enriches the Puerto Rican's life by offering reasons for events that would otherwise go unexplained; within the spiritist community the disorders of daily life are ordered and made manageable. And the positive effects of this religion—its emphasis on loving concern among community members, shared problem solving, individual and group emotional security—are undeniable.

In the madrina's consulting room at the centro, a young woman asks guidance in a personal matter. The madrina's advice will be based on the patterns she discerns in the cowrie shells before her. She also frequently uses these shells to predict the future.
The Great Grizzly Grapple

Christopher Cauble

National parks are for people, plants, and animals. Then there is the big bear at occasionally mauls people.

Stoney Bear is dead. I knew her for the National Park Service (NPS) killed her. Stoney was a grizzly bear in Mount McKinley National Park, Alaska, and we had met several times, while I was enrobed in a car bus or while I was hiking alone. She never caused me any trouble; she never harmed anyone; she never injured property.

Stoney was a wild, naturally foraging grizzly, not a garbage-fed bear. The problem was that she was not a people, being far more tolerant and unconcerned about human presence than any grizzly I had ever encountered. She would feed by the roadside even if a busload of tourists were hanging out the windows, taking photographs, and yelling at her to back up. The Eielson Visitor Center was within her territory, and she could walk its sidewalks hunting the ground squirrels that had become common from tourist handouts and ignoring bystanders only ten or twenty feet away.

Stoney Bear had been living in McKinley since 1972, always in the same roadside area and always alone.

Because of repeated visits to the Eielson Center, she had been relocated by the National Park Service in 1974, but within two weeks she had returned across the crest of the Alaska Range, covering a distance of about sixty-five miles. In the spring of 1976 she was seen mating. Stoney had never given birth before. How dangerous and aggressive would she be with cubs? The prospect of a serious human injury resulting from Stoney's protective instinct and her habitual close contact with people became a crucial factor against her. The NPS considered relocating her again, but it was deemed too expensive. She had returned before, she might not survive in a new territory, and conceivably, the NPS could have had to destroy her. Stoney caused trouble somewhere else. No nearby zoo wanted her. The final decision: kill her.

On June 14, 1976, Stoney Bear was injected with an overdose of Sernylan, a tranquilizer commonly used for large animals. She was destroyed atop Stoney Hill, her topographical namesake. She was killed, not for what she had done, but for what she might do. At the time of Stoney's death, the National Park Service was receiving both blame and blessing for its efforts at managing the grizzly bear.

Not long after Stoney's demise, National Park Service authorities were hunting proven killer grizzlies in Alaska and Montana. On September 12, 1976, a man was killed and eaten by a grizzly in Glacier Bay National Monument. The rogue bear was never found. On September 23, 1976, a young woman was dragged from her tent by a grizzly in Glacier National Park. Her body was found one hundred yards from the tent, and two grizzlies were shot when they charged rangers guarding the body. Three other persons were mauled last summer in Glacier National Park, and four persons were injured by grizzlies...
in Yellowstone National Park. People were charged and treed in Mount McKinley National Park and Katmai National Monument. In Canada a woman was killed and her companion severely mauled in Glacier National Park, British Columbia.

The grizzly bear, having previously been forced to retreat to the sanctuary of national parks, now faced another threat: the pressure from too many people within its last refuge, with a resultant danger for both people and bears.

The recent controversy over grizzly bears began on a hot August night in 1967 in Glacier National Park when, incredibly and inexplicably, two young women were killed on the same night by different grizzlies in separate backcountry areas. It was a night of bizarre horror, and the story appeared on the front pages of major newspapers and on television news broadcasts. A bitter and still-continuing debate erupted over whether or not grizzly bears should be allowed to exist in the national parks.

Normally a quiet bureaucracy, the National Park Service suddenly found itself inspected, dissected, and suspected as never before. When the public discovered that an open garbage dump close to a backcountry chalet and campground had been attracting grizzlies for years and that one of the women had been killed by a sow grizzly visiting the dump, the NPS was charged with careless management and branded a contributing villain in the death.

After the Glacier incidents, personnel at other national parks evaluated their bear situations to correct dangerous practices, such as operating open dumps. Yellowstone had several such dumps, and although they were in backcountry areas restricted from visitor travel the Glacier problem put pressure on Yellowstone to close its dumps too. All agreed that the dumps should be closed, but disagreements over the best procedure to follow developed.
More problem bears in campgrounds would translate into more dead bears because the NPS was under heavy pressure to protect visitors from grizzly-caused injury. This pressure dictated that the NPS act quickly to close the dumps.

The NPS was damned if it closed the dumps and damned if it didn't. In 1968 and 1969 the amount of edible garbage placed in the dumps was drastically reduced. Attempts to improve campground garbage facilities and park-wide disposal systems were also made. By the spring of 1971 all intrapark dumps had been closed. Sure enough, beginning in 1968, here came the bears.

From 1959 through 1967, 170 grizzlies, an annual average of 18.9, were removed from the entire Yellowstone ecosystem. This figure includes control activities by the NPS as well as hunting and control activities outside the park. From 1968 through 1972, 172 grizzlies, an annual average of 34.4, were removed. (Figures for the entire Yellowstone ecosystem are important because of the wide dispersal of garbage-feeding bears after the dump phase-out began in 1968.)

From 1968 through 1972, 51 grizzlies were removed by control actions from Yellowstone National Park itself, an annual average of 10.2 (33 were shot, 9 were donated to zoos, and 9 died from drug overdoses during capture operations). This compares with 37 grizzlies removed from 1959 through 1967, an annual average of 4.1.

The Craigheads and the NPS clashed repeatedly. The scientists warned of severe and possibly irrevocable population depletion. The NPS challenged the scientists’ data and claimed that more bears existed in Yellowstone than they supposed. In some areas the data between the Craigheads and the NPS differed greatly, and the truth was lost in a wilderness of charges and rebuttals.

The Craigheads were no lightweight and the ensuing battle royal captured the interest of the national media. The great grizzly controversy soon enveloped scientists, bureaucrats, and conservation groups. Sec-
sows nurse her two cubs in an open meadow. Many human–grizzly incidents occur because female sows, extremely defensive of their young, will attack anything that seems to pose a threat.

The Craigheads, however, on the basis of their computer model, have projected a 1974 population of between 82 and 233, with 136 being most probable. To further confuse the issue, an Interagency Grizzly Bear Study Team (led by an NPS biologist), mostly using previously collected data, made a sprawling estimate of anywhere from 237 to 540 grizzlies for 1974. In view of so many disparate estimates, the only possible conclusion is that no one really knows the current status of the grizzly population in the Yellowstone ecosystem.

What with the Glacier National Park deaths and the Yellowstone controversy, the park service entered a period of schizophrenia regarding bear management. Grizzly bears were to be preserved as a valuable wilderness feature, but tourists were to be protected from harm—and heaven forbid that park management should ever again contribute to a human injury. Perhaps for these reasons, bear management by the NPS took some very nasty turns. In 1972 a grizzly was trapped in a Mount McKinley National Park campground and hauled away to be relocated. The superintendent and chief ranger reported to the media, and even to other NPS employees, that the bear was simply transplanted to another section of the park. This was a deliberate lie. On orders of the superintendent, the bear was transplanted all right, directly into another dimension by a bullet in the brain. In 1974 a net-slung Yellowstone grizzly was being translocated via a helicopter; en route the net was opened and the bear dropped several hundred feet to smash on the ground. The NPS was between a rock and a hard place regarding bear management and the grizzly got the squeeze.

“The negligence of the defendant, United States of America, was the sole, direct and proximate cause of the death of Harry Eugene Walker on the night of June 24–25, 1972.” With these words Judge A. Andrew Hauk, in an opinion filed in a U.S. District Court in March 1975, ordered $87,417.67 to be paid to members of the Walker family as the result of a suit filed after Walker had been killed by a grizzly bear near Old Faithful in Yellowstone National Park. The judge cited the park’s dump-closure policy, as well as the failure to provide adequate warnings to park visitors about bear dangers, as contributory negligence. Claims by the NPS that Walker was knowingly and illegally camped in a closed area, that he deliberately avoided all opportunities to receive brochures warning of bears, that he was careless with his food and had garbage around his camp failed to move the judge. (It didn’t help that the killer bear had been captured and relocated by the NPS two years earlier.)

The decision in the plaintiffs’ favor caused repercussions throughout the park service. How much protection from wild bears could the NPS be expected to provide? If a hiker didn’t receive one of the bear brochures and was mauled by a grizzly, would the NPS be negligently liable? Where was the line between reasonable visitor safety and excessive bear–people management?

Although the Walker decision was overturned in December 1976 on the basis of a technical exemption to the Federal Tort Claims Act, another suit has been filed by a man who was mauled by a grizzly in Glacier National Park in 1975. Thus the implication of the Walker case remains a Damoclean threat to the NPS.

While drownings, mountaineering mishaps, automobile wrecks, and a variety of other accidents occur in the parks, none seem as likely to be viewed as NPS negligence as grizzly injuries. The reverberations of Judge Hauk’s gavel plucked at the nerves of NPS officials, and everyone prayed for no more incidents. The bureaucratic boat was rocking in the storm and the passengers were frantic.

At the orientation for seasonal employees in McKinley in the spring of 1975, the superintendent handed out copies of the Walker decision and said, “Here’s what we’re up against.” Later in the summer, following an incident in which a bear bit a hiker, a permanent ranger first explained, “It wasn’t really a mauling.” An acute sensitivity to bear incidents developed, including a jargon of euphemisms reminiscent of the war reports from Vietnam. Bears were not killed, they were “dispatched” or, more blandly, “removed from the population.” Bears were not threatening life and limb when they charged someone, they...
were "acting playfully toward hikers by chasing them." (The latter from a memorandum to be read at all interpretive programs after a pair of grizzlies treed a hiker in McKinley, in August 1974.)

After the deaths in Glacier Bay National Monument and Glacier National Park in 1976, the NPS quickly documented the details of each incident as never before. In the event there were any resultant lawsuits, the NPS wanted to be ready with all the facts.

Glacier National Park is a study in the growing problems between people and bears. Within its 1,580 square miles live some 200 grizzlies or about one bear for every eight square miles. In 1976 a record number of 1,662-678 tourists visited the park, an increase of 5.8 percent over 1975. The recorded overnight backcountry usage totaled 28,978 camper days. Although there are no statistics available for day-use of the backcountry, it can be safely assumed that such use, whether to hike, fish, climb, bird watch, or whatever, is also on the rise.

The number of grizzly bear incidents has been increasing in Glacier. In 1975 five persons were injured by the bears; in 1976 three persons were injured and another killed. Incidents of grizzlies charging people in the backcountry have correspondingly increased. During this period the grizzly population remained fairly stable but the number of tourists continued to rise. The figures suggest a simple equation: more people equal more injuries.

The answer to why this is happening is not an apparently simple correlation of numbers, however; there is an ominous belief that bear behavior may be changing. Attacks precipitated by some obvious provocation, such as a sow with cubs charging after being surprised, are expected incidents. An increase in this type of attack may be statistically predictable as human traffic increases. But incidents in 1975 and 1976 do not quite fit as attacks of provocation, and the bears involved were mainly solitary and/or younger animals.

In August 1975, a father and his two children were hiking along a popular trail to Grinnell Glacier. They made a turn and met a lone grizzly. The bruin charged and mauled all three persons before running off. The hikers were not carrying food and they had not harassed the animal. In September 1976, two people were hiking on a remote trail but making a considerable amount of noise when they saw a single grizzly. The bear mauled both of them. The NPS has labeled this attack as "unprovoked." Later in September a grizzly dragged a woman from her tent at the Many Glacier Campground and killed her. The campsite was clean and free of food. A park service board of inquiry could find no reason for the attack.

Clifford J. Martinka, Glacier National Park's supervisory research biologist, is a bear authority. He well knows the grizzly bear situation in Glacier, and he is worried: "I used to think that with prudent management we could largely eliminate bear-human incidents. Now I'm not so sure. I'm beginning to believe the grizzlies have reached the point where they have encountered so many people that it has affected their collective behavior. They may be losing their shyness of humans but not losing their aggressiveness. It might be they are becoming behaviorally more like black bears, which are now very bold around people. If grizzlies get as bold as blacks it could be critical because grizzlies are altogether a more aggressive and dangerous animal."

Hunted bears may be more afraid of humans than are sanctuary-protected bears and less of a threat to campers and hikers. In the Bob Marshall Wilderness Area south of Glacier National Park, grizzlies have been hunted for years and there is seldom an aggressive action toward humans. The bears have learned to avoid humans and their "thunder sticks." In national parks, however, hunting is quite incompatible with the guiding philosophy.

Experiments are now being conducted into such adverse conditioning techniques as the use of lights, chemicals, and noise to encourage bears to avoid people. These are still in the testing stage, however, and research is slow and difficult. What might work with a caged bear may produce different results with wild grizzlies. Also, finding areas where experiments can be conducted without endangering bystanders is frustrating.

Trying to physically separate people and bears is a common management method. In Glacier, for example, a bear-monitoring system collects sightings of grizzlies and reports of bear trouble and examines them to determine if particular trails and campgrounds should be closed. In 1976 more trails were temporarily closed than ever before. Conservation is also being given to build a compound-type campground at a backcountry site. Certain roads in campgrounds may be restricted hard-side camping only, thereby prohibiting tents and allowing only trailers, truck campers, and motor homes.

The argument that parks are for people, not for bears, is heard after every grizzly bear incident, usual from people using such incidents as springboards for their own wishes.

A variation of this premise is encountered, notably in Alaska, where people condemn the NPS policy banning firearms in the national park. After the Glacier Bay incident in September, an outdoor writer for the Anchorage Daily Times blasted the no-gun policy and stated that he would not camp in prime grizzly country, national parks included, without some sort of weapon, adhering to the belief that breaking the law is preferable to being chewed on by a bear.

Basically the no-firearm policy meant to protect wildlife from unnecessary slaughter. Without it, poaching would be far more difficult to control, and in the vast areas of Alaska parks there would be no way the NP could prevent the indiscriminate shooting of any animal. Specifically regarding bears, any appearance of grizzly can be frightening to the inexperienced and unprepared. The NP fears that many people would shoot without real need. Also, if the park became littered with bears wounded by poor or indiscriminate shooting the danger of bear attacks would be astronomically greater.

The NPS is not contemplating the extirpation of grizzlies, although segment of the public favors such policy. While bear attacks are dramatic and nerve chilling, other accidents account for far more tragedy in the national parks. In records dat
back to 1913, 3 persons have been killed by grizzlies in Glacier National Park while 69 have perished from other outdoor accidents, such as drownings (36), falls while hiking (3), or being hit by falling objects such as rocks and trees (6). Considering that only 3 out of 1,600,000 visitors to Glacier in 1976 were harmed by grizzlies, the risk of a bear attack is exceedingly remote. Nonetheless, bears form a large area of concern in the visitor’s mind, and their presence reflects human attitudes in subtle but profound ways.

Why the deeply ingrained fear of bears? Man is not so far removed from his wilderness childhood as he may think. The horror associated with an attack by a wild beast releases fundamental fears that have been sublimated for generations. Perhaps the senseless waste of lives in automobile accidents affects us less than one death caused by a bear not only because the vaster numbers numb us but also because the screams of crash victims cannot penetrate the civilizedarcer protecting us as incisively as the primitive growling of wild beasts. Yet perhaps the automobile is simply new for us to fear intensely. After all, we grew up as both predator and occasional prey of other wild animals and had a long time to learn to be afraid. We have lived with automobiles for but a historical second; the installation of intrinsic fear probably requires far more time.

Besides the statistical evidence in the bear’s favor, defenders of the animal cite the scientific value of the creature. In natural areas, such as national parks, scientists can find relatively pristine ecosystems in which to study and learn. Diversity is the key to ecology, so the removal of any element would reduce the value of a system to science.

Other points made in favor of the grizzly are more abstract. As in arguing for the preservation of a fine painting or a musical composition, esthetic and spiritual values are invoked in defense of grizzly bears and their domain, the wilderness. The bear is formidable, exciting, and stimulating. Does not the human psyche need such varied nourishment for a healthy diet? While hiking in the grizzly’s realm brings one in closer consciousness with these nebulous yet somehow vital intangibles, even the simple awareness that such wilderness continues to exist may be a mental tranquilizer for the frazzled city citizen. The world is not all concrete and steel and pollution; there is also the wilderness and the great bear.

Whatever methods scientists and park managers discover to make tourists safer in the national parks, there will still remain the problem of the grizzly with its aggressiveness and strength. But if we can yawn and accept the reports of tens of thousands of deaths from automobile accidents and mishaps in the home, can we not tolerate the exceedingly rare death due to a grizzly bear? The prospect of encountering a dangerous wild animal will always be unacceptable to some, but to others the image of a grizzly wandering over a high alpine meadow will remain a blessed indication of the diversity that remains for our senses and sensibilities. There will be more tragedies caused by grizzly bears, all of them regretful, but we cannot completely remove the risk without exterminating the great bear. That would be a far greater tragedy than the fate of Stoney Bear.

Grizzlies cover large areas when foraging. Opportunistic feeders, two bears gorge themselves on roots in a thicket of young trees.
Celestial Events
by Thomas D. Nicholson

Sun and Moon  The sun is in Leo from mid-August to mid-September, then in Virgo, well past the solstice, where its northerly position brings us the very long days and high diurnal arc of early summer. In this part of its apparent sidereal path, the sun moves rapidly toward, and eventually across, the equatorial plane. Days are still longer than nights, but are rapidly getting shorter. Nights catch up on September 26, when sunrise and sunset are exactly twelve hours apart.

The moon will be part of the evening sky till the end of August. Early in the month, therefore, we can expect to find a morning moon in the sky. In August, phases are last-quarter on the 6th, new on the 14th, first-quarter on the 21st, and full on the 28th; in September, last-quarter is on the 5th, new on the 13th, first-quarter on the 20th, and full on the 27th. Two eclipses result from the moon’s motion during the period: a penumbral lunar eclipse visible in North America on September 27, and a solar eclipse on October 12—total in the Pacific Ocean, partial throughout most of North America.

Stars and Planets  The show in the morning sky is a good one indeed. Very brilliant Venus is there and spectacular Jupiter, both becoming more prominent during the two months. In early August, they are relatively close, rising several hours before daylight dims them; Mars, although fainter, is prominent nearby, higher and to the right. During August and September, Venus moves well east (left) of Jupiter, but Mars moves closer, passes Jupiter, and then moves east (left) from it. Saturn, meantime, enters the morning sky in mid-August. By mid-September, Venus moves near and passes Saturn; a few days later, Venus passes the star Regulus in Leo, in both cases very close to the objects. From mid-September, for about ten days, you may expect to see Mercury, too, as a morning star, low in the east in the early twilight in one of its more favorable appearances as a morning star. At the end of September, Jupiter and Mars, both in Gemini, will be high in the south at dawn, while Venus and Saturn will be in Leo, lower in the southeast.

August 9–11: The waning crescent moon moves past Mars, Jupiter, and Venus, in that order. Look in the east before dawn.

August 10–14: Look for the Perseid meteors on any morning from 1:00 a.m. on. Best on the 12th, with up to 50 meteors per hour.

August 16: The moon occults (covers) Mercury about 6:00 p.m., EST.

September 4: Mars and Jupiter are in conjunction.

September 5: Mercury becomes a morning star.

September 7: The crescent moon is near Mars and Jupiter (the brighter) in the east this morning.

September 10–11: The moon is close to Venus and Saturn.

September 18: Venus shifts from right of Saturn.

September 19–24: Mercury is favorably placed for observing as a morning star, low in the east in the very early dawn.

September 21: The star nearest Venus this morning is Regulus in Leo.

September 22: The sun arrives at the equinox at 10:30 p.m., EST.

Summer ends and autumn begins in the Northern Hemisphere.

September 27: The full moon is the harvest moon.

October 4–5: In the morning sky, the moon is near Jupiter on the 4th, Mars on the 5th.

October 8–10: The moon again moves past Saturn and Venus.

★ Hold the Star Map so the compass direction you face is at the bottom; then match the stars in the lower half of the map with those in the sky near the horizon. The map is for 1:15 a.m. on August 1; 12:20 a.m. on August 15; 11:15 p.m. on September 1; 9:20 p.m. on September 15; 8:20 p.m. on September 30; and 7:20 p.m. on October 15; but it can also be used for an hour before and after those times.
The Bambi Factor

Good and bad animals are made, not born

Knocking about in out-of-the-way places searching for information on animals and people produces enlightening perspectives on similar themes closer to home. During a recent trip around Australia, I tried to learn something about the roles animals play in different societies. Wherever I stopped, I asked about local wildlife: the native names of species, their habits and habitats, how and when they were hunted and used, and how they were portrayed in art and myth. One encounter in northwestern Arnhem Land, a cloistered corner of Australia’s Northern Territory, gave me some perspectives on my own tribe.

A visit to an aboriginal village had led to a talk with some men about the area’s wildlife. I went through my list of questions and the villagers graciously explained the different clan totems, and the various animal symbols and designs on bark paintings and other arts and crafts. They also told tribal stories involving animals and gave me the common names of local species. They were perceptive and helpful and a joy to talk with. When we finished the list, some of the elders began asking me similar, but culturally reversed, questions about my people. Fair enough. They had made every attempt to help me understand some of their way of life, why shouldn’t I reciprocate and be an informant on my tribe?

I rummaged through the attic and basement of my memory, seeking favorite and most important American animal symbols, myths, and stories. I didn’t find much: the bald eagle, a few James Thurber fables, and a lot on pets. The aborigines were satisfied, but I wasn’t. Their questions stuck and nagged.

Later, the more I dredged up, the more I realized that much of our symbolic system is also heavily based on animals. Culturally blind, I was bumping into an imposing structure, and while I could make out some of the steps and doorways, I could not see the form until the roof fell in and I remembered the Walt Disney-Mother Goose Table of Animal Values. That memory jogger led me to comic books, cartoons, language, television, movies, and the cultural epaulets of identity found on T-shirts, Levi jackets, belt buckles, lapel buttons, automobile hoods and grilles, posters, trademarks, logos, and pennants. Animal symbols were everywhere. I had discovered a mother lode. Just as well I found it after my visit to Arnhem Land for if I had told them of the things that you’re going to read, I might have been put on a wanted list as unnaturalist at large.

I once saw a bumper sticker in Los Angeles that read: “All the world is watching the United States, and all the United States is watching Walt Disney.” Disney animals have had a major, governing influence on all of us. They are part of our cultural DNA, something that sociobiologists should look into. Someone in The magazine recently wrote about “Dneyfication.” What a word! Even Abraham Lincoln, Fran Tarkenton, Barbara Walters, Robert Redford and General Motors haven’t been “cat ed” yet, so you know Disney big stuff. The Disney crowd can make or break an animal. Some Disney animal images apply symbolic critcal mass.

John Livingston, in his imaginative book One Cosmic Instant, pointed out that right along with the multiplication table and the table of chemical elements, we have learned the Walt Disney-Mother Goose Table of Animal Values. Why is it, Livingston asks, that some animals are “good” and others “bad”? Why are wolve coyotes, bears, vultures, weasel and snakes bad; while fawns, chipmunks, rabbits, squirrels, or beavers are good? This list can be extended and appended to include animal heroes and villains in comic books, fairy tales, Saturday morning television cartoons, and Sunday afternoon nature programs.

Despite America’s high per capita consumption of meat, the table of animal values has it that meat eaters are the bad guys, and seed-grass-bar eaters are the good guys. You are what you eat, according to Adel Davis, which appears to apply as well, to fictional animal characters.

Most of the animals in fables, tales, films, and comic books are engaged in make-believe events. Children and consenting adults real

84
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Don't buy that sort of skewed reality, right? (Make a list of animals and ask your children to choose the good and bad ones. You might want to use some less loaded words.) Make-believe animal scenarios are made believable through humanlike plots, social and interpersonal relationships, and dialogue, much of which carries moral and ethical values. However, they are drawn, the animals' faces are simply shrunken human heads that show every grown-up wrinkle, frown, smile, and wart from our experiences, and which preview the adult world for children.

The table of animal values is really a table of human values. Nonhuman animals know nothing of nastiness, saintliness, greed, benevolence, cruelty, or cuteness. Livingston adds that we have failed to realize the utter indifference of nature to human values. But all must be seen in human terms and all must be possessed with human values.

A veritable zooful of animals roams our symbolic landscapes—exotic wild animals, domesticated farmyard creatures, pets. They are found in epithets, clichés, analogies, metaphors, and similes—and in bar-rooms and churches. If I were to call someone a "vulture," "maggot," "dog," "sheep," "pig," "toad," or "habooon," I would be in all likelihood get mad. Yet if I said someone was a "lamb," "tiger," or "fox," they would take it as a compliment. Of the wide range of physical attributes and behavioral characteristics of animals, we have ignored most and substituted human characteristics to condense and heighten an image or to evoke a feeling.

Many of the images of animals in our language are the residue of cultural lint traps. Anything loose and unattached goes through the proverbial wash; some ideas and words are flushed; others stick to the conceptual screen. On first appearance, a new animal epigram may have the impact of a potent new symbol—"pig" of the 1960s or "turkey" of the 1970s. The more success is, the more readily it is assimilated into automatic responses and folk images.

Take "turkey." That single word can evoke fits of near hysteria among my son and his friends. The word is a regular on television and has even been programmed into one of the home video games: in the tick-tack-toe game, "'You Lose Turkey" flashes on the screen, implying more than simply having lost the game. "Turkey" will probably die overuse by the 1980s as "squir-" did after the 1950s. The next an is up for grabs. (We may move to vegetation. My personal pick to o is "turnip."

And then there is the use of word "as," commonly in a simile between a human concept and a specific animal, such as "crazy as a hook," "dumb as an ox," "stubborn as a mule," "slippery as an eel," "big as a lion," "big as a whale," and on, ad nauseum. Such similes com- tute one of our national cultural tra-

I tried to imagine the outcome en being weaned and raised solely on conventional folk animal wisdom. Cats, bats, lions, and jays are crazy, owls are wise. Peacocks, butterflies, and frogs are beautiful, whereas gulls, bobbies, pigs, dogs, and tv are ugly. Ostriches, sheep, and geese are stupid; apes have too much human body covering, while jays have little. Crabs and hornets are always mad or nasty; goats and mules are stubborn; bears are rough and lama- gentle; mice and clamps are quaint. Wolves, vultures, and hyenas are evil and always up to no good; ants and shrimps are about the same size.

From this list of imaginary animal characteristics, one would have to conclude that, with the exceptions of bees, all insects and arthropods are bad; anything found in fresh or salt water is likely to be dangerous, or very big; and reptiles and amphians are to be avoided. Birds are the mixed bag, some of the small ones. OK except for the crazies, but the big ones are either dumb or eat rotten meat. Some of the mammals are tinious and ugly, although a few are more founded with caution.

As for pets, livestock, and farm yard animals, they may be our friends, yet they are often our own enemies in common speech. "Dog, bitch," "pig," "dog," "horse, parrot," "chicken," "goat, cow," "sheep," "canary, an "pigeon" are all derogatory. For the animals, the attention and money devoted to them, and all the dietary and economic importance of the domestic managerie, one might assume that they wouldn't be such verbal victims.

The animals in our language and perceptions have solid niches in society. Animal symbols can be pow- erful. They have to be chosen with care. I mean, would you buy a car that was called a Whale, Toad, Moose,
Baboon? The driveways of America are clogged with Cougars, Jaguars, Mustangs, Ponys, Falcons, Impalas, Foxes, Rabbits, Roadrunners, Hornets, Marlins, Barracudas, Colts. These names were not selected randomly. A lot of market research went into them. Each name conjures a specific and supposedly desirable image, one which a car owner may acquire when he gets behind the wheel.

In discussing culture, anthropologist Marvin Harris wrote: "In a time when many are eager to experience altered states of consciousness, we tend to overlook the extent to which our ordinary state of mind is altered." Although animal symbols are important, they do not yet have the totemic social significance in our culture that they have for many other peoples in the world. Most of us do not form relationships and economic exchanges because of animal images or totems. But some people are so emotionally aligned with animals that this may change. I remember a woman who came up to me at a party and said "I'm into whales. How about you?" I call this the Jonah Factor. It may someday lead to the point where social and economic relationships are based on animals, depending on such things as what pet you own or which endangered species you are worried about.

Animals in homes, in zoos, and in the wild have become cultural artifacts. In this column ten years ago, Marston Bates wrote that "the forests that are gone and those that are left as parks or reserves, the animals that are protected and those that are persecuted—our whole ecosystem is shaped by the concepts of our culture. Our troubles stem from our conceptual environment. We made it. All we have to do is change it!"

Our illusions of imaginary animal traits may become so convincing, so persuasive, that they become reality, and we will see animals that really are too ugly, too stupid, too big, too crazy, too greedy, or too violent to care about any more. All the negative, demeaning symbols in our language should be rare or endangered, not the animals. Let the whales swim deep, the bats fly free, and the wolves roam without anything but our best hopes and strongest protection.

Bernard Nietschmann has completed his field work on dugongs in Australia and will be returning home sometime in August.
“Escape from the ordinary”

Rings Around Uranus

by Stephen P. Ma

A major and unforeseen finding indicates that the seventh planet from the sun is encircled by five rings

In a prime example of serendipity, one of the principal astronomical discoveries of modern times was made last March by scientists who were not looking for what they found and were, in fact, using a research aircraft designed for an entirely different purpose. The discovery was that rings like those of Saturn also exist around the planet Uranus. The finding was so unexpected that both the airborne observers and at least one team viewing Uranus from the ground on the same night thought at first that their instruments were malfunctioning.

Decades of prior observation had seemingly established that Saturn was the only ringed planet. This conviction was such an accepted “fact” that when, in 1975, a Harvard University astrophysicist concluded that rings must have formed around Uranus early in the planet’s history, he felt compelled to add a tentative explanation for a process that presumably had later destroyed them. However, the recent discovery shows that Uranus has at least five rings— one more than Saturn. They are much narrower than those of Saturn and therefore reflect far less light from the sun. In addition, Uranus is farther from the sun than Saturn and is also farther from the earth. These factors make the newly discovered rings more difficult to see than Saturn’s and help explain why they weren’t found earlier.

The events leading up to the discovery of the rings of Uranus began in 1973, when an astronomer at Her Majesty’s Nautical Almanac Office—a unit of the Royal Greenwich Observatory in England, predicted that a distant planet would occult, that is to say block the light from a faint star in the constellation Libra on March 10, 1977. The astronomer Gordon E. Taylor, pointed out in the Journal of the British Astronomical Association that “no useful observations of such an event have ever been made and adequate preparation is essential in order to obtain the maximum amount of information…”

An occultation is the passage of the moon, a planet, or the satellite of a planet in front of another celestial object.
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AUGUST 15th FRIDAY

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Spheniscidae (Penguins) to Laridae (Gulls and Allies)
by Emmet R. Blake

This is the first in a four-volume work that will treat 3,300 species and some 8,300 subspecies of avifauna to be found in Central and South America, the continental islands, and adjacent waters (Mexico, the West Indies, Galapagos, and the Falkland Islands excepted). Volume I covers 600 species and about 1,500 subspecies of 48 families. This comprehensive and authoritative manual provides the fullest information on the birds of a region unsurpassed in the diversity of its avian fauna and which contains more than one-third of the world’s bird species. Handsomely illustrated with 67 beautifully detailed and specially reproduced wash drawings, a section of superb plates, several in color, and 237 maps. 704 pages. 7” x 10”. $50.00

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LIVING NEW WORLD MONKEYS (Platyrrhini)
With an Introduction to Primates Volume I
Philip Hershkovitz

Long-awaited, this is the first volume of two in an encyclopedic work which is the result of eleven years’ study of more than 3,100 museum-preserved specimens and primate fossils, and observation of hundreds of animals in captivity and in thousands in the wild. The author deals first with primates as a taxonomic unit and with New World monkeys from comparative anatomical and evolutionary points of view. The most extensive part of the volume is devoted to the taxonomy and biology of the family Callitrichidae (marmosets, tamarins) and the family Callimiconidae (callimico). ....a masterpiece... A classic, a scholarly enterprise of grand proportions.” — Ronald Singer. Lavishly illustrated with 520 figures and 7 color plates. Bibliography of more than 2,500 published works. Gazetteer. 8 1/4” x 11 3/4”. $75.00 Hill 12/31/77; $80.00 thereafter.

The importance of the occultation of a star by Uranus, as perceived in 1973, was the opportunity the event would offer to time the rate at which the star fades out as it passes below the planet’s thick, cloudy atmosphere. Such information would allow planetary scientists to determine various properties of the Uranus atmosphere, such as the average weight of the constituent gas molecules and the possible presence of high-altitude cloud layers. Timing the star’s disappearance and reemergence would also provide a more precise measurement of the planet’s diameter and perhaps even of its shape. Calculations show that the rotation of Uranus should cause it to bulge at the equator, so that its equatorial diameter exceeds the one measured from pole to pole. Jupiter has a large “equatorial bulge” of this type. While the equatorial bulge of Jupiter is a confirmed phenomenon that has been accurately measured, the corresponding observations of Uranus were in considerable disagreement in 1973. Recognizing the importance of resolving this discrepancy, a group of Uranus experts that met in September 1973 at Moffett Field, California, adopted a resolution directing “the attention of observers and funding agencies to the 1977 Uranus occultation.

One planetary physicist, James Elliot of Cornell University, arranged to observe the Uranus occultation from NASA’s Kuiper Airborne Observatory, a C-141 jet equipped with a 36-inch telescope and normally used to observe infrared light that is absorbed in the earth’s atmosphere. During the March observations, the aircraft cruised at an altitude of 41,000 feet, above 75 percent of the atmosphere. Elliot’s measurements were made in red light, which is readily observable by instrument on the ground, but the need for an aircraft in this case arose from the circumstances of the occultation: the best region for viewing it was at sea, not on the land. Also, a high-altitude observing facility was desired to eliminate the risk that cloudy weather might prevent viewing.

A few weeks before the occultation was to occur, it was found that the occultation track, that is, the zone of the earth’s surface from which the event would be visible, had been accurately predicted. New photographs made by two Lowell Observ
astronomers with a 61-inch telescope in Flagstaff, Arizona, showed the star to be occulted was actually slightly north of its previously predicted position. It was also found that no corrections were necessary in the computed path of Uranus through the sky. As a result, the predicted occultation track shifted to the south. Two teams of Arizona astronomers stationed at the Perth Observatory in Australia this meant that their instruments were now located near the perhaps outside the northern limit of the occultation track. Elliot however, only had to shift the flight path of the airborne observatory.

On March 10, shortly after 20 hours, Greenwich Mean Time, the airborne observatory began tracking a faint orange star SAO 158687, which had been the subject of a search for red light in the red region the spectrum was isolated by filters and beamed to sensitive photoelectric equipment. There, weak electrical signals were generated in the same way that daylight striking a photometer’s light meter produces an electric current that deflects the meter needle. The signals from the photoelectric equipment were amplified and routed to recording devices, including a “strip chart recorder.” The latter device, which was closely watched by Elliot and his associates, for the flight proceeded, has moving pens that record the intensity of the signals on a continuous roll of graph paper. A television monitor also displayed a picture taken through the telescope, thereby providing a visual check on the accuracy with which the star was tracked as the plane flew over the Indian Ocean.

At 20 hours, 11 minutes, 43 seconds, Elliot and two aides from Corliss had their first intimation that nothing unexpected was in the works. Although the star was not yet to be occulted by Uranus, the readings on the chart recorder suddenly slowed, indicating a brief diminution in the measured light. At first, a problem with the tracking system was suspected: perhaps the telescope had moved away from the star. However, the television monitor showed a steady image of Uranus, indicating that the telescope was under control. Actually, the outermost ring of Uranus (since dubbed the “epsilon ring”) had just passed in front of the star. The unexpected event had been detected 74 seconds earlier, farther to the south of the occultation track at Perth.
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92

by a surprised Lowell Observatory astronomer, Robert L. Millis, two associates.

Millis, whose team thus gets credit for the first reported observation of a Uranian ring, later indicated to a reporter for the Flagstaff Sun that the instrument failure had been momentarily suspected when S 158687 first seemed to fade at Peebleshire. Nevertheless, the observations with a 24-inch telescope were continued and additional occultations were recorded. Two rings ("delta" and "alpha") were missed when Lowell astronomers halted their observations at two different moments to recenter the telescope pointings. Further, a few less certain observations were observed, perhaps indicating that more than five definite established rings exist.

It later turned out that the predicted occultation, that is the occulting of the star's light by Uranus itself, was not visible from Perth, but Millis' persistence was rewarded by the observation of the ring occultation. The Perth observations were terminated by the interfering glare of a rising sun; thus the Lowell astronomers did not record the five definite occultations that occurred as the opposite side of the ring system passed in front of the star.

Aboard the aircraft, however, Elliot was able to record both the five "inbound" occultations and the five "outbound" ones. (The occultations were not sighted visually nor were they photographed. They were inferred from dips indicated on a strip chart recorder.) From the measurements, Elliot could prove beyond a reasonable doubt that the events were caused by a circular ring system and not, say, by five previously unseen moons. It appears that the outermost ring, epsilon, might deviate slightly from a true circle or might be slightly tilted with respect to the other rings.

Other observations of the ring occultations were made with a 102-centimeter telescope of the Indian Institute of Astrophysics at Kavallur, where two astronomers at first suspected that they had discovered a new moon of Uranus, and at Naini Tal, India, where astronomers from the Uttar Pradesh State Observatory, expecting only the occultation of the star by the planet, began viewing to late to record the first inbound epsilon-ring occultation, but did detect the four other inbound occultations.
to the west, the five outbound ring
ultations were observed by an astro-
nomer at Cape Town, South
ica. Only the airborne astron-
ers, however, recorded all the in-
land and the outbound events.

What is the significance of the
ringed moons, which revolve
under the planet in the same direc-
tion and in a common plane, tilted
lost at right angles to the planet's
it around the sun. In the very same
ue of the journal, A. G. W. Cam-
of Harvard University, a leading
ority on the origin of the sun and
ets, proposed that rings might
have formed around Uranus as
ical consequence of the same
ess that formed the five moons.
ording to his theory, the moons
ed from a rotating disk of matter
ecled Uranus early in its his-
y, and the rings represent remnant
icles from this disk. Like the rings
 Saturn, the rings of Uranus are not
id objects but must be composed
an enormous number of small
s of ice and stone. Recent obser-
s suggest that the rings of Sa-
are made predominantly of ice,
position that helps explain why
rings have been found around
er and the other planets that are
ser to the sun. Their ice particles
uld have evaporated.

At one time, the status of Saturn as
only ringed planet was taken for
nted. The discovery of rings
and Uranus suggests, however,
ring formation may be a basic
cess in planetary evolution. If so,
purine, the next planet beyond
anus, may also have as-yet-unde-
nded rings. When I visited the Kitt
ok National Observatory head-
rs at Tucson in early April,
y a few weeks after the Uranus
discovery, it was therefore not
prising to find an expert plane-
observer busily poring over
ks and formulas, beginning the
rk of searching for stars that might
eday be occulted by the still-hy-
thetical rings of Neptune.

phen P. Maran is an astronomer
NASA's Goddard Space Flight
ter in Greenbelt, Maryland.
Food in Chinese Culture, edited by K. C. Chang. Yale University Press, $20.00; 429 pp., illus.

"Appetite for food and sex is nature," said Kao Tzu, a Chinese philosopher during the Warring States period. Indeed, food and sex would seem to be the two most basic human activities: the former is necessary to the individual's survival; the latter is necessary to the species' survival. Yet students of the human scene, social scientists, have neglected the study of these activities possibly because they are considered too earthy or too gross. It is therefore of some interest that several recently published works have attempted an anthropological view of food. One of the most successful is Food in Chinese Culture.

Food and sex are often associated. In our own culture, one need only think of the English vocabulary used to talk about sex, with its emphasis on metaphors having to do with eating or with specific foods. Or the scene in Tom Jones, where a rep of suggestive foods, including oysters and hunks of meat, serves as occasion for sexual seduction. Chinese language also makes use gastronomic images in sexual descriptions; so, a sixteen-year-old virgin may be described as being "sw and ripe as a melon ready for eating." Food and sex are intertwined in the first great realistic Chinese novel, Chin-p'ing-mei ("Golden Lotus") written in the sixteenth century in which simultaneous ingestio
d copulation occur once or twice. All societies must limit the natural petites associated with food and sex, but the range of variation in customs pertaining to food is infinitely greater than in those involving sex. Men must eat, but the foods they eat, the ways in which these are prepared, prepared and cooked, the amounts, variety and times of eating, tastes that are liked and disliked, utensils and etiquette of serving food, and the beliefs about the properties of particular foods all vary seemingly infinite ways. Even thin a culture, there are variations sed on class, region, religion, social occasion, sex, and age, and there are variations over time.

Most people would probably agree that, along with the French, the Chinese place a greater value on food and gastronomic delights than most cultures. Even Maoism could not regiment Chinese eating habits: communal mess halls were one of the first innovations of the Great Leap Forward that had to be abandoned. It is interesting to note that in spite of the hilarity between French and Chinese cultures in the high value that place on food, they differ radically in the role they assign to sex.

If food is an important part of culture, it is also a reflection of deeper values. Since at least the Chou dynasty (c. 1100–256 B.C.), the Chinese have recognized a division of food into fan (grains such as rice, the cultural superfood) and ts'ai (mixed vegetables and meats). The former are served in individual bowls (the proper etiquette is to bring the bowl to the is and shovel the rice in with chopsticks), while the latter are served in large bowls placed in the center of the table, from which everyone helps himself. Fan serves as a bland filler and absorbs the rich variety of smells, flavors, colors, and textures possible ts'ai. Unlike the typical American meal of steak, potatoes, vegetables,
ARCHAEOLOGY OF ANCIENT EGYPT—9 Tuesdays starting October 11, 7:30-9:00 p.m. Fee: $35.
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MAGIC AND WITCHCRAFT—8 Thursdays starting October 13, 7:00-8:30 p.m. Fee: $30.
Paul J. Sanfacon, Lecturer in Anthropology at the Museum, leads a serious sociohistorical inquiry into various beliefs and practices of magic, witchcraft and sorcery.

THE STORY OF GEMS—8 Thursdays starting October 13, 7:00-8:30 p.m. Fee: $40. Limited Enrollment.
In this unusual series, Joe Rothstein, Associate in the Department of Mineral Sciences at the Museum, discusses gem stones, their physical and optical properties, as well as characteristics that make them gem quality material. Illustrated with color slides, gem stones from the Museum’s collection, and a visit to the new Morgan Memorial Hall of Gems.

IDENTIFYING MINERALS AND ROCKS—10 Mondays starting October 17, 7:00-8:30 p.m. Fee: $60. (including laboratory fee.) Limited Enrollment.
Laboratory workshops in techniques of identifying common minerals and rocks through physical tests of specimens. Dr. George Harlow, Assistant Curator in the Department of Minerals Sciences at the Museum.

A Special Tour of the new SECTION OF METEORITES, MINERALS AND GEMS—2 Thursdays, October 20 and 27, 7:00-8:30 p.m. Fee: $10. Limited Enrollment.
Dr. Martin Prinz, Curator of the Department of Mineral Sciences at the Museum, and Dr. George Harlow, Assistant Curator of the same Department, will personally interpret this spectacular exhibition of some of the world’s largest gem stones, finest mineral and crystal specimens and the dramatic beauty of earth materials and meteorites.

AMPHIBIANS AND REPTILES—8 Mondays starting October 17, 7:00-8:30 p.m. Fee: $30. Limited Enrollment.
Using color slides and materials from the Museum’s collections, Dr. Charles J. Cole, Associate Curator in the Museum’s Department of Herpetology, discusses classification, evolution, adaptations to various modes of life, uses, and how scientists investigate the biology of amphibians and reptiles. Includes a “behind-the-scenes” tour of the Department of Reptiles and Amphibians and a preview of the new Hall of Reptiles and Amphibians which opens to the public later this Fall.

SOCIAL BEHAVIOR OF ANIMALS—7 Mondays starting October 17, 7:00-8:30 p.m. Fee: $35.
Dr. Ethel Tobach, Curator at the Museum and Adjunct Professor in Biology and Psychology at the City University of New York, discusses the evolution and development of social behavior as an important factor in ecological adaptation of representative species. Experimental studies with live animals will be demonstrated.

THE WORLD OF BIRDS—6 Tuesdays starting October 11, 7:00-8:30 p.m. Fee: $25.
Using color slides and study skins from the Museum collections, Kenneth A. Chambers, Lecturer in Zoology at the Museum, introduces the history of birds, their classification, structure and other interesting aspects such as reproduction, display and migration.

WILD FLOWERS OF THE NORTH—5 Thursdays starting October 13, 7:00-8:30 p.m. Fee: $20.
In this slide-illustrated series, Helmut W. Schiller, Lecturer in Botany at the Museum, explores the world of wild flowers of northern mountains, coniferous forests, and wetlands, from Alaska and the Pacific Northwest across to the New England States.

INSECTS: EARTH’S MOST SUCCESSFUL ANIMALS—6 Thursdays starting October 13, 7:00-8:30 p.m. Fee: $25.
Alice Gray of the Museum’s Entomology Department gives an informal series of slide-illustrated talks on some of the fascinating aspects of the world of insects, including structure, life-histories, environmental relationships, and the significance of insects to man.

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and salad all standing in isolation, as if under analysis, the ts'ait must be a harmonious blend of bite-sized pieces of a variety of meats and vegetables—reflective of the harmony so important in the Chinese social order between Man and Nature, Man and Man, Ruler and Subject.

China offers an immense regional and temporal diversity of gastronomic arts. Chang's book emphasizes the latter, taking us to myriad feasts (and famines), from the time of Peking man (described by Chang) to that of Communist man (by Vera and Francis Hsu, Eugene and Marja Anderson), by way of the dynasties of Han (by Ying-shih Yü), T'ang (Edward H. Schafer), Sung (Michael Freeman), Yuan and Ming (Frederick W. Mote) and Ch'ing (Jonathan Spence). Along the way, we are tempted by pages and pages of fascinating culinary delights, not the least of which was the custom, during the T'ang dynasty, of stuffing newborn rats with honey and allowing them to crawl about the dinner table to be delicately picked up with chopsticks and popped in the mouth alive. Or steamed dumplings filled with minced humans, mentioned in The Water Margin as a specialty of "black devil inns" where evil persons plotted crimes. (Indeed, cannibalism is quite ancient in China; some archeologists believe Peking man was a cannibal because of the many broken skullcaps in his caves.)

In addition, each region, even each locality, has a traditional cuisine: the dishes of Szechwan are hot and spicy; sweet and sour dishes are characteristic of Canton; Fukien is famous for its soups; Shantung cooks are heavy on garlic and seafoods; Honan is the home of sweet-and-sour freshwater fish, and so on.

Behind this regional and temporal diversity, however, one can discern elements of unity. As Eugene and Marja Anderson argue so cogently in their excellent contribution to this volume, Chinese cuisine makes use of a basic repertoire of ingredients and technology, of methods of combination and preparation. The basic ingredients are rice, fish, pork, and vegetables (to which north China adds wheat, soybeans, and mutton). The technology includes a stove, the wok, capable of high heat, the cleaver used for dicing foods, and eating utensils, such as porcelain bowls, spoons, tiny teacups, and chopsticks. In the south, methods of

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marked or asserted, without the sharing of food. The expense, status value, quality, and setting of the food communicated more about the critical social dynamics of the situation than language can; much that is hard to verbalize, and more that would be impolite to verbalize, is communicated by this channel. Such use of food is worldwide, as every anthropologist knows; but no culture has developed it more than the Chinese."

The Chinese even make use of food to communicate with the supernatural. The most direct contact that each family has with the celestial bureaucracy is through the Stove God, who once each year ascends to the spirit world to make his report on the family's conduct and activities over the past year. Of course, shortly before he is scheduled to make this report, the family pleases him with tasty, glutinous rice cakes. Food offerings used to be buried with the dead (one source of our knowledge about past gastronomic customs), but now the spiritual essence of the food satisfies the supernatural. Although some spirits have favorite foods and every festal occasion has its traditional dishes, there is a hierarchical rank of food offerings, from lowest to highest: (1) tea and fruit, (2) bowl noodles and wine, (3) duck, chicken, and pork dishes, and (4) a pig, especially the "golden pig" (roasted with a sugar glaze that gives it a slight gold color). Although Westerners often interpret these festival meals unnecessarily lavish extravaganzas that add to the burden of daily gaiety, it must be remembered that pigs and chickens are very efficacious converters of wastes into high-quality protein; protein, moreover, is a basic need that food and health care appear to support, and the lack of which would in the long run have detrimental effects upon their health.

Food in Chinese Culture offers readers a fresh perspective on a well-trodden subject; its scope and treatment are worth the price of admission, especially for those who have not traveled far or gone far enough to appreciate the differences in eating patterns between nations and cultures.

Alain Y. Dessaint is assistant professor of anthropology at the University of Maryland. His book on the minority of Southwest China will be published later this year.
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A Conjugation of Snails

photographs by Hans Pfletschinger

The edible ground snail, *Helix pomatia*, is an animal with an appropriate common name. A terrestrial species found throughout central and southeastern Europe, it is viewed as a culinary delight by a variety of cultures. The French in particular have developed a number of *escargot* dishes featuring this species.

Land snails are more specialized and recently developed than their marine relatives. Breathing through a kind of lung, rather than the gills used by marine species, land snails have had to evolve adaptations to meet the dangers of desiccation and cold. Edible ground snails, for example, hibernate during the cold European winter months. They do this by burrowing among roots and leaf mold to a depth of up to thirty centimeters (about twelve inches), then roofing the excavation with a mixture of leaves, soil, and mucus. Once in its burrow, an edible land snail also forms an epiphragm, or lid, over its shell aperture as further protection against cold. The epiphragm is sufficiently porous to allow humid air to pass through.

Spring sun elevates the temperature in the burrow, and when sufficiently warmed, the edible ground snail breaks through its epiphragm and digs its way to the surface. Most active during periods of high humidity, the snail forages primarily at night. Equipped with thousands of minute teeth on a chitinous, bandlike radula, the snail rasps off bits of vegetation. Their preference for broad-leaved plants has led snails to be common inhabitants of gardens and vineyards.

May and June are the main mating months for this hermaphroditic species, although mating may continue into summer. Cross-copulation (photograph 1) takes place when two partners erect the anterior parts of their bodies and press firmly together. The mating couple rock back and forth and shoot calcareous darts, up to twenty millimeters long, into each other. These darts, formed in a genital gland, probably serve as a stimulus to mating. Shortly after the darts are exchanged, sperm transfer begins. Sperm is stored in a receptacle within the snail’s body. Four to six weeks after mating, the fertilized eggs in each snail have matured enough for deposition to take place. The snail seeks a shady, humid, semibarren spot where the earth is not too hard. With its foot, the animal digs a shaft about the width of a finger. The excavated earth is arranged around the lip of the shaft, forming a small mound. At a depth of five to six centimeters, the lower part of the shaft is widened to form a chamber. The digging process takes an entire day.

After a rest period of several hours, egg laying begins (photograph 2). The genital opening is located between the mouth and eye tentacle on the right side of the head. The peap-sized eggs (photograph 3), are rich in yolk and covered with a mucous coat that lubricates their passage through the genital opening. A substance in the mucus, possibly an enzyme, prevents the eggs from rotting or being attacked by fungi while they mature in the egg chamber.

There is a long interval between the laying of each egg, more than thirty minutes in some instances. The number of eggs in a clutch can vary from a low of thirty to seventy or more. In the clutch pictured, sixty-nine eggs were laid, the first at 7:30 A.M. and the last on the evening of the following day—a period of thirty-six hours.

The eggs are covered by a soft, white, calcareous shell that allows humid air to pass through. Desiccation is a threat, so the adult plugs the shaft leading to the egg chamber, using soil from the shaft excavation mound as building material. As the parent snail crawls over the mound, earth particles stick to its slimy film. The snail then crawls in tight cir cl around the shaft and scrapes the particles off, repeating the process until the shaft is completely plugged.

About two weeks after deposition (under controlled conditions), hatching of the young snails is indicated by small droplets of water on the egg. During the next two days the eggs change color, and begin to disintegrate (photograph 4). Disintegration is due to the young snails insorbing calcium carbonate from egg covering to form their own shell. Twenty-four hours later, the egg covering has disappeared and young have hatched.

After hatching, the young attach themselves to the walls of the chamber (photograph 5). They begin their first active feeding by eating away at the surrounding soil. Nutrients, in the form of organic substances in the soil, pass through the hatching. Calcium carbonate is absorbed, and the bodies and shells of the young grow larger and stronger.

As they eat away at their chamber, the young snails enlarge cavity sideways and upward. Over the next three to four weeks, hatchlings nibble the soil, continue enlarging the chamber and near the surface. When they are with about five millimeters of the ground surface, the snails begin to break through (photograph 6).

Once above ground, (photograph 7), the hatchlings disperse toward nearby vegetation to begin the herbivorous diet they will maintain adults. Their numbers are reduced sharply by predators such as beetles, ants, and toads, and by farmers and gardeners seeking to eradicate them from their plots. Of those that survive, many succumb to still another type of predation: humans on the prowl for another meal of *escargot*.

*Frederick Hartma*
The tasty, old-fashioned tomato is the victim of its own success

The tomato, as everyone knows, is an endangered species. The spheroid, commonly red and tangy fruit has not, of course, been pursued to the point of extinction, like that other prized native of Peru, the vicuña. Indeed, from its first encounter with the conquistadors (tomato derives from the Nahuall tomatl), Lycopersicon esculentum went on to conquer the world in salade de tomate, salsa di pomodoro, and in that most reliable lunch-counter sandwich, the BLT. So popular is this once-maligned cousin of the deadly nightshade (and other Solanaceae family members, such as the potato and the eggplant) that, year-round, no supermarket can afford to be without it. And that is the trouble.

But you know that already. You have heard that mass-produced, artificially ripened, mechanically picked, long-hauled tomatoes aren’t worth the vines they were forced to grow on, in Florida or other agriculturally “advanced” centers of tuniculture. Even without the barrage of antitomato propaganda emanating from James Beard and other epicures, who have lately been resorting to canned Italian tomatoes, you would have known by the evidence of bite, tongue, and teeth that the modern American tomato is a com¬ sham. It has no taste and it won’t splat.

Horticulturists, who should be burlied as traitors to the proper standards and practices of their trade, have sold themselves to agribusiness and have fabricated sturdy-walled tomatoes that can survive the truck cross-country without bruising or squashing.

Fortunately, for a few weeks of the year, local growers in all parts of the country sell their own, antique-sty¬ squishable, blotchy, tart, and sometimes green-dappled tomatoes at country stands. These tomatoes are a test of a good knife. And they put industrial tomato in the shade.

You too can grow them. And you should reserve the sunniest corner of your garden or your fire escape for a few plants. (It’s worth the ti and trouble, for most people, bother with seeds.) In temperate zones, tomatoes, which are natura perennial, are grown as annuals and develop into spreading vines or erect plants. Among their other more apparent virtues, tomato plants of a convenient home laboratory for the study of the arrangement and gene geometry of a common type of lee

Tomato leaves usually grow in alternate (one leaf per node) arr
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Antarctica’s winter population of 220 swells to a modest 3,000 in summer. Among the summer visitors recently was John Langone, whose report on the hardworking, raucous lifestyle of the last frontier is "enthralling." —Publishers Weekly.
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along the leafstalk, or petiole. They also emerge, alternately, to one side—and then the other—of a central axis, just as feathers grow on two sides of a central quill. This configuration is, hence, known as pinnate (pinna is "feather" in Latin). And since a single leaf grows at the apex of the "quill," the tomato leaves are said to be odd-pininate because of this unpaired, extra leaf at the end of the petiole.

Furthermore, as with leaf arrays in other plants, if you draw a line along the stem that connected the bases of successive leaves, you might, if you measure the segments cut off by the leaf bases on the resulting spiral and cogitate cleverly, rediscover the phenomenon known as phyllotaxy.

Before you reach for your dividers and your ruler, you should know that the neat ratios found in botany textbooks for phyllotaxy (from the Greek words for "leaf" and "arrangement") do not work out perfectly but only approximate whole-number perfection. Still, phyllotaxy does basically work out to be a complex mathematical regularity in the placement of leaves along a stem. To return to our example then, not only do tomato leaves have a visual, featherlike pattern but they also emerge along a spiral track that twists around the basically cylindrical surface of the stem. Furthermore, this array is mathematically specific, the same, for all tomatoes. The spiral line connecting tomato leaf bases must twist around the stem two times and run through five leaf bases before it reaches a (sixth) leaf that will grow directly above the leaf you started with. In other words, there is a recurring pattern in the arrangement of leaves around the stem. Every sixth leaf starts the twisting series anew.
The recurring pattern, in tomatoes, boils down to a ratio of 2:5—two full twists around the stem and five leaf bases. It is also the case that the angle of the arc of the spiral between two leaf bases is 144 degrees, which is two-fifths of 360 degrees. Or, if you looked straight down the stem, so that the vertical distance between leaf bases played no part in what you saw, the length of the arc between successive leaf bases would be two-fifths the circumference of the stem.

Botanists say, then, that tomatoes have a phyllotaxy of 2:5. Ditto for tobacco plants. But several other phyllotactic ratios have been observed in nature: 1:2, 1:3, 2:5, 3:8,
In every case, the numerator is the number of circles around the stem and the denominator is the number of leaf bases in a pattern or series. These observations also apply to arrangements of seeds on pine cones, to the curving of florets in sunflower disks and the ordering of cauliflower florets. As I know, no one has satisfactorily explained the genesis of these ratios. The so-called "spiral" itself is really a kind of "spiral" since it is a regular curve of a stem that may, for most length, be closer to a cylinder if it is to a cone. And it is also true that the "spiral" itself is really a kind of spiral since it is a regular curve of a stem that may, for most length, be closer to a cylinder if it is to a cone. Helices are the closest comparisons to the microfibril model propounded by Crick, Watson for the genetic material DNA.

Thus drawing such high-flown sections, we can still be properly satisfied by an undoubted property of the phyllotactic ratios. Look at them in the descending order of magnitude in which they are listed above, we can see that, as the series progresses, the numerator of each fraction is the sum of the preceding two numerators; the denominators are, each, sums of the preceding two denominators.

This kind of series, in which each term is the sum of the two before, is known as a Fibonacci series. After its discoverer Leonardo Fibonacci, (Leonardo da Pisa), a twelfth-century mathematician. Fibonacci also introduced Arabic numerals to Europe, but his series brought him eventual personal celebrity, partly because it converges mathematically to 1.618, the Golden Section.

All this has undoubtedly led some to see the hand of God at work in the humblest tomato patch. But it was demonstrated as far back as 1872 that there was nothing mysterious at all about the numerology of phyllotaxy. Fibonacci ratios are merely a mathematical description of the most efficient method for arranging leaves so that they do not keep sun off each other. Different-sized leaves produce different ratios. This is not only common sense, but a confirmation of the working of the fine hand of nature. Leaves that shade each other will shrivel, kill the plant, and consign its genes to oblivion.

Fortunately for tomato-lovers, their favorite plant exploits its 2.5 ratio to produce yellow flowers containing five stamens around a pistil with two (or more) carpels, which give way, after a 120-day growing season, to the fruit we crave.

The trouble with this happy result is that it works too well. Too many tomatoes at one time is a feast; it is also a glut. The agribusinessman's solution was to move to Florida and minimize the importance of seasons. You and I can either give away our excess or we can preserve it.

Thousands of Americans have recently rediscovered home canning. There was even a national shortage of Mason and Bell jars not long ago. (These are the tight-sealing glass containers most home canners prefer over metal containers.) This revival raises all sorts of complicated technical questions, and many books have been published that speak to the need of reeducating Americans to the special sanitary and mechanical requirements of canning.

These "technicalities" are no joke. Death from botulism is swift.

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and horrible for those who forget that the anaerobic bacterium *Botulinus* *clostridium* thrives in improperly heated and evacuated batches of canned food. Done properly, of course, canning is a blessing. Ever since François Appert invented canning in 1804 (in a 12,000-franc competition Napoleon held to promote the discovery of a good way to preserve fresh food), careful canning has benefited millions. Happily, however, for the tomatophile with an extra bushel on his hands, acid fruits do not produce botulism. The acid in the natural juices will, in conjunction with normal boiling, kill *B. clostridium* and other hungry little flora. Tomatoes, those paragons of acidity, can with great ease and safety.

The so-called cold pack method is very easy and leaves the tomatoes whole. First, wash both the tomatoes and your hands. Wash the jars, lids, and washers in hot, soapy water. Boil them in water to sterilize, for fifteen minutes, and leave them covered with the boiling water until you need them.

 Blanch and peel the tomatoes. Pack them into the sterilized jars, leaving about one-half inch of headway. Push down lightly on the tomatoes as you pack them, filling the jars as tightly as possible. Add one teaspoon of salt to quart jars; one-half teaspoon to pint jars (salt also kills *Botulinus*). Run a knife around the side of the fruit to press out air bubbles. Press again on the tomatoes so that they are covered by their own juice.

Now seal the jars—carefully—for this is a fine art. Wipe the rims of lids and rubber rings clean. Moisten rubber rings just before sealing to insure a good fit. Then, seal the filled jars, but watch out. Each kind of jar requires a slightly different method.

Self-sealing Mason jars, which have two-part metal lids with a sealing compound on the bottom edge of the flat piece of the lid, should be sealed tight. They will still allow air to seep out during boiling and do not need to be tightened afterward. Mason jars with separate rubber rings should first be fully tightened, then loosened, by turning the lid back a quarter-inch, to let air out during processing. Tighten completely afterward. Wire-clamp-type jars should also be only partially tightened before boiling; pull the long wire down, but leave the short wire up. After processing, pull the short wire down for a complete seal.
Processing itself is almost as easy as boiling water. Completely immerse your properly sealed cold-pack tomato jars in hot water that has not quite boiled. Bring to a boil and keep it boiling. Process pints for 35 minutes, quarts for 45 minutes. Top up water level with more boiling water if necessary. Store finished jars in darkness.

Preserving tomatoes with sugar is even easier. Sugar is a preservative in its own right. The great simplicity and safety of this method is one reason that homemade jellies and jams never went out of style. Mireille Johnston's sophisticated tomato preserve (see below) comes from the south of France, but, minus rum, it is identical with traditional American tomato jellies and can be used with red and green varieties alike. In any of these recipes, of course, the original tomato is what counts. No taste gives no taste. Grow your own.

Red Tomato Preserves
(Confiture de Tomates Rouges, after a recipe in The Cuisine of the Sun, by Mireille Johnston.)

4 pounds local tomatoes
4 pounds sugar
Rind of 1 lemon
Juice of lemon
2 tablespoons dark rum (optional)

1. Hold the tomatoes, one by one, in simmering water for 5 seconds, to loosen the skins. Peel with a sharp knife and set each one aside as you finish with it, to cool.
2. Halve the tomatoes, squeeze out seeds, and place in a heavy-bottomed, nonaluminum saucepan. Stir in sugar, lemon rind, and lemon juice.
3. Bring to a boil, stir briefly with a wooden spoon, lower heat, and simmer for one hour or until the tomatoes have become transparent and sticky.
4. Remove the lemon peel, stir in rum, if desired, and then put the preserved tomatoes into dry, sterilized jars. Pour the syrup over them. Seal, with a layer of melted paraffin.

Serve with cookies or on toast, at tea or for a snack.

Yield: About 3 quarts.

Raymond Sokolov's most recent cookbook is The Sauzier's Apprentice, a guide to French sauces.
THE MARKET

Art

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Announcements

Now that the Museum is open on Wednesday evenings until 9:00 p.m., visitors can enjoy an increased variety of activities. On August 24, three exhibition halls in the Museum will be enlivened by the performances of Three Musical Groups. At 6:00 p.m. the delicate sounds of panpipes will float through the Hall of Mexico and Central America as a trio called Tahuantinsuyu presents a concert of Andean music. The Mitchell Korn Ensemble will perform at 7:30 p.m. in the Hall of Pacific Birds. Korn plays a twelve-string guitar and composes his own imaginative pieces, which the ensemble performs with percussion instruments, a piano, a trumpet, and tapes of the sounds of nature. The last concert, at 8:00 p.m. in the Hall of Asiatic Mammals, will present Eastern music performed by Shyam Yodh playing the sitar, accompanied by a tabla and tamboura. All three concerts are free to those who have paid the Museum entrance fee.

Each autumn, thousands of birds of prey, which inhabit eastern Canada and the northeastern United States during the summer months, waft their way south for the winter in a massive and dramatic migration. Many make the journey by following the Appalachians, taking advantage of the updrafts offered by the ridges of the mountain chain. Most of the birds are broad-winged, red-tailed, or sharp-shinned hawks but the migration also includes ospreys, American kestrels, red-shouldered hawks, and some bald and golden eagles.

So close do the birds come to various outcroppings, cliffs, and peaks that there are several points along the Appalachians where man can virtually meet raptor. One of the most famous of these vantages is Hawk Mountain in central Pennsylvania, an S-shaped ridge which provides admirers of the migration an unsurpassed view of the birds.

On August 25, just before the height of the migration, the Museum will sponsor a slide show and film entitled Birds of Prey of North America. The program will be presented by James Brett, director of education at the Hawk Mountain Sanctuary, who has observed the migration for the past thirty years. The program will be held in the aquarium at 8:00 p.m., and is free to participating and donor members of the Museum. Tickets for associate members and the public will be available at the door for $2 each.

During the weekend of September 17-18, the Museum will sponsor the largest Anthropology Film Festival ever offered to the general public. Held in honor of Margaret Mead, now a professor emeritus of ethnology, who will this year celebrate her 50th year on the staff, the free event is designed to attract the broadest possible audience. On view will be hundred films, ranging from those made in the early 1900s to the latest release anthropologists and filmmakers.

The two-day event will offer continuous screenings in eight different areas of the Museum—the aquarium, the Education Hall, the Pe Center, and in five exhibition halls. Not only does the Museum’s size itself to such a large undertaking, but also its exhibits of the peoples and the environments of the world provide an ideal setting for this festival.

Speakers, including Dr. Mead, will introduce the films, which will be followed by question and answer periods. The festival will include a technical exhibit of camera and filming equipment, a screening room, and a room for children’s films. A special feature of the event will be ever screening of films by Jean Rouch, the noted French ethnographic filmmaker. Mr. Rouch will be present to discuss his work and the art of making ethnographic films. For further information regarding price of admission and ticket availability for the event screenings, call (212) 873-1300, extension 559.
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"How you all must love God's creatures," said Annabel, who knew so well that the sculptor's hand was a messenger of the heart.

Write for free booklet, titled, "Beau & The Birds & The Beasts" Aynsley Bone China, 225 Fifth Avenue, New York, N.Y. 10010. A member of the Waterford Crystal family.

Photos By...
2 Authors

8 The Hazards of Coal Dependence Wallace S. Broecker
Our energy decisions may unwittingly bequeath to future generations a disastrously hot climate.

22 This View of Life Stephen Jay Gould
Sticking Up for Marsupials

34 Airs, Waters, and Places Robert S. Desowitz
Harmonious Parasites

40 The Call of the Duck Gilbert Gottlieb
Embryos hear their mothers and even talk to themselves.

48 Looms of Otavalo Joseph B. Casagrande, photographs by Victor Engelbert
Traditional weaving is vanishing, but the weaving tradition is flourishing.

60 The Auroras Raymond G. Roble
Immensent geomagnetic storms produce these unpredictable light displays.

68 The Siege of Paris Gerald Carson
Hosts served le rat, sauce madere without apology.

78 The Case of the Missing Monk Seal Peter M. Knudtson
Under human pressures, another creature probably has become extinct.

84 Skin Batteries and Limb Regeneration Richard B. Borgens
Electrical currents control the remarkable regeneration of salamanders.

90 Three, Two, One Tortoise Peter C. H. Pritchard
He may have been looking unsuccessfully for a mate since the last century.

102 The Market

106 Sky Reporter Jeremy Bernstein
Physics and the Cosmos

114 A Matter of Taste Raymond Sokolov
Palm Readings

118 Book Review Dan Morgan
The Roots of Hunger

122 Additional Reading

124 Celestial Events Thomas D. Nicholson

126 Eskimo Tales Dorothy Harley Eber
A literary tradition apparently has to include a little nastiness.

131 Announcements

132 Letters

Cover: On market day at Otavalo, Ecuador, an Indian resis with his purchase. His wool poncho comes from local looms. Story on Page 48. Photograph by Victor Engelbert.
Joseph B. Casagrande first learned of the intricate weaving of the Otavalo Indians when he began his field work in Ecuador in 1962. He has since returned to the country many times to continue his studies on the position held by Indians in Ecuadorian society from colonial times to the present. His research has also taken him to Spain, where he scoured various archives for information on Spanish attitudes toward the Indians. A professor of anthropology at the University of Illinois in Urbana, Casagrande is currently studying the recent conversion from Catholicism to Protestantism among Indians of a number of Ecuadorian highland communities.

The science of the upper atmosphere has been Raymond G. Roble's field of interest throughout his working life. He has been with the National Center for Atmospheric Research in Boulder, Colorado, since 1969, the year he earned a Ph.D. in aeronomy from the University of Michigan. His current research involves modeling the meteorology of the atmosphere above sixty miles. Future projects include an investigation of the effects of the aurora on the upper atmosphere. Living in Boulder makes it possible for Roble to indulge in all his hobbies—mountain climbing, backpacking, and skiing.

"When I was working on my book Men, Beasts, and Gods: A History of Cruelty and Kindness to Animals," said Gerald Carson, "I began to consider the interaction between men and animals when war comes to nation-states. This led to an investigation of the situation in Paris during the siege of 1870–71, when even the animals were eaten." Result: the month's article. Carson, who began career in the advertising field, has been an author and social historian for the past twenty-five years. A frequent contributor of books for Natural History, this is his fourth article for the magazine.
"If you're like me, you probably think that taking really good pictures is very difficult... that it must take a lot of skill and very expensive camera equipment. You know, like those professionals you always see with their 35mm Nikon cameras.

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NIKKORMAT FT3

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Peter M. Knudtson combines seasonal work as a wildlife biologist with free-lance nature writing and photography, some of which has been published in *Natural History*. He wrote about Wintu culture ("Flora, Shaman of the Wintu") in May 1974, and the social behavior of harbor seals ("Birth of a Harbor Seal") in May 1975. During the winter of 1976, he spent three months traveling in Central America, and witnessed the February 4 earthquake in Guatemala. He devoted part of that trip to a search for the rare Caribbean monk seal, generally believed to be extinct. Having recently returned from Prince William Sound and southeastern Alaska, where he worked as a wildlife biologist for the U.S. Fish and Wildlife Service, Knudtson describes his future plans as "more travel, more writing, more study."

"A scientist who aspires to a pure of science that is adventurous and esthetic as well as rigorous," is the Peter C.H. Pritchard describes himself. In pursuit of his aspiration, English-born zoologist has done work in the southern United States, Iran, Guyana, Surinam, Mexico, Honduras, Peru, Micronesia, Galápagos Islands, and earlier year, Venezuela, where he studied habits, distribution, and classification of that country's turtles. Pritchard vice-president for science and research of the Florida Audubon Society, has served as a special investigator the the sea turtle specialist group of International Union for the Conservation of Nature.

While working on his master's project, which concerned embryonic chick limb development, it was proposed to Richard B. Borgens that naturally produced electrical current might be the control of limb regeneration. He found the notion fascinating and his curiosity was, as he says, "permanently aroused." Now a postdoctoral research fellow at Purdue University, he is continuing his research into the endogenous electrical controls of amphibian regeneration, specifically investigating what the cellular target of the regeneration currents (in salamanders) might be. Borgens feels that there is good evidence for the assumption that internally produced electricity plays a role in the replacement of tissues, and of wound healing in general, in all vertebrates.
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As global oil reserves dwindle, we struggle with the problem of deciding on our next major energy source. The utopia of a world powered by light from the sun lies, perhaps, a century in the future. Fusion power awaits an even greater number of technical advances. Hydropower, wind, tidal, and geothermal power are destined for secondary roles. There is no way to obtain the amount of energy we will need from any one or combination of these sources. This leaves coal and uranium as the only stopgap energy sources for the period between the demise of petroleum and the onset of large-scale use of solar power. Despite the rape of the land and the toll of life accompanying the recovery of coal, and despite the host of environmental poisons released during its combustion, it is the current front-runner. The threats of catastrophe resulting from reactor malfunction, sabotage, or nuclear weapons manufactured from reactor byproducts has turned a sizable segment of society against nuclear power.

In this debate over energy sources, one aspect of the problem has received relatively little attention. Burning the world’s coal reserves will produce about eight times the carbon dioxide (CO₂) currently in the atmosphere. In order to see our way through to the era of solar power we will almost certainly have to burn enough of these coal reserves to double the atmosphere’s CO₂ content. Once in the atmosphere, this CO₂ will linger for hundreds of years before being removed to the sea, a second reservoir for CO₂. During this time the earth’s climate, and therefore its ecology, will be quite different from that of today. As there is no practical means of capturing the CO₂ produced during the combustion of chemical fuel, the coal economy will inevitably lead to higher atmospheric CO₂ content and consequent environmental changes. Thus, before we take actions that will lock us into bequeathing to the generations to follow a millennium of what I believe will be a warmer climate, we had better learn more than we now know about life in this “superinterglacial” world.

I say superinterglacial because over the last million or so years the climate of our planet has swung back and forth between intervals of relatively cool conditions, called glacials, and relatively warm conditions, called interglacials. For the last ten thousand years we have been in one of the interglacial intervals. The addition of large quantities of CO₂ to the atmosphere would probably push the earth’s climate into a realm considerably warmer than we have experienced during the last several interglacials. In this sense, the post-coal-burning era will be a superinterglacial.

The fossil-fuel-derived CO₂ we release into the air will make itself through its ability to capture infrared light being given off by the earth. It is often used analogy between our atmosphere and a greenhouse, although the perfect, is apt. Just as glass panes allow sunlight to enter a greenhouse and greatly impede the loss of heat, so CO₂ transmits incoming sunlight but impedes the passage of outgoing earthlight. The white-hot sun sends high-frequency, visible and ultra-violet light that cannot be intercepted by CO₂. The relatively cool earth gives off low-frequency, infrared radiation that can be intercepted by CO₂. The human invention of extra CO₂ between the earth’s surface and the sun will, accordingly, alter our planet’s radiation balance. The earth adjusts its energy budget to required state, in which the amount of energy lost daily just matches amount of energy gained, primarily means of temperature change. If higher the temperature of an object,
He sacrificed his sanity and his life to see and to paint as no one ever had before

The World of Van Gogh

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HE TRIED to express his feeling for man and nature by becoming a minister, but his fervor alarmed his superiors. He fell in love with two women of his own class and they fled from him as from a dangerous lunatic. The famous incident in which he cut off part of his ear and gave it to a prostitute was only one more attempt to give something of himself to anyone who would accept it.

This torrent of emotion—for which society had no use—turned Vincent Van Gogh into one of the greatest painters of all time. Never has a man poured so much pure responsiveness into his art. You can see in it everything from salvation to suicide. Sacrificing his life and sanity to his work, he burned himself up in a blaze of perception, a controlled riot of color that washed over modern art like a tidal wave of lyricism.

Love, for Van Gogh, was a means of seeing...of fusing himself with his subjects. Even the lavish way he squeezed a tube of paint directly onto his canvas symbolized a generosity that knew no limits. To the humblest subject—an old pair of boots, an empty chair—he brought the special light of his own fervor. As one critic put it, Van Gogh had the courage to look the sun squarely in the face and steal its radiance.

Beside almost 1,700 works of art, Van Gogh also bequeathed to the world—in 661 letters to his brother—one of the most moving autobiographies ever written. It shows this dauntless man trying to learn Greek in order to be allowed to preach to Dutch coal miners. You find him, his hairband stuck full of candles, painting the stars at midnight. You trace letter by letter, canvas by canvas, the collapse of his sanity and his subsequent suicide.

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more heat (infrared light) it emits. Thus, by trapping the outgoing infrared radiation, the primary effect of more CO₂ in the earth's atmosphere will be a warmer planet.

Associated with a global warming will be a host of climatic side effects. Among these, one of the most important will undoubtedly be a change in the pattern of rainfall on the earth's surface. Some regions will get more rain than they now do; others will get less. This, in turn, will affect the ability of a given area to grow food. Somehow, we must determine in advance of a global warming what these regional changes will be and evaluate their effects on the web of activity that allows our planet to support so many human beings.

There are two different ways in which this might be done. One would be to wait until the warming induced by increased CO₂ becomes perceptible and then make a direct calibration of its effects. Such a calibration will only become possible when CO₂ has moved the climate well beyond the range of natural variability. Unfortunately, by then the die will have been cast. As no substantial change in our energy supply can be made in less than about fifty years, this empirical evaluation of environmental hazards must remain a last-ditch backup.

The only before-the-fact method of assessing the effect of increased CO₂ is by atmospheric modeling. To do this, a mathematical simulation of all the important processes occurring in the system is constructed. With the aid of large computers, this model atmosphere is perturbed by the addition of CO₂. The changes in the climate of the model atmosphere are then taken as indications of those of the real atmosphere.

The problem is to make a realistic simulation. This is difficult for two major reasons: even the largest existing computers are too small to duplicate the atmosphere in sufficient detail, and we do not adequately understand some of the physical processes operating on the earth's surface. Shortcuts and simplifications must be introduced into the models; consequently, the applicability of the model's results to the real atmosphere remains in question.

At present, about the only useful piece of information that can be obtained from these models is an estimate of the change in mean global temperature associated with a given change in atmospheric CO₂ content. Although falling well short of our real need for regional estimates of variables, such as temperature, rainfall, and wind speed, such a calculation can tell us whether we are dealing with a change of major consequence. Before stating why this is so, let us first see what the magnitude of the temperature change will be.

Based on the models currently in use, the consensus seems to be that for each doubling of the CO₂ content of the atmosphere, the mean earth temperature will rise by about four degrees fahrenheit. Thus, if we raise the atmospheric CO₂ content from its preindustrial value of 295 molecules of CO₂ per million molecules of air to 590 parts per million (ppm), the planetary temperature will rise from its current mean of 60° F to about 64° F.

The main concern with the validity of this result has to do with the manner in which cloud cover is handled by the models. In the absence of greater computational capability and of an adequate knowledge of cloud physics, the modelers have been forced to hold the earth's mean cloud cover fixed at the current average value. The modelers are fully aware that the mean cloud cover will change with rising CO₂ content but it is not possible at present to determine with certainty whether it will increase or decrease, let alone foretell how the change will be.

Clouds reflect back into space some of the incoming sunlight that strikes them. If rising CO₂ levels enhance the extent of cloud cover, then the earth's extra reflectivity will partly compensate for the excess infrared capture and the planet will not warm as much in response to added CO₂ as predicted by models currently in use. On the other hand, were cloudiness to decrease, oppositely would take place: less sunlight would be reflected and the earth would get even warmer than predicted.

At present there is no way to determine even the sign of the cloud effect, let alone by how much it will alter the current global temperature-change estimates. As much as a decade will pass before even preliminary estimates of the importance of cloud cover changes can be made.

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holes.

They’re specially designed using a computer, so the front end will help absorb energy in the event of a collision.

We also developed such things as an “independent stabilizer rear axle,” which increases the stability of the car on rough roads.

And for our deluxe Rabbit, we developed special seat belts that actually put themselves on when you close the door.

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Yet today, Volkswagens actually have more combined interior space and trunk space than most other cars in their class.

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In fact, Rabbits have more interior room than 25 other cars you could buy.

And more trunk space than a Cadillac Seville.

They’re also surprisingly quick, with acceleration from 0 to 50 mph faster than a Triumph Spitfire.

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We never made anything like our Dasher wagon before. With more cargo room than any other wagon in its class. With a plush interior and carpeting all around.

And in our beautifully appointed 2-door or 4-door sedans, Dasher has more room than most American cars in its class.

Yet, with all the changes we've made, some things always remain the same.

We still employ 13,500 inspectors to insure the quality of every car we make.

And much of our work is still done by hand.

Like the paint. It's hand sprayed, over and over. It's hand sanded and hand cleaned. It's even checked by people wearing special mittens. And before it's finished it's put through 29 individual steps of preparation.

There's also that familiar "jingle" you get putting money in the bank. Because all three VOLKSWAGENS get 24 MPG in the city. Rabbit and Scirocco get 37 MPG on the highway. Dasher gets 36. (EPA estimates with standard transmission. Actual mileage depends on how and where you drive, optional equipment and the car's condition.)

VOLKSWAGENS aren't sounding like VOLKSWAGENS of the past.

They're sounding more like cars of the future.
The absence of the capability to generate clouds in computer models also prevents modelers from estimating the changes in regional rainfall. As this information is absolutely essential to any evaluation of the effect of enhanced CO2 levels on the ecology of “wild” plant communities and on agricultural productivity, the forecasts we need cannot be made until this hurdle is surmounted. Thus, all possible efforts must be made to speed research in this area.

In the meantime, we will have to live with the estimate that if through the burning of chemical fuels we double the CO2 content of the atmosphere, this doubling will lead to a four degree rise in the mean temperature of our planet. What effect will this have on the earth’s environment? From the point of view of personal comfort, the answer may well be, not much. There might be fewer opportunities for skiing but more for swimming. This approach, however, proves to be extremely misleading. It is not personal comfort that is at stake, but the state of the whole web of life—the ecosystem. Plants are sensitive to the amount of rainfall, the intensity and timing of frost, the speed of the wind. Animal life is ultimately geared to the food provided by plants.

I know of only one method that might indicate the effects of the coming warming on the ecosystem and that is examination of past times during which the earth’s temperature was different from that of today. Global climate, when averaged over several decades, has remained remarkably constant during historic time. We have experienced no prolonged period when the earth as a whole was much warmer or much colder than it is now. Since the present interglacial has persisted for the last ten thousand years, we have to go back well beyond the beginning of written records to find a time when climate was quite different.

Between ten and thirty thousand years ago, the earth was immersed in one of its glacial periods. Because we know of no time in the last million years when the earth was much warmer than during the present interglacial, we will have to make do with what we can learn from the changes associated with the warming that took us from that last glacial to the conditions that have prevailed during historic time. Fortunately, nature keeps her own records and has preserved the information we need to reconstruct the environmental changes that took place during that transition.

Sediments preserved on the sea floor, for example, carry a wealth of information regarding past climates. From the hard parts of microscopic plants and animals found in abyssal muds, scientists have been able to reconstruct surface-water temperatures over the last million years. The astounding.result of oceanwide research CLIMAP (Climate/Long-Range Investigation, Mapping, and Prediction) comparing deposits formed during the last glacial period with those formed during the current warm epoch, is that the oceans are, on the average, on about four degrees warmer now than they were then.

Continuous records are contained in the slowly accumulating ice of the “highlands” of Greenland and Antarctica. Changes in the air temperature of these regions can be reconstructed from ice cores recovered in long borings through these polar caps. This record is kept by the isotopes of oxygen in the ice itself. The colder the air, the more depleted in the “heavy” isotope of oxygen are the snow flakes that form in clouds over the icecap (and hence, the ice ultimately formed on the cap below). These isotopic temperatures tell us that the polar regions were only about two degrees cooler during full glacial times than they are today.

Finally, sediments in bogs and lake-bottom pollen grains blown in from the surrounding terrestrial vegetation. Relative abundances of pollen from different plants are clues to the ecology of the adjacent lands. In a number of spots on the globe these clues indicate a degree to which the temperature in tin continental interiors changed between glacial and postglacial time. The values show quite a range, and suggest that the continents warmed from 10° to 30° F at the close of the last ice age.

With the help of computer models this information has been pieced together to yield a global average temperature difference between peak glacial time (twenty thousand to sixty thousand years ago) and peak interglacial time (six thousand to thirty thousand years ago). The result turned out to be only nine degrees. Thus, if CO2 we generate warms the earth four degrees, we will have succeeded in making a change about half as large as the one that occurred when the great ice sheets covering virtually all of Scandia and Canada shrank to oblivion at the close of the last glacial period. The environmental changes associated with the transition from the present interglacial to the CO2-induced super-interglacial are half as great as the
On Photographing the Invisible

To the naked eye, it was a Swedish 80-cnt postage stamp. A rarity, and
very valuable.

The camera, however, told quite another story. The stamp was a coun-
feit.

Faint traces of tampering that were
den to the naked eye were revealed
the camera. Someone, somewhere,
iently altered the stamp by
imically removing a surprint. The
mp was worthless.

What manner of exotic camera
this that could “see” the invisible?

The lens: one of the 20 in the
sselblad arsenal, the 105mm Zeiss
Sonar f4.3. Designed for pho-
raphy within the ultraviolet portion
the electromagnetic spectrum, its
ily quartz elements can detect
tions that are unseeable by the
man eye.

It has peered at objects in outer
ice, examined forgeries, laid bare
ts of counterfeit money. Not
n for everyone, obviously, but an
ication of just how awesomely com-
ensive the Hasselblad System is.

The camera: an otherwise per-
dy standard Hasselblad 500C/M,
ormally fitted with an 80mm Zeiss
lar f2.8 multi-coated lens.

This is the basic model that allows
you to tap into the vast Hasselblad
System. It is one of the most bewild-
eringly versatile cameras the world has
ever known. Yet so marvelously simple
to operate that it often plays the part
of the family snapshot camera.

A True System.
The Hasselblad System is a prodigious
array of 4 cameras, 20 lenses, 8 view-
finders, 9 film magazines, and over
00 other accessories. Choose the right
ieces, and your 500C/M would be
ipped for sports, sports, architectural,
nd fashion photography.

And portrait, landscape, medical,
water, and news photography.

And wildlife, laboratory, industrial,
nd child photography.

And you would always have the
ight film in the camera at the right
time. You can shift from color to
ack-and-white and back again to
color—and resume shooting at pre-
cisely the right frame—by popping in
the protective dark slide and switch-
ing film backs.

The Camera with Nine Backs.
There is a small button on the film
back of every Hasselblad 500C/M. Slide it sideways with your thumb and
the back will come away in your hand.

The standard back holds 12 ex-
posures. Each frame of film is 2½
ches square, almost four times the
rea of a 35mm frame. (See box, below
right, for actual size.)

This is only the beginning. There
are eight other backs available: Backs
that let you change to a 6 x 4.5cm for-
mat...or a 4.5 x 4.5cm superslide
format for showing in any 35mm
jector. Backs that give you a choice
of 1, 12, 16, 24, 70, or 500 exposures.
A back that is a sheet-film adapter.

Even two backs for Polaroid film, so
you can check composition, lighting,
and exposure ahead of time.

You begin to realize why eight out
of ten top commercial photographers
surveyed name Hasselblad as the
medium-format camera used in their
work.

Retained Value vs.
Obsolescence.
In an age when machines spew out
cameras in the tens and hundreds of
ousands, when flashy new models
trum last year’s marvels into early
bsolescence, Hasselblad goes its own

Planned obsolescence is taboo at
Hasselblad. All but two of the acces-
sories for the 500C/M will fit every
Hasselblad made since 1957 (except
the Super Wide Cl)...and will fit every
future Hasselblad.

The greater part of a year is spent
building each camera, much of it
rafted by hand. And fully one quarter
of the work force devotes its time to
thing but quality control.

Little wonder, then, that a pre-
owned Hasselblad commands such a
high price...if its owner can be per-
suaded to part with it at all.

The Hasselblad 500C/M.
A lavish brochure is available free if you write.
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Cambridge Parkway, Cambridge, Mass. 02142
Braun North America is a division of The
Gillette Company, and exclusive marketer of
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I now, the greatest works of art from these greatest museums will be captured for all a unique and enduring form. One hundred works of power and perfection—masterpieces of every kind, from every era and every corner of the world—captured forever in a magnificent new collection of finely sculptured art treasures selected by a distinguished panel of eminent scholars and art experts. And their choices are the result of a thorough and totally objective evaluation—indeed the most significant and stirring art ever created. Timeless masterpieces of every kind, from every major period in the history of art—the very best that art museums have to offer...

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very terms of our taxonomy reinforce this prejudice. All mammals are divided into three parts: the egg-laying monotremes are called Prototheria; the intermediate marsupials lie in limbo as Metatheria; or middle mammals — not all question.

The argument for structural inferiority rests largely upon differing modes of reproduction in marsupials versus placentals, bolstered by the usual smug assumption that differs from us is worse. Placentals, as we know and experience, develop as embryos in intimate connection with their mother's body and blood supply. With some exceptions, they are born as reasonably complete and capable creatures. Marsupial fetuses never develop the essential trick that permits tensive development within a mother's body. Our bodies have an uncanny ability to recognize and reject foreign tissues, an essential protection against disease, but a currently intractable barrier to medical procedures ranging from skin grafts to heart transplants. Despite all the homilies about mother love, the presence of 50 percent maternal genes in offspring, an embryo is foreign tissue. The maternal immune system must be masked to prevent rejection. Placental fetuses have "learned" to do this; marsupials have not.

Marsupial gestation is very short, twelve to thirteen days in the common opossum, followed by sixty to seventy days of further development in the uterine pouch. Moreover, internal development proceeds, not in intimate connection with the mother,
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shielded from her. Two-thirds of gestation occurs within the shell membrane, a maternal organ that prevents the transfer of lymphocyes, the "soldiers" of the immune system. A few days of placental contact follow, usually via the yolk sac. During this time, the mother mobilizes her immune system, and the embryo is born (or, more accurately, expelled) soon after.

The marsupial neonate is a tiny creature, equivalent in development to a rather early placental embryo. Its head and forelimbs are precociously developed, but the hind limbs are often little more than undifferentiated buds. It must then undertake a hazardous journey, slowly pulling itself along over the relatively great distance to the mother’s nipples and pouch (we can now understand the adaptive necessity of well-developed forelimbs). Our embryonic life within the placental womb sounds altogether easier and unconditionally better.

What challenge can then be offered to these biogeographical and structural accounts of marsupial inferiority? John A. W. Kirsch has recently marshaled the arguments in the May-June 1977 issue of American Scientist. Citing the work of P. Parker, Kirsch contends that marsupial reproduction follows a different adaptive mode, not an inferior path. True, marsupials never evolved a mechanism to turn off the maternal immune system and permit a completed development within the womb. But early birth may be an equally adaptive strategy. Maternal rejection need not represent a failure of design or lost evolutionary opportunity; it may reflect an ancient and perfectly adequate approach to the rigors of survival. This argument goes right back to Darwin’s central contention that individuals struggle to maximize their own reproductive success, that is, to increase the representation of their own genes in future generations. Several highly divergent, but equally successful, strategies can be followed in (unconscious) pursuit of this goal. Placentals invest a great deal of time and energy in offspring before their birth. This commitment does increase the chance of an offspring’s success, but the placental mother also takes a risk: if she should lose her litter, she has irrevocably expended a large portion of her life’s reproductive effort for no evolutionary gain. The marsupial mother pays a much higher toll in neonatal death, but her reproductive cost is small. Gestation has been very short and she may breed again in the same season.

Moreover, the tiny neonate has not placed a great drain upon her energy budget and has subjected her to little danger in a quick and easy birth.

Turning to biogeography, Kirsch challenges the usual assumption that Australia and South America were refuge for inferior beasts that couldn’t hang on in the placental world of the Northern Hemisphere. He views their southern diversity as a reflection of success in their ancestral homeland, not as a feeble effort in peripheral territory. His argument relies upon M. A. Archer’s claim for close genealogical relationship between borhyaenids (South American marsupial carnivores) and thylacines (marsupial carnivores of the Australian region). Taxonomists have previously regarded these two groups as an example of evolutionary convergence — separate developments of similar adaptations (as in the marsupial and placental saber-tooths, mentioned previously). In fact, taxonomists have viewed the Australian and South American radiation of marsupials as completely independent events, following the separate invasion of both continents by primitive marsupials pushed out from northern lands. But if borhyaenids and thylacines are closely related, then the southern continents must have exchanged some of their products, probably via Antarctica. A more parsimonious view imagines an Australian center of origin and a dispersal to South America following the evolution of thylacinids, rather than two separate marsupial invasions of South America —borhyaenid ancestors from Australia and all the others from North America. Although the simplest explanations are not always true in our wondrously complex world, Kirsch’s arguments do cast considerable doubt on the usual assumption that marsupial homelands are refugia, not centers of origin.

Yet I must confess that this structural and biogeographic defense of marsupials falters badly before one cardinal fact, prominently featured above: the Isthmus of Panama rose, placental carnivores invaded, marsupial carnivores quickly perished, and the placentals took over. Does this not speak for clear competitive superiority of the North American placental carnivores? I could sneer around this unpleasant fact by ingenious conjecture, but I prefer to admit it. How then can I continue to defend marsupial equality?

Although the borhyaenids lost big, I find no scrap of evidence to attribute defeat to their status as marsupials. I prefer an ecological argument predicting hard times for any indigenous group of South American carnivores, marsupial or placental. The real victims happened to be marsupials, but this taxonomic fact may be incidental to a sealed for other reasons.

R. Bakker has been studying the history of mammalian carnivores through the Tertiary. Integrating some ideas with conventional wisdom, he finds that the northern placental carnivores experienced two kinds of evolutionary “tests.” Twice, they suffered short periods of mass extinction, new groups, perhaps with great adaptive flexibility, took over. Due to times of continuity, high diversity, both predators and prey engaged in tense competition and strong evolutionary trends for improvement (quick ingestion and efficient slicing) and locomotion (high acceleration in ambush predators, endurance in long-distance hunters). South American and Australian carnivores were tested in neither way. They suffered mass extinctions, and the original cumberbunds persisted. Diversity never approached northern levels, and competition remained less intense. Bakker reports that levels of morphological specialization for speed and ingest of carcasses lie far below those of northern carnivores living at the same time.

H. J. Jerison’s studies of brain size provide an impressive confirmation. On northern continents, placental predators and prey evolved successively larger brains throughout the Tertiary. South America, both marsupial carnivores and their placental prey quickly plateaued at about 50 percent of body weight for average modern mammals of the same body sizes. Anatomical stasis as marsupial or placental seems to make no difference; a relative history of evolutionary challenge may be crucial. By happenstance, northern carnivore had been marsupials and southern carnivores placental. I suspect that outcome of ishthian exchange would still have been a rout for South America. North American faunas were continually tested in the fiery furnaces of mass destruction and intense competition. The South American carnivore were never strongly challenged. With the Isthmus of Panama rose, they weighed in the evolutionary balance for the first time. And like Daniel’s kids, they were found wanting.

Stephen Jay Gould teaches biology, geology, and the history of science at Harvard University.
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Harmonious Parasites

Some of the common diseases of industrialized societies may be countered by those of developing societies

Those of us engaged in teaching parasitology to medical students usually present a Grand Guignol pictorial display of the more devastating effects of our favorite pathogens. This show business technique helps keep students awake in a course that might otherwise not rate too highly in the curriculum popularity polls. Even students who want to be psychiatrists (perhaps especially these students) rarely fail to respond empathetically to a photograph of the grotesque testicular enlargement caused by filarial elephantiasis. The initial impression is that parasites are inevitably malevolent.

While the balance sheet would show that parasites undoubtedly do more harm than good, recent research has brought to light some curious and intriguing examples of parasitic infection that may contribute to the total health of the host. These are not merely oddments in the biological curiosity cabinet. The phenomenon of the harmonious parasite has greater import.

Modern medicine now appreciates, or rather reappreciates — since the concept goes back to the ancient Greek founding fathers of medicine—that a causal relationship exists between the nature of our ailments and the character of the ecosystem in which we live. The unhappy affairs of the heart in industrialized countries are well known, as are the infectious diseases associated with primitive agriculturists in the tropics. We tend to think of these societies and their ill worlds apart, but the emerging picture from natural and experimental observations reveals a dynamic balance in which the diseases of one society can actually suppress those another.

While the primitive and poor of tropical world may be wanting in tomobiles, television, washing machines, and clothes dryers, they generally enjoy a freedom from hypertension and the cardiac problems suffered by more civilized, affluent societies. Not only is abnormally high blood pressure conspicuously absent in these areas but blood pressure does not rise with increasing age as Westernized, urban populations.

Several explanations have been offered for this, such as diet and a more of life without stress. Undoubtedly these are important factors, but they have not convinced some investigators as being the complete story.

Studies conducted in a region New Guinea where malaria hyperendemic concluded that disease, as well as other chronic infectious diseases, causes a lowering of blood pressure. In one investigation, the blood pressure of adults with enlarged spleens — a hallmark of malaria — was compared with that of individuals from the same village who had normal spleens. The group with the big spleens had both lower systolic and diastolic pressures than the affected individuals. Similar results were reported by a research team at the Papua New Guinea Institute of Human Biology, which studied the communities: one living in the hu
Eleven questions to ask yourself before buying a 35mm SLR.

Knowing what to look for in a 35mm SLR can save you money and prevent problems later on.

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2. Which match-needle or electronic auto-exposure control best? Minolta offers both, so our only concern is that you get what's best for you. Generally a match-needle camera costs less. To set exposure, you line up two needles in the viewfinder. It's easy, fast and accurate, but you do the work. Minolta's latest match-needle cameras offer a wide variety of features and prices.

Minolta's newest 35mm SLR's have electronically controlled shutter speeds. So even if the light changes instantly before you shoot, the camera will set itself correct exposure. Among Minolta's electronic SLR's, I'll find features like interchangeable viewfinders. Screens, shutter speeds to 1/2000th of a second, multiple-exposure capability.

3. What should I look for in the viewfinder? First of all, see clearly and focus. Judge this by comparing several brands under the same light conditions. Then, exposure information. The more the viewfinder shows, the more you know about how the camera is taking the picture. It this means a lot to you, pay the extra cost. If not, save on a simpler camera.

The important thing about Minolta SLR's is that in any single one, you can compose, focus, set exposure and shoot without ever looking away from the viewfinder. So you won't miss shots of even the fastest moving subjects.

4. What range of shutter speeds do I need? Most picture taking is done at speeds between 1/60th and 1/500th of a second. But to stop very fast action, higher speeds are handy to have. And slower speeds are useful for available-light shooting and spectacular night shots. Depending on the Minolta model, you can get speeds as fast as 1/2000th of a second and as slow as 5 seconds.

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10. How do I judge craftsmanship? Compare. Everything should be tucked in neatly. Finishes should be even and unmarred. No machining marks should be visible, even inside the camera.

11. What is the camera's reputation? Be sure to ask friends about Minolta. Since it's the best-selling imported camera brand in the U.S., chances are someone you know owns one.

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lowlands where malaria transmission is intense; the other in the highlands where lower temperatures inhibit development of the malaria parasite in the mosquito vector. No one knows how malaria and other chronic infectious diseases lower blood pressure. With further research, scientists might be able to reproduce the effects without the infection, thereby alleviating the problem of hypertension in industrialized societies.

The heart attack, the civilized world’s number one killer, rarely occurs in the less civilized societies of the tropics. High blood pressure and high blood cholesterol are the notorious risk factors implicated in coronary heart disease. Again, the malaria parasite may be prophyllactic, for it not only lowers blood pressure but also appears to lower cholesterol level.

Some years ago my colleagues and I carried out experiments to determine the long-term pathophysiological consequences of malaria in primates and rodents. One of the consistent alterations in blood chemistry that we observed was the found decrease in the amount of serum cholesterol in the infected animals. There was no precise understanding of the mechanism involved, but we hypothesized that the parasite might affect the cholesterol-processing tissues, notably the liver, consuming the serum cholesterol of its own metabolic needs.

Still another possible beneficial outcome of the malaria parasite is its influence on the immune response. A highly activated does the response come in attempting to mount a defense against the parasite that impairs the system to certain other antigens may depress. In some circumstances this is undoubtedly harmful. Child with malaria, for example, do not respond to immunization against tuberculosis as well as do uninfected youngsters. Another example is that of immune response to Burkitt’s lymphoma—a form of cancer of the lymph system. Researchers have speculated that this cancer is caused by a virus that the immune system usually suppresses. The presence of the malaria parasite, however, might depress the immune surveillance system to such an extent as to allow proliferation of the lymphoma virus.

On the credit side of the balance sheet, however, there is evidence that malaria prevents autoimmune diseases, such as lupus erythematosus and inflammatory conditions, such
While the autoimmune and inflammatory diseases rarely occur in West Africans, American blacks of West African origin incur these conditions more frequently than do white Americans. Researchers have thus directed their studies toward environmental factors, but they have not by any means explored the role of parasites. To date, only a few experimental jals have tested the hypothesis that malaria suppresses autoimmune diseases. Two British scientists, B. M. Greenwood and A. Voller, however, conducted one investigation. They obtained a strain of mice that spontaneously developed autoimmune kidney disease and infected these animals with a rodent malaria, *Plasmodium berghii*. In their results, the infected control mice developed severe renal disease and died while the malaria-infected animals (once the parasitic infection had been resolved by self-cure) remained alive and well. These two researchers did not discover a manner in which the mice were infected from autoimmune renal disease but suggested that the implications of their research might carry over to the treatment of such diseases in humans.

The benevolent effect of parasites as their victims is not limited to malaria infection. The lowly, ill-guarded intestinal worms may also have a beneficial quality. These parasites may act as antagonists in preventing certain pathological conditions of high prevalence in sanitized, worm-free populations. Undoubtedly, the most striking of these relationships is that between worms and allergy. Epidemiologists have noted at allergies such as hay fever and pollen asthma are rare in wormy populations. Immunological theories on the causes of allergy and the elegant experiments of R. C. Godfrey and C. F. Badige in England have created a persuasive hypothesis to account for this.

Allergic reactions are caused by the production of a special class of antibody known as IgE, or reaginic antibody, in response to myriad allergens such as pollens, foods, and even mites in house dust. IgE has the unique property of attaching itself to specific receptor sites on the membranes of histamine-rich cells of the body called basophils and mast cells. Through a series of reactions, still not entirely understood, disruption of the cell with the release of histamine and other allergy-inducing substances occurs when the antigen (allergen) specifically bridges two adjacent antibody molecules projecting from the cell surface.

The manner in which the helminth parasites, or worms, prevent this immune reaction is indeed curious since helminths are even more potent stimulators of IgE than pollen and other allergens. In fact, it is this very immunogenic potency that accounts for inhibition of the allergic process. The IgE level in asthmatic patients averages about 400 units per milliliter of serum. The level in humans with worms averages 1,000 units, with concentrations of 5,000 units per milliliter or even higher. Quite simply, then, the amount of IgE produced by the presence of worms is overwhelming, occupying most of the receptor sites on the cell. The IgE produced in response to pollen or other allergens has no place to go.

The paradox in this situation is that in these parasitic infections there is no hard evidence that the "worm" IgE antibodies provoke reactions as they do in allergic patients. The reason for this difference remains a mystery. Hypotheses abound, but no convincing experimental evidence has come forth. Nevertheless, insights into the mechanism are of obvious importance in developing a treatment for those who suffer allergies.

Even that vampire of the intestinal tract, the hookworm, deserves some consideration. Hookworms cause an iron deficiency anemia, but if the worms' toll is not too high and iron intake from food sources adequate, the anemia is not so severe as to be markedly deleterious.

Admittedly, chronic anemia cannot be advanced as a sign of blooming health, but even so, it may have a beneficial effect, still another example of the exquisitely balanced give-and-take between infections. People with worm-induced iron deficiency anemia are particularly resistant to bacterial infections. Only anemia of this type confers such protection. Patients with anemias arising from impaired function of the tissues that manufacture red blood cells or hemolytic anemias, which destroy red blood cells, such as occurs in...
sickle-cell anemia, appear to be fully susceptible to bacterial pathogens.

Some researchers have speculated that since many bacteria require iron as a metabolic element to sustain life, iron-deficient individuals could not easily support bacterial growth and proliferation. Another possibility is that a serum protein factor, transferrin, which may play an accessory role in the natural ability of serum to stop bacterial growth, is elevated in iron-deficient states. Although these studies require further confirmation and exploration, the results so far again suggest that a kernel of goodness exists within the seed of evil.

Virtually all living species shelter and nourish parasites. Indeed, even parasites may have parasites. Some parasites cause disease; others are entirely benign. Still others, as those mentioned here, may actually provide some benefit. Natural and experimental observations on the effects of parasites in lower animals lend further evidence for the latter relationship. The primary measure of beneficience applied in these experiments has been the increased size of weight of the parasitized host.

One of the earliest observations on this phenomenon was made by that remarkable naturalist-parasitologist Miriam Rothschild. She found that certain estuarine snails parasitized by the developmental stages of a trematode (the phylum of flatworms that includes the schistosome blood fluke of man) were much larger than parasite-free snails. She reasoned that the size of the host, which involves an increase in the soft tissue, as well as the shell, is of great advantage to the parasite. The faculty of producing this increase in size is a character that is most susceptible to selection.

Following Rothschild's lead, parasitologist Thomas Cheng and his colleagues at Lehigh University sought experimental confirmation for enhanced growth of trematode-parasitized snails. Their studies revealed that the infected snails were heavier than the uninfected controls but that this was due to a heavier shell rather than to growth of the soft parts. They attributed this effect to the parasite's destruction of the snail's digestive glands and the consequent release of calcium, which was then incorporated into the shell. Rothschild, however, believed that the parasite attacked the growth-regulating glands and in effect "caponized" the snails that she studied.

As we ascend onward and upwind through the evolutionary tree, we find other intriguing examples of parasitized, provided they are not present overwhelming numbers, stimulating the growth of the host's. Just Mueller's work on the implantation of the larval stage of the tapeworm _Spirometra ranarum_ into mice resulted in a weight gain that sometime extended to obesity in his experimental animals. In this instance, appears that, rather than altering the host's physiology, the parasite secretes a growth-stimulating, homon mononuclease substance.

Perhaps the most ardent champion of the harmonious parasite is David Lincicome, formerly of Howard University. He and his colleagues conducted a series of exemplary experiments from which they showed that rats and mice infected with _Trypanosoma lewisi_, T. duttoni, and the roundworm _Trichinella spiralis_ (the cause of trichinosis in man) all grew significantly heavier than their uninfected cohorts. What is even more amazing is that the trypanosome-infected animals lived considerably longer than their uninfected controls. In one typical experiment, the control mice lived an average of 49 days, while the animals infected with _Trypanosoma duttoni_ survived an average of 82 days. The apparent reason for the longevity was that the parasites provided the hosts with the essential energy-mediating vitamins, thiamine, pantothenate and pyridoxine.

Of course I do not counsel hypotension, asthematics, and those who desire to prolong the salutary days of the youth to embark on a journey to their nearest malarial, parasite-infested pesthole. I do believe, however, that there is a lesson to be learned from a more tolerant view of host–parasite relationships. Too often, biomedical research takes a microscopic, molecular approach, neglecting the clues generously provided by the events of the natural world. This, I suggest, has been an important reason for our getting so relatively little bang for our research buck. By expanding our sights into these dynamic relationships and learning to control the effects without the infection, we may aid in relieving hypertension, asthma, and the velocity of aging.
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The above list of content is by the limitation of space, just a mere summation. The actual content of Gray's Anatomy is so massive that the table of contents in the book needs 16 entire pages with 1,932 separate category entries. And the index of this masterpiece covers 41 pages with 8,541 separate listings.

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Hearing their own vocalizations while still embryos apparently enables young ducklings to recognize the calls of their mothers after hatching

More than a hundred years ago, Douglas Spalding, a British scientist considered by many to have been the first experimental animal behaviorist, noted that “when guided by sight alone,” young domestic chickens “will follow any moving object,” but that when auditory cues are supplied, “their ear prior to experience attaches them to the right object [emphasis added].” Since Spalding's time there has been considerable research showing that young birds of various species other than chickens—for example, wild and domestic ducklings—exhibit similar behavior.

Although Spalding did not know the social-ecological basis of his observations, it is now clear that this aspect of avian behavior is intimately correlated with the predominance of auditory over visual perception in the early social relations between the newborn and their mothers. (In most avian species, except songbirds, the male does not play an active role in incubation or otherwise take care of the young.)

In a previous article in this magazine (“Components of Recognition in Ducklings,” February 1965), I described my work on the early social interactions between mother and young in the hole-nesting wood duck and the ground-nesting mallard duck. The main, and entirely unanticipated, discovery was the start of a “dialogue” between the hen and her young that begins in both these species when the embryo “pips” the egg twenty-four or more hours before hatching. The hen of each species at that juncture utters a species-typical maternal call in response to the vocalizations of her young.

These embryos begin their social relationships with their mothers even before they can see them. Wood ducks nest in deep, dark cavities and the young do not have an opportunity to see the maternal parent until they leave the nest. She calls the ducklings out of the nest with essentially the same vocalization she emitted to the embryos and throughout the immediate posthatch brooding period of some twenty to thirty-six hours. The same situation pertains with the ground-nesting mallard, except that the young of this species can see the mother when she calls them from the nest. In both species, the maternal call appears to be almost irresistible. In wood ducks, once the call is initiated, the entire brood usually leaves the nest within two to four minutes, never to return. Mallard hens, on the other hand, sometimes have to make several efforts to get their entire brood to follow them out of the nest as a group.

I took tape recordings of the species-specific maternal calls of mallard and wood ducks back to the laboratory to do some experiments. I was about to have to relinquish a previously unquestioned assumption concerning the perceptual basis of the early attachment between the hen and her young. Unaware, at the time, of Spalding's observations on chickens, I was completely convinced by the central theme of the imprinting concept, the crux of which was summarized in 1937 by Konrad Lorenz.

It is a fact most surprising to the layman as well as to the zoologist that most birds do not recognize their own species “instinctively,” but that... their reaction... [to] a fellow-member of their species must be conditioned... during the individual life of every bird.

The first experiment I did involved hatching wood ducklings and mallard ducklings in laboratory incubators in order to test the response of these “naive” young animals to a choice between the maternal calls of the two species. Since the ducklings had never been exposed to the maternal call of their own species, I was certain that they would respond indiscriminately to the maternal calls of both species and not show a selective preference for that of their own species. I was wrong. The "maternal..."

(Please turn to page 44)
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*Commercial forest is described as that portion of the total forest which is capable of, and available for, growing trees for harvest. Parks, wilderness and primitive areas are not included.

The two Douglas firs to the right grew in the forests of the Cascade Mountains of Washington State. Both were harvested when they were 25 years old. The difference is, the larger one grew in an Operation Double Tree area, while the smaller one did not.
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gilbert Gottlieb is a developmental biopsychologist in the Research Division of the North Carolina Department of Mental Health.
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Original prints, whatever the process used to create them, are "hand-pulled" under the artist's supervision, or by the artist himself. This means that any work produced photographically or by another purely mechanical process is not an original print.

If you examine a print under a magnifying glass and discover a regular pattern of small dots, you will know immediately that it is not an original work.

If the print is a serigraph (produced by a silkscreen process), the ink will seem rather like paint and appear to be sitting upon (rather than absorbed into) the paper.

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Original prints are always produced in limited editions, at the most several hundred copies. If thousands of copies are available, then the work is almost certainly not original. (In most cases, to assure that the integrity of their work is not violated, artists will destroy the plate after the edition has been produced.)

The print will have a figure on its border, indicating the number of prints pulled and the number of the individual print in the sequence.

For example, the figure 50/100 means that the edition has been limited to 100, and that this is the 50th print pulled.

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Looms of Otavalo
by Joseph B. Casagrande
photographs by Victor Engelbert

The conquistadors may have destroyed traditional Indian society in Ecuador, but their presence resulted in an economic organization that survives to this day.

Even on an ordinary day, there is a constant flow of people along the highway near Otavalo in the Andean highlands of northern Ecuador. Despite the burdens most of them carry on their backs—a sheaf of cornstalks, a roll of woven mats, a bundle of firewood—they usually walk at a rapid gait, as if on the verge of breaking into a trot, even while herding a flock of penicky sheep or prodding a few refractory pigs.

Their distinctive dress marks them at once as being both Indian and as coming from this region of the country. Although there are minor differences from one community to another, discernible only to the practiced eye, the basic costume is much the same. Even the clothing of the very young replicates that of the adults. For men, this consists of white, calf-length trousers fastened at the side, a white shirt, and a wool poncho, usually indigo blue in color, but more recently of a large-checked blue or tan pattern. Most distinctive of all is the long, single braid of hair, a symbol of ethnic identity and manhood.

Women typically wear two skirts of heavy blue or black wool, secured by one or more finely woven colored belts. Their face-trimmed cotton blouses are elaborately embroidered with brightly colored floral designs. A large blue shawl, loosely tied in front, usually covers their shoulders. They may also wear a second shawl that doubles as a sling in which to carry an infant or other load. Perhaps the most outstanding feature of women's dress is their jewelry—multiple bracelets of real or simulated coral and strand upon strand of hollow glass beads wound around their necks.

For centuries, the Indians of Otavalo have been weavers. Now, with the introduction of large-scale commercial weaving, many have achieved a degree of affluence unknown to other Ecuadorian Indians, most of whom are impoverished subsistence farmers. The products of the looms of Otavalo are sold in department stores and specialty shops throughout the United States and Europe, as well as by itinerant salesmen in virtually every large city in South America and the Caribbean Islands.

Of the forty to fifty thousand Indians living in the communities surrounding Otavalo, only one-tenth work as full-time weavers. Peguche and Quinchiquí, two villages a short walk from Otavalo, are foremost in the industry. Many Otavaleños (those who live in the Otavalo Valley) are also part-time artisans who make rush mats, pottery, and bricks. A few are still bound to haciendas as day laborers, but are no longer required to work four days a week in exchange for a meager wage, access to a small plot of land, and other hacienda resources.

Given the valley's high population density, land is prized and costly. Many young Otavaleños with no hope of inheritance are obliged to seek employment in occupations other than agriculture. There is, accordingly, a steady stream of recruits into the weaving industry. Many others, however, must seek work elsewhere. The recent construction boom in Quito, spurred by petroleum discoveries, has been a prime source of employment. Other work in Quito's textile factories. Some young women have entered domestic service or work as salespeople or waitresses in Indian-owned shops in Quito.

Weaving was transformed from handcraft to an organized industry immediately after the arrival of the Spanish in the sixteenth century. After the conquistadors had secured what is now Ecuador for the Spanish crown, they lost little time in setting up institutions to exploit Indian labor and to drain off a steady stream of tribute into both crown coffers and private pockets. The obraje—a kind of workshop or primitive factory in which textiles were produced—was among these institutions. Established throughout Ecuador, the largest were operated as crown enterprises, others were license.
worked endless hours in cold, dark structures that were virtual jails. One official report in 1666 on conditions in an obraje near Pelileo in central Ecuador describes in gruesome detail how workers were flogged and died in chains for such offenses as falling asleep on the job, leaving the obraje without permission, or complaining about work conditions.

The community obraje of Otavalo was established in the mid-1500s by Rodrigo de Salazar, a conquistador

*Most woven goods displayed in the Otavalo market are made for the tourist trade. Otavaleños usually wear traditional ponchos: blue on one side; a plaid design on the other. Patterns on long rectangles of woven cloth, which can be used for curtains or wall hangings, are not indigenous to Otavalo, frequently being copies of designs from isolated Ecuadorean towns.*
who had received an encomienda from the crown — a form of payment for services rendered during the conquest. An encomienda gave the holder the rights to tribute and labor exacted from a specified number of Indians residing in a particular domain. At the height of its productivity, five hundred Indians labored in this obraje, including boys as young as nine years old.

Three hundred Indians worked in the Peguche obraje, begun in 1613 under the by the crown. For the next two centuries this obraje suffered a series of misfortunes, but according to W. B. Everson, a British soldier of fortune, was still flourishing when he passed through the area in the 1820s. He noted that the Indians seemed more inclined toward weaving than agriculture.

In 1863, Friederich Hassauer, the first United States minister to Ecuador, observed another account. "Peguchi is the name of the factory and beautiful country residence of Don Manuel Iijon, coarse woolen goods are made, such as bayetas for ponchos, jergas for the Indians, and shawls for their women. These shawls are dyed red, yellow, blue, or brown, but the red color is most in demand; cloth for coats, vests, pantaloons, carpets, etc. These goods are shipped chiefly to New Granada as far as Pasto and Popayan in the interior, or Barbacoas on the coast."

During the nineteenth century, weaving in Otavalo underwent a decline, due in part to imports of inexpensive cloth from Great Britain. In 1917, however, a fortuitous event occurred that ultimately led to a rejuvenation of weaving and set it off in its present direction. According to one account, a wealthy resident of Quito was given a handsome and beautifully woven poncho. Greatly impressed with its quality, he sought out its maker, Jose Cajas of Quinchi, gave him an upright Spanish loom, and persuaded him to try to imitate Scottish weed. Although the result was not good, Cajas found a ready market in Quito for his homespun woolen goods. Other weavers soon followed his lead.

During World War II weaving was given further substantial impetus when imports from Great Britain came to a virtual halt. As a result, the demand for local woolen goods jumped ahead. After the war's end, however, the resumption of British imports stimulated the search for other markets and new products. Greatly improved roads and other means of transportation eased the way for salesmen who traveled throughout Ecuador and into neighboring countries. Added to this was a rapidly increasing influx of foreign tourists passing through Ecuador, many of whom were hungry for locally made textiles. The present-day, wide-flung weaving industry was on its way.

Today, the popularity and profitability of weaving in Otavalo continues to flourish. It is nicely ironic that the weavers have turned to their own advantage the skills learned and perpetuated in the hard schools of the obrajes — the instrument of their exploitation has become the key to the greater economic independence and affluence they enjoy today.

In nearby Peguche, weaving is a constant activity, and scores of former residents carry on the occupation elsewhere. Virtually all men and most boys over fourteen, as well as many girls and women, work full time in some aspect of the industry. The household is the basic unit of production, and even the largest enterprises have expanded from this common base.

Very young children assist in such simple tasks as cleaning raw wool, and from the time their legs are long enough to reach the pedals, young boys take a turn at the loom. Although many tasks are shared by men and women, weaving is strictly the province of the men, and finishing the textile is usually women's work.

Weaving in this community has undergone a series of profound changes in recent years. The efficient Spanish loom replaced the back-strap loom, which dated from preconquest days, and now, power looms are beginning to supersede Spanish ones. The woolens and cottons formerly used for men's and women's clothing has virtually disappeared. Cheaper, factory-made cloth is now preferred. Gone, too, are the heavy woolen ponchos formerly woven on the old back-strap loom with laborious care. Very few people, even among the older men, still know how to weave the magnificent ponchos with a different color on each side. The hand-held drop spindle yielded to the spinning wheel, and it, in turn, gave way to manufactured yarn. Similarly, synthetic fibers are being substituted for wool and cotton.

Just as the materials and the technology of weaving have changed, so, too, have the products. These are now made with an eye primarily to the tourist trade and the foreign market. Among the more popular items are women's large fringed shawls, ponchos, scarves, shoulder bags, small tapestries, and ponchos for children. Shawls and ponchos are brushed with large burs to give them a soft, downy appearance that, incidentally, serves to hide imperfections in the weaving. The women's ponchos follow the same basic design as those worn by Indian men, but no Indian woman would ever wear one. Bright hues and pastels that span the whole spectrum are used. The center of the poncho often has a varicolored geometric animal or other design. Otavaleños, however, disdain these brilliant colors and large designs and prefer dark blue, black, and brown in their own clothing.

In communities not yet engaged in large-scale commercial weaving, older techniques are still practiced. A visit to such communities is a step backward in time. Here, one can still follow the laborious production of a poncho, from the cleaning of the raw wool to sewing the two halves together as they come off a back-strap loom. Only after studying the intricate procedures used to prepare raw wool for weaving, can one appreciate the eagerness with which orlon and other manufactured yarns have been adopted by the weavers. Workers must first remove bits of foreign matter from the wool by hand. They then wash the wool, often using the juice of the cabuya plant, which yields a cleansing foam. After drying, the wool is cleaned again, fluffed by beating it with a long rod, and carded to align the fibers in preparation for spinning. As it comes from the carder, each fluff of wool is rolled prior to spinning. For fine work, two threads are spun together or the yarn is spun a second time.

At this point the yarn may be dyed. Today, commercial aniline dyes are used almost exclusively, although a few
people still use the fruit of the black walnut tree to make a dye that ranges from black to light greenish brown.

Even after all this, the process is far from over. The warp threads must be put on a special frame before being transferred to the loom. This is a complicated and variable procedure, depending on the type of loom used and the article to be woven. The weaving process is relatively simple and can be performed by an apprentice, but setting up the loom usually requires the expertise of a skilled weaver.

There are many ways in which individuals participate in the weaving industry. Many families carry out the entire process, from preparation of the wool to selling the finished product, but others specialize in only one phase. At one end of the scale is the man who spends a few hours a week on a poncho that may take him several months to finish; at the other end, the entrepreneur who employs about sixty persons in two round-the-clock shifts. In these small industries young Indian men, some little more than boys, from Peguche and other neighboring communities operate the imported power looms, while girls sew and do other finishing work. A steady stream of shawls, scarves, ponchos, and a variety of "novelty" items, all in garish colors and bold designs, comes off the looms. These are stacked in great piles in storerooms, either to be sold in quantity to salesmen or shipped directly to customers.

Although the industry depends greatly on its weavers, it is largely the salesmen who carry the flag of Otavalo identity. They travel to virtually every major city in South America and the Caribbean and venture as far afield as the United States, Spain, and even Germany. A familiar sight in every Ecuadoran city and town of any consequence, they can be spotted wherever tourists congregate: in ports and airports, in front of hotels, in markets, parks, and main thoroughfares. They do a lively business selling textiles to passengers and crew members of ships calling at Guayaquil, Ecuador's largest port. Wherever one encounters a salesman in South America, he is invariably dressed in full native costume, complete with braided hair. In a tropical port he may be drenched with sweat and still not shed his poncho.

As in other Ecuadoran towns, life in Otavalo revolves around the weekly market. Although Otavalo's weaving business has expanded far beyond the community's bounds, its local market is still important for the weavers and sellers of textiles, including salesmen—the more so since in recent years the market itself has become a prime tourist attraction. Saturday is market day in Otavalo. Beginning well before dawn, Indians from throughout the valley and from even farther afield begin to converge on the plaza. They come by foot, in packed and dilapidated buses, in trucks, taxis, and even in private cars. By sunrise, the usually empty plaza is transformed into a thronged market in full swing. But several hours later, the plaza is again nearly bare, and except for a few stragglers packing up their goods, the market is over.

The weavers of particular kinds of goods occupy the same relative positions each Saturday. Lined along one wall, they offer ponchos or other items that lie at their feet. Some have only a single garment, probably finished that week, while others have a sizable pile to sell. Cotton and flannel yardgoods, blouses, belts, and blankets, as well as shawls, scarves, and other tourist items are all displayed.

The future of these weavers is in many ways problematical. It is doubtful whether the industry's rapid expansion since 1950 can be sustained. Given the increased competition from those recruited to weaving in recent years, profit margins have fallen. Long gone are the days when a handful of pioneering salesmen sold their wares on the streets of Bogota at handsome profits. Quick to recognize a good thing, mestizos have begun to encroach on what was the exclusive preserve of the Indian. Abroad, there is increasing competition from finer textiles produced elsewhere. And unhappily, at least in my eyes, the goods now mechanically produced for a mass market have become increasingly shoddy and gaudy—a fate that has befallen native handicrafts throughout the world.

Community work projects warrant the wearing of traditional dress. For women, this consists of a white and a blue skirt, a white blouse, and a blue poncho. Kerchiefs cover their heads.
The Auroras
by Raymond G. Roble

These brilliant displays of multicolored light may exert subtle effects on our atmosphere and weather.

The polar regions of our planet are known for their barren, wind-swept ice fields and the feeling of desolation that may assail a traveler to those parts. But when darkness falls, the same traveler is often compensated by a dazzling display that can fill the entire sky. This multihued light show, known as the aurora borealis, or northern lights, in the Northern Hemisphere and the aurora australis, or southern lights, in the Southern Hemisphere, is an awesome sight to those who witness its largest manifestations. In polar regions, the aurora is a nightly event. At lower latitudes, it is less frequent. In most of the United States, these light spectacles can only be seen during geomagnetic storms, when the aurora moves from its normal polar position toward the lower latitudes.

The brilliant light emissions of the aurora are a sign that enormous amounts of energy are being transferred to the earth's high atmosphere, about sixty miles above the planet's surface, from the space nearby. Where does this energy originate? How is it introduced into our atmosphere? Does the aurora — and the energy transfer that accompanies it — affect our atmosphere and perhaps influence our weather? These are some of the questions that scientists are attempting to answer.

To examine the physical mechanisms responsible for the aurora, a huge volume of space surrounding the earth must be probed, directly by satellites and remotely by aircraft and ground-based instruments. It is not possible at the present time to put forth a unified theory of the many processes associated with the aurora with which all scientists will agree. Yet we are beginning to get glimpses of some fascinating effects associated with the aurora.

The ultimate energy source of the aurora is the sun — not the sun's radiant energy, but rather the solar wind energy that flows outward from the sun's surface in all directions. (The source and properties of the solar wind were described in "The Turbulent Sun," a special supplement in the November 1976 issue of Natural History.) Unlike the wind we know, the solar wind is composed primarily of charged particles, electrons and protons, which form a gaseous medium called a plasma.

The solar wind is turbulent, with large variations in its speed and density as well as in its magnetic and electrical properties. Because of these latter properties, the solar wind does not impinge directly on the earth's atmosphere but, instead, interacts with the earth's magnetic field, which extends high above the atmosphere. During the interaction of the solar wind with the outermost portions of the earth's magnetic field, electric and magnetic forces are generated that deflect the charged particles of the solar wind and cause the wind to flow at large distances around the earth toward outer space. The earth's magnetic field in this way forms a huge, invisible protective shield, called the magnetosphere, around the globe. The solar wind, however, is strong enough to distort the configuration of the earth's magnetic field as it flows by. The size of the magnetosphere depends on the variable strength of the solar wind. On the sunward side of the earth, the solar wind compresses the magnetosphere, which extends about 40,000 miles from the terrestrial surface toward the sun; on the night side of the earth, the solar wind stretches the magnetosphere into a long tail extending about 40,000 miles from the earth surface.

The shielding property of the magnetosphere is not perfect. Small quantities of solar wind particles and energy regularly enter the magnetosphere, but how much, varies in time. The amount appears to depend on such properties of the solar wind as its speed, density, and magnetic field direction. Once inside the magnetosphere, the solar wind plasma is energized by electrical and magnetic processes and ultimately gets its way to the earth's polar atmosphere where it produces the aurora.

The solar wind blows continuously although variably, and the aurora consequently always presents in the polar regions. In its typical form, the aurora is quiet and relatively small, suggesting a shimmering curtain or array of light. But observations show that not all of the solar wind energy entering the magnetosphere is steadily released into the earth's atmosphere in the form of quiet auroral arcs. Instead, the magnetosphere has a tendency to store some of the solar wind energy for later discharge. When the energy stored in the magnetosphere develops an instability on a global scale, it is suddenly released from the magnetosphere into the atmosphere. These intermittent discharges, called auroral substorms, generally last a few hours before the aurora returns to its normal condition of quiescence. Substorms occur on an average of five to six times a day, every day, each time...
depositing impulses of solar wind energy into the polar regions of our atmosphere at heights above about sixty miles. The average rate of energy these auroral substorms release into the earth's atmosphere every day amounts to approximately a million-million watts.

Despite the regularity and energy of auroral substorms, they are not generally seen at mid-latitudes. It requires geomagnetic storm, an event powered by still greater energy than a substorm, to make the aurora visible over the United States, and even then the viewing is commonly restricted to the northern part of the country. During geomagnetic storms, the solar wind flowing past the earth is enhanced by the eruption of solar flares in the sun's atmosphere. Solar flares eject streams of energetic particles from the sun into outer space. The particles that flow toward the earth require a few days of travel time before encountering the earth's magnetic field. In the course of their journey, the solar flare particles combine with the solar wind, and when the augmented solar wind interacts with the earth's magnetosphere, a global geomagnetic storm occurs on earth.

Unlike auroral substorms, geomagnetic storms are not a regular occurrence nor do they follow any known pattern. They are characterized by increased auroral activity, which moves toward the equator from its normal position. There are also changes in the earth's magnetic field strength caused by the intense electric currents of a few million amperes that flow into and out of the upper atmosphere during these events. At these times, radio communication may be disrupted and power failures may occur because of interference with sensitive power monitoring circuits.

A geomagnetic storm can last from one to five days. During this period, the auroral substorm sequence continues as usual but the size and frequency of the daily substorms increase greatly. The amount of energy transferred from the enhanced solar wind into the magnetosphere and then into the earth's atmosphere in the form of the aurora can increase the energy level by ten times or more than that of geomagnetic quiet periods. As the strengthened portion of the solar wind flows by the earth and the solar wind returns to its prestorm condition, the geomagnetic storm subsides and auroral activity moves away from low and mid-latitudes, returning to its quiet-time position in the polar regions. The sequence of quiet auroral displays and less intense substorms also returns.

Satellite observations of the aurora show that it has considerable variability in its special extent, geographic location, and intensity, indicating that the solar wind energy input into the earth's atmosphere is also highly variable. Studies demonstrate that the energy from the solar wind can vary by a factor of 100 from geomagnetic quiet to geomagnetic storm conditions.

Bombarding streams of particles that have been accelerated from the magnetosphere into the upper atmosphere cause the atmospheric gases to glow and produce the auroral light displays. These particles flow along magnetic field lines from the earth's magnetosphere into its atmosphere in the vicinity of its magnetic poles. This is also the vicinity of the geographic poles. Particles flow through the rarefied regions in the magnetosphere without many collisions because there are few particles there with which to collide. As the particles flow toward the earth, however, they penetrate into ever denser regions of the earth's atmosphere and hence undergo more and more collisions with atmospheric gases. The particles can only penetrate the atmosphere to a depth at which the gases composing the atmosphere are dense enough to absorb the energy of the particles.

The energy of the auroral particles is such that when they collide with neutral atoms and molecules in the earth's atmosphere, they break the molecules apart to form atoms, excite the atoms and unbroken molecules to higher energy levels, and even ionize the atoms and molecules, that is, strip away electrons, leaving these formerly neutral entities in a charged state. In perturbing the background atmospheric gases in this way, the aurora changes the normal chemical reactions that occur in the upper atmosphere. About 50 percent of the energy of auroral particles goes into exciting atmospheric molecules and atoms to higher energy levels, causing them to radiate and thereby produce the dazzling light displays of the aurora. About 20 percent of the particle energy is involved in chemical reactions of atmospheric gases produced by the aurora, namely, atomic oxygen and atomic nitrogen; the remaining 30 percent of the particle energy heats the gases of the high upper atmosphere without exciting the molecules.

Low-energy particles (of a few hundred electron volts) deposit most of their energy high in the atmosphere at an altitude about 150 miles above the surface of the earth. Atomic oxygen is the main constituent in this rarefied region of our atmosphere. The low-energy auroral electrons excite atomic oxygen to a higher energy level, and when the oxygen atom releases its energy, it is radiated as red light. A completely red aurora indicates that the atmosphere is being bombarded with low-energy particles and that most of the particle energy is being deposited high in our atmosphere where atomic oxygen prevails.

Higher energy particles (of a few thousand electron volts) can penetrate deeper into the earth's atmosphere and consequently deposit most of their energy at a lower altitude of about sixty miles. These higher energy particles also excite the oxygen atom, but to a higher energy level, producing a glowing green aurora. When the oxygen atom is excited, it requires a finite time before it can produce light by radiating its excess energy.

The amount of time is determined by the level of excitation of the atom: 110 seconds for the atomic oxygen red line and about one second for the atomic oxygen green line. The red emission of atomic oxygen is suppressed at altitudes below about 125 miles because the excited atom loses its excess energy by collisions with other particles in the denser atmosphere of the region before it has time to radiate. But in the rarefied atmosphere above 125 miles, where collisions are infrequent, the red emission occurs. Thus, the visible color of the aurora is an indication of the height at which the bombarding particle energy is being deposited within our atmosphere: red near 150 miles; green near 60 miles. And the intensity of the aurora is related to the number of particles entering the atmosphere. The appearance of simultaneous red and green in the aurora indicates a mixture of low- and high-energy particles.

Particles with energies greater than a few thousand electron volts also bombard the earth's atmosphere. They penetrate to within fifty miles of the earth's surface but do not produce any visible light displays. Although the atoms and
molecules of atmospheric gases are excited, they lose their energy very rapidly by collisions in the denser atmospheric regions before they can radiate. The visible light displays of the aurora therefore only occur above heights of about fifty to fifty-five miles. The energetic particles that penetrate below fifty miles, however, can cause enhanced ionization that affects radio waves and communications on earth.

The energy from the aurora, and its associated electrical processes, is as variable as the auroral light displays, but at times it can exceed the amount of solar radiant energy absorbed in the atmosphere above sixty miles. As a result, the earth's atmosphere above that height has a meteorology of its own, which differs somewhat from the familiar weather we experience near the earth's surface. Unlike the lower atmosphere, which is driven by direct visible solar radiant energy, the atmosphere above sixty miles is driven primarily by two other forms of solar energy: ultraviolet radiant energy and the energy of the solar wind that is deposited within our atmosphere through auroral processes.

For example, during spring and fall, the maximum solar radiant heating occurs at the equator where the sun is overhead. The incoming radiant energy heats the air in that region, causing it to expand and rise. As the heated air rises, it develops an increase in pressure and flows northward and southward toward the poles, which are cooler regions of less pressure. The mean wind circulation, or flow of air, in the upper atmosphere is consequently from the equator toward both poles. This circulation pattern exists when the aurora is quiet and ultraviolet energy is the main driving force in the circulation of the upper atmosphere. When the aurora is being turned on and off by daily substorms, however, the average auroral heating is large enough to disrupt the mean wind circulation. Occurring simultaneously in both polar regions, the aurora provides sufficient added heat to force the air to flow away from the poles toward the equator. Just how far back toward the equator the aurora-driven circulation pattern pushes the mean wind circulation depends on the size of the aurora. During very large geomagnetic storms, the auroral heating is so large that the airflow is completely reversed, and in most of the upper atmosphere above sixty miles, circulation moves from both poles toward the equator. Then as the aurora becomes quiet again, normal circulation in the upper atmosphere redevelops and the airflow moves again from the equatorial region toward both poles. Through these processes, the global atmospheric circulation above sixty miles is kept in a constant state of agitation, being forced one way when the aurora is quiet and in the opposite direction when geomagnetic storms are in progress.

The winds associated with the mean circulation pattern described above are quite strong compared with the winds we experience near the earth's surface. During quiet auroral conditions, the daily winds at heights of about 185 miles have typical velocities of 225 to 450 mph. When auroral activity increases, the winds also increase to speeds of about 670 to 900 mph. During very large auroral storms, winds approach velocities of 1,120 mph. During one large storm on July 4, 1974, a wind measurement of 1,433 mph at an altitude of about 150 miles was made from Fritz Peak, Colorado, about twenty miles west of Boulder.

The temperature of the upper atmosphere also increases by some 100° to 500°K during auroral events from its normal quiet time value of 1,000°K at heights of 150 miles. These large atmospheric responses take place in a region of our atmosphere that is very rarefied, where satellites in orbit experience only minimal air drag. Nevertheless, our upper atmosphere near the fringe of outer space can undergo large temperature and circulation changes whenever the aurora interferes.

The effect of the aurora on atmospheric motions and temperatures diminishes progressively below 60 miles. At that altitude the atmosphere becomes so dense, as compared with the rarefied region near 150 miles, that changes in atmospheric circulation and temperature caused by the aurora are relatively small and difficult to detect. Yet, some scientific studies have suggested that the aurora can affect weather even near the surface of the earth. Such a relationship between the aurora and surface weather is difficult to understand. Auroral energy, although large enough to cause changes in the atmosphere above 60 miles, is about a million times smaller than the visible radiant solar energy that drives the surface weather. What physical mechanism can account for the influence of the aurora on our weather?

Auroral activity is related to sunspots; both have a well-defined eleven-year cycle. Auroral activity is greatest when the sun has the largest number of sunspots. The sun also has twenty-two-year cycle, composed of two eleven-year cycles, during which the sun's magnetic poles are reversed. Studies of droughts on the high western plains of the United States also reveal twenty-two-year cycle. The well-known dust bowl of the 1930s, the dry period of the 1950s, and the current drought in the western states have all occurred during periods of sunspot minimum and minimum auroral activity. Can this be mere coincidence or is the aurora really affecting our weather in some subtle way?

No matter what the answer to the question may be, the aurora does produce a number of clearly documented effects on our atmosphere. The increased ionization that results from bombardment by auroral particles affects the ionosphere (the outer part of the atmosphere, beginning at an altitude of about forty miles) and radio communication. Very energetic particles, penetrating deep into the atmosphere, produce chemical constituents that affect the ozone layer, fifteen to twenty-five miles above the earth's surface, which shields us from harmful solar radiation.

We are beginning to understand the effect of auroral activity on the upper atmosphere, but it is going to be very difficult to find and verify auroral effects on the lower atmosphere, particularly those associated with weather events. Until that is accomplished, the aurora will remain a demonstration of the terrestrial effects of the vast solar wind, producing the greatest light show on earth.

Charged particles from a solar flare on April 14, 1974 contributed to the large auroral displays encircling the northern border of the United States, as shown in this composite satellite photograph taken several days later.
Surrounded as you are by animals, Madame, you need not fear starvation!
The Siege of Paris

By Gerald Carson

aced with starvation, aristians consumed their pets and zoo animals

Without allies or a ready army, Napoleon III, the emperor of France during the Second Empire, was manipulated into attacking Prussia, the strongest military power in Europe, in a point of etiquette. Thus, by declaring war on July 19, 1870, he created an empire—the German—and collapsed another—his own.

Following the catastrophic defeat of the French army and the capture of Louis Napoleon at Sedan, two Prussian armies, moving rapidly, reached round the City of Light like the laws of some giant crustacean. The strategical plan was simple—it would be cheaper to starve the city than to assault it. The defenses were formidable: a garrison of 180,000 troops on the line, a body of marines, and reservists called Mobile Guards, plus 100,000 National Guardsmen—essentially untrained, part-time soldiers, gut full of fight. Ramparts, averaging thirty feet in height, surrounded by a ditch eighteen feet in depth, and with glacis in front covered by felled trees, enclosed a circle of nearly twenty-one miles. Seventeen detached forts defended the approaches to the main fortifications.

An odd euphoria seized Paris, as well as a fanatical determination to exist the Germans. Having vowed to fight to the end, the Parisians were constrained to do it. A republic, the Third, was proclaimed. Amidst general rejoicing over being rid of the Bonapartist Second Empire, the foreign invader was for the moment strangely ignored. The imperial eagles were torn from public buildings and military shakers. Street names celebrating the late regime were expunged. One shouted for la patrie, sang the Marseillaise, shook hands, and wore something red—a carnation, a sash, a cockade. The bust of Napoleon III at the Comédie Française disappeared from view, and an American dentist, Dr. Thomas W. Evans, gallantly spirited the Empress Eugénie off to England.

Uncomplimentary stereotypes about Napoleon’s big nose and the empress’s morals provided caricaturists, songwriters, political journalists, and the radical political clubs with inexhaustible material for piquant and often scurrilous commentary. Hawkers cried up their leaflets and satiric broadsides on the boulevards: “The Conspiracy of the Jesuits Against the Republic!” “The Confession of Napoleon III,” “The Bonaparte Woman, her Lovers, her Orgies.” One cartoon depicted Bismarck, the Prussian chancellor, as a cook and explained why the Germans neither bombarded nor attacked. The placard showed the Iron Chancellor as saying: “To cut down these Parisians whom I detest, it is necessary to let them stew in their own juice until the right moment.”

Inside the city, the theaters, cafés, and boulevards were crowded and colorful. There were flowers, illuminations, and the sound of drums and bugles. Patriotic visits were made to the statue of Strasbourg in the Place de la Concorde to honor the fortress in Alsace that was putting up a heroic defense. Spy hysteria erupted. One American clergyman was arrested and dragged off to prison for writing in his diary what he had for breakfast. The suggestion was considered of arresting the functionaries of the late imperial bureaucracy, although the appropriate question was how to arrest the Prussians.

Everyone who could put on a uniform did so, including pretty ladies who competed aggressively for custody of the limited supply of wounded soldiers then available. A wounded man was valuable. He defended a residence against the billeting of refugees, peasants, against incendiarism from social malcontents, against robbery or possible Prussian requisition. Semaphore signaled by day from the Arc de Triomphe, and giant electric searchlights on the hilltop at Montmartre swept the northern approaches to the city at night. Soldiers drilled in the squares. War industries hummed in factories and railroad stations and the gardens of the Tuileries palace were cock-a-block with caissons and cannon. The opportune appearance of the aurora borealis early in September offered convincing evidence to those with a receptive cast of mind that nature was signaling an early deliverance for France, while the devout put their faith in Saint Geneviève, the city’s patron saint. But the early enthusiasts who had purchased maps of Prussia in order to follow the triumphant French army on its march to Berlin quietly put their cartes aside. Mass graves were being dug at Montmartre.

There would be food enough for all, the Government of National Defense announced. Two hundred and fifty thousand sheep and forty thousand oxen herded into the Bois de Boulogne, bleating and bellowing unhappily, made a bucolic scene where but lately the world of fashion and elegance had taken its pleasure. Thousands of meat animals milled about in the confines of the Luxembourg Gardens, while masses of agitated cattle blocked the boulevards, pushing against the horse chestnut trees and the urinals. The huge central market was filled with casks of smoked or salted meat, barrels of flour, great wheels of cheese, mountains of dried vegetables. The partially completed Opéra, the marble-and-gold masterpiece of Jean Louis Charles Garnier, was converted into a water reservoir below, and transformed above into a bakery, a hospital, and a depot for food and army clothing. Fruits, fresh vegetables
from nearby truck gardens, dairy products—all the components of the traditional French cuisine—poured into the city although rising prices began to cause some apprehension as early as August.

September was never more warm and beautiful and early October provided a delightful interlude of Indian summer. While the weather held, and before the Germans had completed their encirclement, the general public was invited to clean out the game in the oak-and-chestnut forest of Compiègne, once the hunting preserve of kings, to deprive the invading army of meat and sport. In the suburbs, houses were leveled and trees cut down to create fields for artillery fire. The exodus of upper-class families to Brittany, Normandy, Tours, and Bordeaux was more than replaced by an inflow of refugees who temporarily provided more food than they consumed. According to a story widely circulated at the time, a farmer-refugee, who brought his way of life with him, was lodged in a handsome mansion and soon smelled up the neighborhood. The owner of the property investigated and found a rooster and his harem on the balcony. The ante-chamber was muddy and well manicured. The next room was a rabbit run. The master bedroom contained a basin for the ducks, and grunting from the drawing room announced the presence of a pig. When the owner of the residence asked why the farm animals could not have been kept in the garden, the farmer replied: "But it is the time for sowing and where would I sow my barley?"

The theaters were closed by edict of the Provisional Government, not for any good reason, but because that is the sort of thing governments think of. Meanwhile, those with ready money paid in private stocks of food-stuffs and gave chic siege dinners—un dîner de siège was the phrase in vogue—as a kind of defiance of the enemy and to break the ennui. Recreation was narrowly limited. One asked for the news, but there was no news. On Sundays, crowds rode on the beltway railroad inside the ramparts, climbed the walls to gaze at the French outer forts and the Prussian batteries through telescopes or opera glasses, or chatted with the Mobile Guards who had little to do except gamble, drink to the point of indiscipline, and hunt rats. By mid-September, Paris saw its last train depart, last regular mail delivery; and Felix Turnachon, an ardent believer in airships, was testing the possibilities of communication with the outside world by balloon flights.

The public powers were reassuring. Louis Trochu, president of the Government of National Defense and military governor of Paris, proved to be a talkative general who declared that if the Germans penetrated the fortifications, they would be killed and provide abundant humus for future generations of Frenchmen. Private Trochu was lukewarm in loyal toward the republic he headed as considered capitulation inevitable. military officer of towering importance, the general’s first probing sortie was a failure, as were all his subsequent efforts to break through the German lines. Trochu talked much of his plan. But in fact he had no plan.

Mid-October. Chill rains turning the sleet fell heavily from gray skies. Lack of heat and light posed new problems; the food situation grew tighter. The outlines of "the terrible year" were becoming visible. The government had only the vaguest idea of how many people were in Paris—the actual number on December 30, 1870, not counting armed forces, was 2,005,709—not did it develop reliable information as to the quantity of food available. But those in authority calculated roughly that all could be fed for eighty days. After that, Providence or Saint Geneviève would surely intervene.

The foreign population was the object of some hostility as representing like animal pets, unnecessary mouths to feed. United States citizens were generally well regarded for a number of reasons: because this country was the first nation to recognize the Third Republic, because Americans were not numerous, and because the American legation was headed by a remarkably able diplomat, Elihu Benjamin Washburne. Washburne was the only minister of a major power who stayed in Paris throughout the siege. The American "ambulance," meaning hospital (drawing on the lesson of our Civil War), also had the best record of all in the city for the care and recovery of the wounded.

Bread was price controlled and did not yet present a problem although the quality was dropping. Winter flowed like water. There was plenty of mustard but little beef to put it on. As early as September 27 there was an angry demonstration on the Boulevard des Italiens against the food speculators and the inequities already opening up between the rich and the poor. A curious phenomenon arose. All Paris was seized by a sudden and uncontrollable appetite. Those former content with two eggs and a bit of cheese now wished for red meat grilled rare, and a bottle of Burgundy.
Potatoes and dried beans rose four
six times in price and shortly disa-
ppeared from grocers' stocks. A laying
hen was truly a bird that laid golden
egs. 'Lamb' was still displayed in
shops and appeared on restaurant
menus but, curiously enough, at the
same time the dog population
topped sharply. "Rabbit" became a
common euphemism for cat or kitten,
ten smothered in onions or served
as a stew. Accomplished hosts, noted
for their good tables, offered—
without apology—le rat, sauce
cadere. The fork hesitated over such
ishes. But cultural conditioning
against unaccustomed viands could
not hold out indefinitely against the
hierous demands of a growing
tomach. One meat, the flesh of the
illygoat, defeated the best efforts of
the most ingenious cooks. As one re-
saurant proprietor noted despairingly,
'Il m'a été impossible de faire dis-
paraître l'odeur.'
Parisians disdained horse meat
when it first appeared on the market,
or the French do not modify their
eating habits lightly. Louis XVI, it
will be recalled, was obliged to wear
the blossom of the potato plant as a
oumniere to persuade his subjects
to accept the white tuber as an el-
ment in their diet. At the com-
encement of the siege, the notion of
eating horse produced a shrug and a
grimace. But Dr. Edme Bourgoin,
chief pharmacist at the Children's
Hospital, lectured on the health-
fulness and nutritive values of horse-
flesh. The government instituted
inspection at the horse markets. The
press and the Horse-eating Society
praised horse beef. Hippophagous
fare carried the day, winning accept-
ance first among such group leaders
as scholars, writers, artists, and jour-
nalists. The fat of the horse was also
pushed as a butter substitute since
even lard had become mythical,
something remembered nostalgically
from a former life. People formed
lines just to gaze when a luxury shop
at the Palais Royal displayed a single
pat of butter, like some precious
jewel, centered for dramatic effect on
a stand that slowly revolved.
Butcher shops were frequently
shuttered. When they were open,
meat was obtained only after hours of
waiting. The customer presented a
roughly printed blue ration card with
coupons attached. As the supply of
horses diminished, the meat allow-
cance fell from 150 grams (slightly
more than 5 ounces) a day per person
to 100 grams, then to 88, and finally
to 33 per day (or slightly more than
an ounce). Before long the queues of
patient women obtained horse beef
only after the animals had died on the
battlefield. About 70,000 horses, it is
estimated, were eaten during the
siege.
Theophile Gautier, the novelist and
critic, who published a volume of
eyewitness vignettes of life during the
siege, speculated on whether animals
respond to events around them that
are outside their instinctive sphere.
He concluded that they might not
know what King William I of Prussia,
General Moltke, and Bismarck were
up to, but they sensed well enough
that all was not as it should be in
Paris. Dogs reproached their masters
who offered meager rations, often of
gray, gluey bread, asking with plead-
ing eyes for what fault they were
being punished. Lost dogs from the
provinces, trying to find a new protec-
tor, rested their muzzles in the palms
of passersby, pleading good and
faithful service if only they would be
received. And then they noticed that
people were looking at them in a pe-
culiar way; that the caressing hand
was feeling them over with the
fingers of a butcher. They had be-
come game and were in mortal danger
of the running knot, the sack, and the
club. Cats assessed the situation first.
Prudently, they took to the rooftops
and deep cellars to avoid ending up
on a sharp hook invitingly set off with
paper frills and colored ribbons.
To many, the idea of eating dogs
was revolting. One French journalist
wrote that he could only compare it
to Orestes, of classical literature, eat-
ing his best friend, Pylades; or to Paul
devouring his true love, Virginie. But
as with the horse dilemma, hunger
has a marvelous effect upon attitudes.
In the last bleak months of 1870, spe-
cialized canine and feline butcher
shops opened in many locations.
They also handled rats.
During this time of misery and near
starvation, French wit still flashed
across the pages of the illustrated
papers. One cartoon set forth the risk
involved in eating rats by picturing a
cat that had jumped down a man's
throat after the rat, leaving only its
hind legs and tail sticking out of his

Parisiens selling pets at a market specializing in dog and cat meat.
A fish market holds a public auction of its dwindling supplies.

A few months. Le Figaro printed the story that a pack of dogs pursued a man who could not understand their interest in him until he remembered that he had eaten a rat for breakfast. Another illustrated sheet showed a handsome officer escorting a young lady into a restaurant, a loaf of bread under his arm. A sign on the wall warned, "Clients Bring Their Own Bread."

Gallows humor often turned on the fate of pets. A good bourgeois couple had a little dog of whom they were very fond. But a day came when there was nothing to eat. Their companion had to be killed and cooked. His master and mistress ate with tears in their eyes, and as the wife mechanically placed tiny rib bones on the side of her plate, she sighed, "What a treat these would have been for poor Bijou!"

Nerves grew taut while the besieged city waited for the attack that did not come. Sorties were made but bloodily repelled, while crackpot ideas proliferated for dealing with the impasse. One idea was to infect dogs with rabies and turn them loose on the Germans. Another suggestion, endorsed by a number of journals, was to release the carnivorous animals in the zoo against the besiegers. A difficulty, of course, was that the beasts would have to be familiar with the Prussian uniforms so as to know whom to attack. Since balloons could not be steered, another Rube Goldberg idea for achieving improved communications with the rest of France was to have the balloons pulled by four eagles while the human passengers in the gondola pointed poles skewered with red meat in the direction desired. The use of pigeons to carry messages worked reasonably well until the winter storms arrived. The carrier pigeon came to be regarded almost as a sacred bird, reasonably safe from ending up in a pigeon pie. Paris was especially bitter when the Germans imported falcons from Saxony to bring down the winged messengers, which bore such affectionate names as Gladiator, Vermouth, and Fille de l'Air.

November and December were bone cold, gloomy, snowy. The Seine froze over. Alternate street lamps were cut off. Transportation was almost nonexistent since most of the omnibus company's horses had been sacrificed. For a time in November the theaters reopened, giving short benefit performances—a movement from a symphony, scenes from Corneille's Horace or Molière's Le Misanthrope—for the wounded, the orphaned, or for the purchase of cannon. Ernest Lebouvé, the playwright, lectured on "Moral Foul During the Siege," and there we poetry readings from Victor Hugo, Mlle. Marie-Justine Favart, lookin' adorable in a satin dress that suggested the plumage of a dove, delivered a charming topical poem called "Les Pigeons de la République," at matinees on the Left Bank, Sara Bernhardt of the Odéon passed that. It was, appropriately, a Prussian helmet.

The performances ceased by the end of December because of the cold and lack of fuel and light. Many restaurants closed. Even such a well-known rendezvous as Chez Brébier 32, Boulevard Poissonière, when Edmond de Goncourt joined friend in the arts and sciences to dine at an talk, shut off the gas at seven-thirty. The amenities of life steadily shrank. While lunching at the Tavern d'Lucas, Goncourt found on his bill a charge for the napkin, reflecting the difficulty of obtaining hot water and fats for making soap. Men walked home through silent streets, hearing perhaps the clop-clop of a single fiacre, while finding their way with a lantern as in the middle ages. The silence, L'Illustration said, was oppressive enough to make one think he was in Carpentras (chief town of the Vaucluse)—a French way of saying that Paris had become Dullsville. The American minister, who had been a congressman from Illinois, said that the Champs Elysées in January made him think of Main Street in Galena, Illinois. Hunger, cold, dirt, and malnutrition were doing their work. Public health took a sharp downturn due to respiratory diseases, diarrhea, dysentery, cholera, and smallpox, which together tripled the mortality rate.

Parisians of whatever class were startled when they happened to pass the show window of Chevét's of the Palais Royal. Chevét's had been a famous luxury food emporium, somewhat like Fauchon's today on the Place de la Madeleine. Chevét's had been known for artistic compositions of fresh fish on marble tables, lobsters and turtles surrounded by...
A couple setting off for dinner take the precaution of bringing their own bread.
Hungry customers line up in the rain outside a butcher shop for their quota of meat.
oss, fat turkeys, deer hanging in front of the boutique. Other featured delicacies were the fine chickens of France, pheasants, Scotch grouse, and the paté de foie gras, brochettes of ortolans, peaches and melons, pears worthy—it is easier speaking, almost overcome by memories—of the grand dukes of Tuscany. But gone, all gone, were the gratifications of yesteryear. Instead, the stroller saw the blinding artistry of the tinsmith—in other words, tuned goods. The containers were square, oblong, but all were tiny and all were ticketed with prohibitive prices. Only those who still had gold or bank notes could touch them. For the poor, the government established municipal butcher shops and canteens. For bread, they ate a ray-to-black lump compounded of bran, rice, barley, straw, and other ingredients not readily identifiable. By mid-January the government did what it had vowed it would ever do—ban the free sale of bread altogether, allowing a daily quota of 300 grams for adults; for children, half that amount.

Osséine, an ersatz food devised by a chemist Edmond Fremy and containing ground-up bones, was introduced; also a kind of artificial milk. "You talk about what is eaten, can be eaten, or can be found to eat," wrote Joncourt's confidant to his diary. "Conversation does not go beyond that." Each problem tied in with some related shortage. With coal, coke, and wood disappearing, mobs desperate for heat snatched away faggots and benches, raided the wood yard in the rue Biot. They broke up looms, furniture, and leveled the remaining trees in the parks and along the great avenues, the Champs-Élysées and nobly shaded, fashionable streets in the west end of Paris, such as rue Montaigne or the handsome Avenue de l'Imperatrice (now Avenue Foch), where the American minister lived. Here Washburne saw women and children hacking away at the trees, gleaning every branch and twig, anything for fuel to cook their grams of food and create some warmth on the home hearth. The green wood, unfortunately, produced much smoke and discomfort, but little flame or heat.

The menagerie animals represented a last food resource. It was a telling point, too, that it grew more and more difficult to support them. An enterprising butcher began the zoo slaughter and resold his carcasses at astronomical prices. The establishment carried on its business under the name of Boucherie Anglaise, possibly to deflect the sorrow and anger of zoophiles by placing the onus for what was happening on the English. France was already exceedingly unpopular because its government had made no serious effort to help France extricate herself from the grasp of the Prussians. At any rate, dog's leg flanked with rats, sauce poivrée, was varied at the Boucherie Anglaise for those who could pay the tariff. 

With food stores empty, the predator becomes the prey.

by the flesh of unusual creatures—bear, antelope, kangaroo, ostrich, yak. Antelope, for instance, cost 18 francs per pound—call it $16 a pound in 1977 dollars. Two young elephants named Castor and Pollux, the pride and joy of Paris, were ineptly executed by explosive bullets and re-tailed at 20 francs per pound; however, the trunks, being especially choice, brought from 30 to 45 francs. Voisin's restaurant offered elephant blood sausages the evening of New Year's Day. A few days earlier a supper was tendered in compliment to M. Bonvalet, mayor of the Third Arrondissement, at the well-known Peter's restaurant in the Passage des Princes. The principal dish at this dinner was...
A fanciful siege menu includes such exotic items as a salmi of rat, elephant foot, and camel hump.
scalloped elephant with a sauce of nallots.

Perhaps it was a touch of anthropomorphism, but everything became much more difficult when one knew an edible animal by its given name. One hungry gentleman found it to be when he ate the heart of a donkey known as Ernest. Ernest's heart was old by a pale, young girl at the tâcher des Ternes, wrapped in one of General Trochu's optimistic proclamations: *Paris ne capitulera pas!* Ernest's heart gave the purchaser a case of indigestion that put a new edge on his grudge against the Germans.

Eating the wild beasts, if done indiscriminately, raised for some persons of scruple the rule of Levitical law: "Whatsoever parteth the hoof, and is cloven footed, and cheweth the cud, among the beasts, that ye shall at." Many verses follow in the Book of Leviticus listing those animals and birds that are forbidden as food, including "whatsoever goeth upon its paws," but when hunger took over, there were dinners to be had based upon English wolf sautéed with mushrooms, entrecôte of camel as a substitute for Christmas turkey, or old slices of toucan from tropical America, consumed in semidarkness, prinkled with a brut champagne. Other zoological novelties from theardin d'Acclimation, which by no means exhaust the possibilities, were tiger cutlets, boa à la tartare, and marinated of crocodile.

The order in which the animals were sacrificed is interesting. Those considered most valuable were saved until the last. At first only those species of which the zoo possessed two or more specimens were sent to the butchers. But this policy was abandoned under the pressure for more animal protein. The hippopotamus was spared for purely economic reasons. No butcher could finance so great a live weight. Last to be slaughtered were the monkeys. "These were kept alive," wrote an English correspondent for the London Daily News, "from a vague and Darwinian notion that they are our relatives, or at least he relatives of some of the members of the Government, . . ." The writer, Henry Labouchere, British but of French Huguenot ancestry, confessed that when he dined upon spaniel he felt like a cannibal. While there are no known instances of anthropophagy during the time Paris was besieged, the idea lingered not far below the level of consciousness. Sometimes it surfaced in a nervous witticism. Adrien Hébrard, director of the moderate liberal republican newspaper, *Le Temps*, while having a dog dinner at Chez Brébart, wondered if they would soon be eating the shepherd.

The bombardment. Often predicted, surely it would come—but when? A German newspaper explained that Bismarck was waiting for the psychological moment. The French laughed over the moment psychologique as an example of heavy-handed Teutonic philosophy. The phrase passed into ordinary conversation: "I am hungry. The psychological moment has arrived to dine," or to shave, to carry on some household duty, or whatever. On January 5, 1871, shells began falling in the gardens of the Luxembourg palace, the cemetery of Montparnasse, on the normal school, the Jardin des Plantes, and other locations. The French, more curious than frightened, nodded and said the psychological moment had arrived. There was no panic. Street gamins and the poor picked up and sold the shell fragments. Indeed, a kind of market quotation developed on the souvenirs: a hot piece of metal was worth an extra fifty centimes. Damage from twenty-one days of firing was limited, casualties were light, and there was no terror.

The end was near. The National Guard was filled with martial spirit and self-confidence, yet had never been allowed to fight. At last General Trochu led 100,000 guardsmen on a desperate effort. The attack was made, without feint or any diversionary scheme, in the direction of Montmartre and Buzenval where the German positions were especially strong—surely a curious strategy. The Guard retreated in defeat with heavy casualties. It was the day after William I of Prussia was proclaimed Emperor of Germany in the Hall of Mirrors at Versailles. "Never in the history of the world," Washburne wrote, "has an army of half a million men cut such an ignoble figure." Trochu, generally regarded as a military imbecile, and by many as probably a traitor, resigned his military functions. Shortly after the debacle, an angry, radicalized battalion of the National Guard attempted to take possession of the Hôtel de Ville (City Hall) and overturn the government. It was the first time during the terrible year that French troops had fired on Frenchmen.

At the end, famine brought Paris down. The newspapers still dared not mention the idea of surrender, but the rumor spread that by the end of January there would be nothing to eat and that a million people would die before a sack of wheat could be unloaded. A three-week armistice was negotiated, followed by a peace treaty. Under the armistice the city was allowed to repromiss itself. The ordeal had lasted 135 days.

Food was slow in arriving. Great crowds of hungry men, women, and children pressed outward at the city gates, but food trains and carts were met with shrugs and delays at the Prussian forts. When foodstuffs reached the central markets there were riotous scenes and some of the pavilions were looted. Relief ships arrived from both England and the United States and order was gradually restored at the shops. Once more, the fragrant, crusty, wheaten French bread emerged from the ovens of the bakeries, every morsel tasting as though it had been blessed by the Church. The windows at Chevet's were again filled with delightful edibles, and the rat catchers and dog and cat butchers retired into the shadows from which they had emerged.

The people of Paris quickly recovered their physical health. But the accumulation of frustrations, of humiliations, the feeling of betrayal by the responsible authorities, the political and psychological damage were beyond repair. The resistance to the Prussians became transformed into a bloody class struggle between the rebellious Paris Commune and the forces of a conservative national government. During April and May the French fought each other, street by street, barricade by barricade, until the Communards were scattered or dead, while the sound of music from German military bands in the outer forts floated down into the burning city.

But that is another story.
The Case of the Missing Monk Seal
by Peter M. Knudtson

In late August 1494, a ship commanded by Christopher Columbus then on his second voyage to the New World, lay anchored off the island of Alta Vela, just south of Haiti. A shore party disembarked and approached the rocky island. On the beach, they chanced upon a herd of eight "sea wolves," or seals, each about eight feet long, resting peacefully. Their brown pelages were lightly frosted with gray, fading to pale yellow on their stomachs and hoodlike rolls of fat surrounding their retracted necks. They closely resembled the monk seals that some crew members might have seen in the Mediterranean's more familiar waters. Astonished by the animals' lack of fear the men crept closer and within a few minutes easily killed all eight.

And so ended, in a prophetically bloody manner, the first recorded encounter between Europeans and the sea mammal now known as the Caribbean monk seal, Monachus tropicalis. (Species classified in the genus Monachus are the only tropical seals.) Caribbean monk seal herds once thrived along the shores and islands of the Caribbean and the Gulf of Mexico, but harvested and harassed over the last five centuries their populations have steadily dwindled. By the late eighteenth century, a sighting had become a rare event. The

No photographs exist of the Caribbean monk seal, although local fishermen periodically claim to have seen the missing animal. It closely resembles the Hawaiian monk seal, left.
The first authenticated sighting of a Caribbean monk seal occurred in 1952 on Terranilla Bank in the western Caribbean, and the scientific world has all but conceded the animal's extinction. Ask most any resident within the monk seal's former range — south from the Bahamas and northern Gulf of Mexico far as Honduras, cast from the Caribbean shores of Mexico and Central America to Jamaica, Cuba, and Haiti — whether he has ever seen a seal. His answer will almost certainly be no; probably he will softly assure you, as if speaking to a foolish child, that seals are creatures of colder seas and currents and have never lived in these tepid waters.

Nevertheless, since 1900 the Caribbean monk seal has been seen at various locations — the Tortuga Islands, Key West, the Texas coast, the waters off Kingston, Jamaica, and at Isla Mujeres off the Yucatan Peninsula. Many of these sightings, including several within the past two decades, remain unconfirmed because a trained scientific observer was not present; other reports are tenuous or may have been sightings of her sea mammals in the same waters — the manatee, Trichechus manatus, which appears regularly, or the occasional California sea lion that has escaped captivity. Yet, persistent seal sightings in recent years — infrequent and vague as they are — by fishermen from Yucatan and Belize must, like any seen animal's spoor, tantalize even the most fatalistic biologist.

The Caribbean monk seal's life history is almost as mysterious as the question of its current existence. Beyond its incredible lethargy and fearlessness on land, and some evidence that single black-and-white pups probably have been born in parts of the Caribbean in early December, we know almost nothing of its habits. We do possess some reserved skin and skeleton specimens, which have provided anatomical descriptions of monk seal characteristics; for example, an unusual skull shape, four rather than two mammary teats, and structural modifications of the flippers. But specimens did not reach European museums until the mid-nineteenth century when the monk seal population already was depleted.

Some scientists, in their zeal to learn more about the animal, probably contributed to its decline. In December 1886, a joint Mexican-American expedition to study monk seals spent three days on the Triangle Islands west of the Yucatan Peninsula. Although the expedition gathered undeniably valuable scientific data, it killed at least forty seals — and preserved only a fraction of them — at a time when the Triangles were perhaps one of the last breeding grounds of the Caribbean monk seal. Around the turn of the century, collecting for zoos and aquariums resulted in seal deaths in the field and in captivity.

We do know that there are three geographically distinct species of monk seals classified within the genus Monachus. By this century, all three species had shrunk to perilously low numbers, although only the Caribbean monk seal seems to have slipped from scientific view. Its widely separated relatives, the Mediterranean monk seal, M. monachus, of the Black Sea, the Mediterranean, and adjacent areas, and the Hawaiian monk seal, M. schauinslandi, from waters around Hawaii and Laysan, definitely survive, and may number from 1,000 to 5,000 and from 500 to 1,000, respectively.

Monk seals are peculiar among the Pinnipedia (an order of aquatic carnivores that includes seals, sea lions, and walruses) in their year-round preference for tropical seas. In this habitat,
their conventional pinniped adaptations to cold water, such as insulating coats of blubber and high metabolic rate, would seem a hindrance. We do not know exactly how monk seals reconcile their body plan with their fondness for warm waters; we can only assume that they have evolved physiological and behavioral strategies to avoid overheating.

Judging by similarities in teeth and skeleton, monk seals are most closely related to seals of the Southern Hemisphere — the Weddell, crabeater, leopard, and Ross seals of the Antarctic. Monk seals probably emerged from a parent stock in the Mediterranean, from whence some may have drifted astride the Canary and North Equatorial currents to seed the West Indies with their kind. A few may have penetrated the narrow Isthmus of Panama and eventually crossed the Pacific to the Hawaiian Islands. Reproductively isolated from each other by oceans, these three monk seal populations gradually underwent sufficient independent evolutionary change to warrant their current classification as separate species.

Although Caribbean monk seals must have been hunted previously, they were apparently numerous when the first Europeans arrived. However, from the seventeenth until the late nineteenth century, the seals were relentlessly exploited for the commercially valuable oil produced from their fat. In the early 1700s, a local Bahamian historian indicated the proportions of the rich seal fishery and its potential for destroying its resource: "The Bahamas are filled with seals; sometimes fishers will catch one hundred in a night. They try or melt them and bring off their oil for lamps to these Islands."

Vulnerable on land, like other seals, monk seals suffered a further disadvantage: since seal-hungry predators had not been a part of their tropical environment, the monk seals failed to evolve the innate suspiciousness characteristic of many seals. Disarmed by their own calm dispositions, the sluggish monk seals succumbed when introduced to a new force of natural selection — club-wielding men. And local fishermen have sniffed relentlessly at seals, regarding them as competitors for fish, as well as sources of income from blubber, hides, and meat.

Besides these pressures, recent evidence indicates that the ultimate factor in the decline of Caribbean monk seal populations may simply be too many people: seals have been losing their habitat to an expanding human community. In 1973, wildlife biologist Karl W. Kenyon carried out, under the auspices of the Office of Rare and Endangered Species and the U.S. Fish and Wildlife Service, a 4,000-mile aerial search for the Caribbean monk seal Kenyon reported:

At every island group visited, we found either fishing vessels or shrimp trawlers at anchor, or fishermen and their sacks on shore, or the remains of abandoned fishermen's camps. We looked without success for any indication of the existence of monk seals... my conclusion from the 1973 survey is that the Caribbean monk seal has been extinct from the early 1950s... Even had a few old Caribbean monk seals survived to the 1970s, all available evidence leads me to believe that there is no hope that the species can recover. Man has now dominated its environment.

While the survey is necessarily inconclusive, its failure to locate any remnant monk seal colonies in the most promising parts of its former range must dampen hopes for the Caribbean monk seal's survival. But reliable sightings within the last thirty years, plus other, unconfirmed reports by fishermen, encourage a continued search. During March 1976, I spent two weeks in Honduras, Belize, and Mexico, and ran across several intriguing accounts, along with numerous negative reports, of seal sightings in Caribbean waters. Traveling overland from one coastal fishing town to the next, I questioned local fishermen on the wharfs and in the markets. Many seemed unable to distinguish between manatees, otters, and seals; most, upon studying an illustration I carried, quickly denied the monk seal's existence in the Caribbean. One Belizean conch fisherman insisted that neither he nor his 86-year-old father, in their lifetimes of fishing, had ever seen or heard of seals; my reports to the contrary, he said, were simply lies.

But erratic as they are, reports to the contrary do turn up. A young fisherman from Belize City talked of seeing several very young seals, each weighing about forty pounds, swimming near offshore reefs between Punta Gorda in southern Belize and Livingston, Guatemala. Even there, he admitted, the seals were a very rare sight, visible only at dusk or dawn.

Another fisherman, a middle-aged man from Stann Creek, Belize, spoke confidently of seal sightings some twenty years before on the beaches of the uninhabited Mexican atoll, Chinchorro Reef, east of Yucatan Peninsula. Here, he said, the seals had often proved a nuisance by becoming entangled in turtle nets.

In Chetumal, Mexico, an elderly and obviously poor fisherman mentioned still other seal sightings at Chinchorro Reef, where he claimed to have seen the animals dive from rocks on which they were basking and disappear into underwater caves. Prodding the old man for further details, I patiently explained the seal's plight. Alert to the seal's rarity, the man leaned forward and asked earnestly, "Could a man sell the meat of such a seal for much money?" I was sharply reminded that concern for the welfare of endangered beasts is a luxury to people with empty bellies.

At the very least, these and similar unauthenticated reports of monk seal sightings underline the difficulty of finally establishing a species' extinction. Local fishermen log far more time in the monk seal's waters than most expeditions can afford, and hence their reports could conceivably constitute a sort of grass-roots monitoring system of a remnant breeding colony. In fact, anyone within the Caribbean monk seal's range who spots a nearly uniform brown seal, without apparent external scars, tinged with gray and fading to pale yellow or yellow-white ventrally, measuring six to nine feet from nose to tail, and weighing perhaps 550 pounds should photograph and report it to local and international conservation authorities. (The Marine Mammal and Endangered Species Division, National Marine Fisheries Service, Washington, D. C. 20235, has legal jurisdiction over the Caribbean monk seal.)

The case of another supposedly extinct seal, the Juan Fernández fur seal, Arctocephalus philippii, of South...
America, may serve as an inspiration in the search for the Caribbean monk seal. Once common on a cluster of islands some 400 miles off the coast of Chile, the Juan Fernández fur seal also suffered terrible commercial exploitation, beginning in the eighteenth century. By 1900, the species had been all but eliminated from its island range.

While scientists were lamenting the fur seal's disappearance, Chilean fishermen of the Juan Fernández Islands continued to encounter them from time to time in remote fishing grounds. Not until 1958, when a series of documented fur seal sightings began, did the scientific community begin to accept the "rediscovery" of the Juan Fernández fur seal. Reduced to several hundred, and inclined to retreat to isolated sea caves when disturbed, the seals had for a time been lost to scientists, but to sharp-eyed resident fishermen, the animals had never completely vanished.

However, the monk seal's critical vulnerability to human disturbance and harassment, especially during the breeding season — and the amount of human activity in the Caribbean — weaken the animal's chances of survival. Monk seals, it appears, simply will not breed successfully in the face of continual human disturbance, which poses a serious problem in their management. The case of the missing Caribbean monk seal may be another instance of international concern arriving too late. Had recent proposals for a monk seal breeding sanctuary been put forward and acted upon early in this century, a more optimistic prognosis for the species might be possible.

Although its memory lingers fresh and close, the Caribbean monk seal will probably remain a stranger. And at times, I find myself wondering what dark and fleeting image of species-end might have passed — barely sensed like a frigate bird's shadow — before the eyes of a monk seal as it lay, not long ago, on the sands of some remote Caribbean key.

Hawaiian monk seals bask in South Pacific sunlight. On land, all seals are easy prey, but Caribbean monk seals, in particular, were decimated because they failed to recognize humans as predators. Another threat to their survival is that monk seals simply will not breed if disturbed by people. In the well-traveled Caribbean, remote retreats are now very few.
Skin Batteries and Limb Regeneration

by Richard B. Borgens

bioelectricity is the key to growing a new foot

Losing a limb would be disastrous for most animals. But a large number of species—worms, fish, lizards, and cockroaches, to name but a few—are able to replace certain parts of their bodies if they are lost. Some animals have even evolved the regeneration of a lost appendage as a defense mechanism. The tails of some lizards, for example, have built-in breaking points; when seized by a predator, the lizard’s tail separates from its body. The predator is left with a small meal, while the lizard is usually able to scamper off and eventually regrow what the predator has eaten.

For several years, I have studied the remarkable regenerative abilities of newts and other salamanders. When certain species of salamanders lose a limb, they grow a replacement that will be a nearly perfect copy of the original. This capability, common to most tailed amphibians, has been a puzzle to scientists because there are no obvious differences between the tissues of these animals and those of vertebrates that are able to regenerate lost body parts. On histological level, the same types of structural and functional tissues make up the limbs of salamanders and those of humans. Yet, the regenerative power of newts and salamanders is virtually limitless. For example, a surgically removed salamander’s retina will regenerate and perfect vision will be restored to the animal.

Much has been learned about the regeneration process since the first modern description in 1769 by Lazzaro Spallanzani, an Italian naturalist who worked with newts, salamanders, and other animals. The changes that take place after the amputation of a salamander’s limb serve to characterize the sequence of events during regeneration. After amputation, the tip of the stump quickly becomes covered with a thin, transparent wound epithelium, which seals off the lesion from the external environment. Internally, the damaged tissues of the appendage are cytolyzed and removed by the body’s natural “cleanup” mechanism, and the remaining healthy cells begin a process called dedifferentiation. This means that many of the subepidermal tissues of the stump tip begin to lose the morphological characteristics that distinguish them from each other. Cartilage, bone, and muscle tissues regress to a cell type resembling the embryonic mesenchyme (unspecialized mesodermal connective tissue) from which all were derived. The resultant homogeneous mass of mesenchymatous cells, with its epithelial covering, is called a blastema.

The blastema, after reaching a certain size, then redifferentiates. It reorganizes and develops back into a replica of the severed portion of the limb. The length of time needed for this body repair is variable, depending on the season of the year, and the age and particular species of salamander. In general, a fine forelimb, with only minor differentiation still in progress, is produced in two to four months.

Experimental limb amputations in salamanders and adult grass frogs, a related but nonregenerating species, have provided clues to the factors controlling the power of regeneration. A classic example is the pioneering work of biologist-anatomist Marcus Singer, who deciphered the relationship between nerve supply to the limbs of salamanders and grass frogs and their ability to regenerate. Singer has shown that a critical relationship must exist between the cross-sectional surface area of nerve tissue at the stump tip and the total area of the amputation surface. In salamanders, if enough nerves leading to the stump are cut away so that this ratio is lowered to a certain point, the limb will not regenerate. Adult grass frogs, like other nonregenerating vertebrates, are naturally deficient in this axoplasmic ratio. However, if an extra large nerve, such as the sciatic nerve of the leg, is surgically rerouted to the stump of a grass frog’s amputated limb, the appendage will begin to regenerate. (The limb does not regrow fully, however, and what does regenerate is deficient in internal structure and organization and atypical in outward appearance.)

Other experimental methods have been successful in promoting regeneration in grass frogs, namely, immersion of an amputated stump in aqueous solutions of sodium chloride (table salt).
One of the most provocative recent experiments dealing with the induction of regeneration in frogs was performed by Stephen D. Smith of the University of Kentucky Medical School. Smith implanted (for experimental convenience) small electrical stimulation units, made from hearing-aid batteries, into the backs of adult frogs (Rana pipiens). With an insulated wire, he directed minuscule levels of current (100 billionths of an ampere) to the amputated forearm stumps of the frogs. In four weeks, the batteries were removed and the forearms began to regenerate.

This experiment caught the attention of Lionel Jaffe, a scientist whose major research has demonstrated how naturally produced electricity helps shape the development and modify the growth of a variety of plant and animal cells. Primarily an embryologist, Jaffe has proved that certain types of cells act like miniature batteries, giving electrical currents through themselves and setting up a natural, stable electrical field. (This is not to be confused with nerve activity, which produces a rapid, transient electrical event, or with the membrane potential of all living cells, which is, in an electrical sense, more similar to a capacitor than a battery.) His laboratory at Purdue University developed a remarkable tool, the vibrating probe, to measure these tiny, naturally produced electrical fields. Jaffe, developmental biologist Joseph Vanable, Jr., and I felt that the startling results of this current employed on frogs provided evidence for a direct connection between self-produced electricity and regeneration.

The first step was to demonstrate that the regeneration promoted in adult frogs was, in fact, caused by electricity. All the methods that had been used to stimulate tissues electrically relied on metal wires. Whether the regeneration effect was due to the electricity or to electrode byproducts was unclear. The effect might have been caused by chemicals that form when electricity passes through metal into a conductive solution such as body fluids.

To answer this question, we developed a nonmetallic, fluid-filled stimulating electrode that would be free from byproduct contaminants. Current was carried by this "aqueous wire" to the surface of amputated grass frog limbs through a salt solution, similar to body fluids, insulated by a jacket of biologically inert silicone polymer.

Having eliminated the chance of electrode byproduct contamination, we achieved results comparable to Smith's: organized extension of the forearm bone, abundant new muscle, large quantities of new nerve tissue, and development of cartilage masses resembling the bones of the wrist and hand. In all cases where the stimulating electrode (lead) was negative, regeneration was initiated. (Interestingly, if the positive lead was used, the opposite effect occurred—severe tissue destruction of the forelimb.)

Two years of experimentation did not, however, support a report, widely circulated in the popular press, of "perfect" limb replacement in adult frogs by electrical means. Although perfection was not reached, the frogs certainly produced more than if left to their own devices. This, plus the amazing low-curent employed, made us look more closely at salamanders. Could self-generated electrical currents account for their ability to regenerate lost body parts?

The notion that electricity plays a role in the normal replacement of salamander limbs dates back to 1905, when biologist Oren E. Frazee unsuccessfully attempted to influence regeneration with imposed electric fields. Actual electrical measurements were attempted in 1940 by biologist Albert Monroy in Naples. He measured voltage differences along the surface of limb stumps, from the shoulder to the tip. These translimb differences in electrical potential (since noticed by other investigators) yielded no information about the actual flow of current but provided provocative indications that natural electrical currents existed. To settle the issue of current flow, the vibrating probe was used. The flow of current was measured around the regenerating forelimbs of red-spotted newts. In a biological sense, the current densities were enormous, often reaching 100 microamperes per square centimeter. The path of the current arose from the end of the stump and reentered the animal's body and the shank of its forelimb. These currents persisted for the first two weeks after amputation and seemed to mark the location of the budding blastema.

The measurements of current flow raised a number of exciting questions. Yet one thing was certain: from inception, the normal regeneration of appendages in salamanders is a highly electrically active event.

Three major questions arose: What is the source of the animal's electricity? How necessary for regeneration are the naturally produced electrical fields? If the fields are required, what tissues do they affect? Further experiments with the salamanders helped us answer two of these questions.

The source of electricity was the simplest question to approach experimentally. Nerves are certainly electrically active and might be the source of the current we had measured. Any ver
limate limb can be rendered nerveless by clipping its spinal nerve supply. Monroy's voltage measurements demonstrated that nerves could not be the source of the electrical regeneration currents since the presence or absence of the majority of nerves in the arm did not affect his readings. Although a later investigator insisted that nerves were the source of the voltage differences, vibrating probe measurements confirmed Monroy's findings: no change in electrical activity was noted after nerve transection.

Amphibians possess another electrically active tissue, the skin, that operates like a battery. The skin of most amphibians possesses a sodium-specific transport system, which moves sodium from the water on the skin's surface into the body. In effect, the transport system acts as a complicated, sodium-dependent "pump" that drives strong electric currents.

The "skin battery's" sodium dependence provided us with a test of whether the skin is the source of the regeneration currents. Using red-tailed newts, we deprived their skin of sodium (either through the use of chemicals that block the sodium channels or simply placing the animal in sodium-free water), and so were able to turn off their skin batteries.

By increasing sodium well above the normal levels found in pond water, we were able to increase the magnitude of the currents. With these inhibition and modulation techniques, we have been able to prove that the skin surrounding the remainder of the amputated appendage, and perhaps some of the body, is the source of this electrical activity.

The same approach was used to test the necessity of these currents for regeneration. The experiments are still in progress, but one thing is clear—limb regeneration can be severely disrupted by techniques that shut off the skin battery current and its associated field.

In one such experiment, the diuretic

Frogs lose the ability to regenerate body parts during metamorphosis from the tadpole stage. Regeneration can be induced experimentally, however, through the use of electricity, salt baths, and rerouting of nerves.

Dan Budnik, Woodlin Camp & Associates
brisk amiloride was applied only to the tip of skin surrounding the forelimb amputations of tiger salamanders. Amiloride applied this way specifically blocks the sodium channels of the outer layers of skin, thereby turning off the skin battery. Fifty percent of the animals so treated were inhibited from regenerating or regenerating grotesque facsimiles of a forearm and hand. Preliminary evidence also shows that most animals either inhibited from regenerating do not regenerate normally, if kept in low-sodium medium, while those in a high-sodium medium regenerate extraordinarily fast. We can now begin to take sense of how immersions in salt solutions are able to initiate regeneration in grass frogs: the electrical output of their skin batteries was stimulated increased by the presence of more salt than is found in the pond water inhabited by the frogs.

We know that the natural replacement of body parts in salamanders is exceeded by a period of high electrical activity, during which a naturally produced electric field is set up around the limb stump. We also have some evidence that such a field is necessary for normal regeneration in these animals and that artificially stimulating the stump of nonregenerating adult frogs will partially restore their regenerative abilities.

We do not know what the cellular target(s) of this current might be, but we have some guesses. Ironically, although nerve tissue is not a source, it may prove to be the target of the current. Studies of embryonic chicken neurepithelium have shown that the direction of growth of new nerve processes can be controlled by weak electric fields, perhaps nerves (which are also essential for regeneration) are directed by these natural fields into the region here they influence blastema formation.

Another unanswered question concerns the electrical behavior of the limb stump in frogs. Adult frog skin also acts as a sodium-dependent battery, yet these animals do not regenerate. (The vibrating probe is now being modified to permit measurements on these animals.) Preliminary work suggests that the current exiting from the stump of adult frogs is one-tenth the magnitude of that in salamanders—possibly frogs are "shorted out" internally. This may well prove to be true: beneath a frog's skin are large lymph pockets that do not exist in salamanders. The lymph may short circuit the flow of electricity around, and not through, the internal tissues of the stump.

Human beings, like all vertebrates, are not complete nonregenerators. Skin, bone, and parts of other organs and tissues of our bodies replace themselves as a normal part of the life process. Yet the ability to form functional tissue, instead of nonfunctional scar tissue, or to replace missing portions of the body is greatly restricted in all vertebrates except the tail amphibians.

To discover some of the critical factors separating the two groups would have the most profound medical consequences. Bioelectricity certainly seems to be one factor.

At present, some success is being achieved in healing chronic nonunions of human bone fractures by stimulating the fracture sites with low levels of current. Electricity has also been used to aid the healing of bed sores. Replacement of articular cartilage through electrical stimulation has been accomplished in rabbits, and the technique may soon find practical applications in hospitals.

There is a parallel between humans and nonregenerating amphibians that also demands close scrutiny. Although adult frogs do not regenerate portions of their appendages, tadpoles do. They lose this ability during metamorphosis. Adult humans, of course, do not replace portions of their extremities, yet it is not well known that children do!

Pediatricians Cynthia Illingworth of England and B.S. Douglas of Australia have demonstrated that children (up to eleven years of age) can perfectly regenerate the tips of their fingers from past the first joint. The cosmetic results are remarkable, including well-formed fingernails. This extraordinary result was achieved without any experimental intervention. The fingers were simply splinted and bandaged, without surgical tampering, and nature did the rest.

Nothing is known about whether electricity plays a role in the finger regeneration of children. Interestingly enough, before the American Civil War, physiologist E. Du Bois-Reymond discovered that natural currents emanate from wounds of human skin. In light of our data, the existence of these currents suggests that they may aid in wound healing and, conceivably, finger regeneration.

Humans apparently also lose their regenerative ability as they mature. Could bioelectricity be involved in regaining this ability, as it certainly is in frogs?

We may well hope that biological research in amphibian regeneration will someday deliver tools to modern medicine for making tissue-regeneration therapy a normal part of hospital procedure. This may sound more like science fiction than science fact, yet it is certainly possible that latent in human beings is the promise of whole-tissue regeneration so elegantly realized in the tailed amphibians.
Three, Two, One Tortoise

Peter C.H. Pritchard

On a clear tropical evening in early 1972, my wife, Sibille, and I were enjoying dinner with Dr. Joseph Vaghy, a Hungarian-American authority on land snails, in his tiny cottage on Santa Cruz Island in the Galápagos. As often happens when botanists convene socially in the Galápagos, the conversation drifted onto the subject of giant tortoises, and since I was the turtle specialist and Joseph was the malacologist, I was doing most of the talking.

"The tortoises with normal, dome-shaped shells live on the lush higher islands where they are never short of food," I explained. "But on the small, lower, dry islands, the tortoises have evolved long legs and raised shell front—the famous 'saddle-backed'—so they can reach higher for food, since the ground vel vegetation is not enough to sustain them. The one exception to this appears to be the tortoise of Pinta Island, which is an extremely saddle-backed shell at which lives on a relatively high land with lush vegetation in the interior."

Joseph interrupted quietly at this point. "But the tortoise we saw on Pinta last month did not have a particularly saddle-backed shell." My jaw dropped. Not because of the shape of the tortoise—that was irrelevant for the moment—but because the Pinta tortoise, Geochelone elephantopus abingdoni, had not been seen alive for fifty years.

I questioned Joseph closely. Yes, he had taken photographs of the tortoise, which he had encountered on December 1 in the upper part of the arid zone on the southern slopes of the island. The tortoise had not impressed him as being particularly large or strikingly saddle-backed. He promised to send me photos when he returned to the United States a few months later.

I found it a little hard to concentrate on social pleasantries the rest of the evening. The Pinta tortoise was not just one of about fifteen subspecies of giant tortoise in the Galápagos Islands; to me, it was the focus of a boyhood dream. Thirteen years earlier, when I was a turtle-obsessed teenager in, of all places, Northern Ireland, my parents had given me for my birthday a copy of Albert Gunther’s classic monograph Gigantic Land Tortoises, published by the British Museum in 1877. This ponderous Victorian work was liberally illustrated with enormously detailed engravings of various giant tortoises and their bones. But the one that caught my attention showed a peculiar beast whose shell looked more like a wrinkled, leathery mantle than a true carapace, and whose long, stout neck, raised straight up, carried a tiny head with expressionless eyes.

The text indicated that the drawings were based on three tortoises collected on then named Abingdon Island by one Capt. James Cookson and presented to the British Museum in June 1876. Cookson had tried to bring them back alive, but had not succeeded; he concluded that their extraordinarily thin shells rendered them especially liable to blows, falls, and other rough treatment, and they were therefore unable to survive the rigors of a sea voyage. Gunther agreed with this opinion. But since the tortoises had been collected on the island so recently a population obviously still existed there.

But that was in 1877—82 years before Gunther’s book fell into my hands. Galápagos tortoises in general were known to be suffering from the depredations of humans and introduced pigs, dogs, and competing herbivorous animals (notably goats), but the Galápagos were highly inaccessible before the 1960s, and the few scientists who went there had more than enough to hold their attention in the central islands without spending the time and money to visit remote Pinta.

I resolved that some day I would lead an expedition to try and find any survivors of this prehistoric-looking creature. During my Oxford years, this dream was kept alive by a signpost indicating the mileage to the nearby town of Abingdon. That ancient but prosaic English city had no special interest to me; but the signpost regularly reminded me of its faraway namesake in the tropical Pacific.

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The last known Pinta Island tortoise makes final tracks on his native island shortly before he was deported to the Charles Darwin Research Station for safety reasons.

in 1684, when the buccaneer William Ambrose Cowley published a chart of the “Galápagos Islands.” It was shown as the “Earl of Abingdon’s Island,” and was considerably exaggerated in size, nearly the same size as the Duke of Norfolk’s Island (now known as Santa Cruz, which is, in fact, several times larger than Pinta). Details included a South Bay and an East Bay, as well as the Norias Rocks, off the northern tip, and Rycot Rock to the west.

The fact that a pirate such as Ambrose Cowley should have named many of the Galápagos Islands after the establishment figures and royalty of England is worth a little explanation. At the time, England was not actually at war with Spain, and it was theoretically British policy to cooperate with Spain in suppressing the buccaneers. Nevertheless, the raids Cowley and the other buccaneers the time were directed against Spanish ships, and it was thought that the royal decrees against piracy, halved heartedly issued in the first place, were virtually ignored by the English.

New World administrators in Bermuda, Nassau, and Jamaica. Cowley showed his appreciation for this tol...
attitude by naming the islands after his friends in high places. It was not until many years later that the Guadoreans renamed Abingdon, Isla Pinta.

From the time of the discovery of Pinta Island, buccaneers and other visitors undoubtedly collected tortoises there. The first extant record of such collecting, however, is for January 22, when Capt. Basil Hall visited the island. He wrote in his 1840 publication, *Extracts of a Journal Written on the Coasts of Chili, Peru, and Mexico*, in the Years 1820, 1821, and 1822: "We took some [tortoises] board which lived for many months, but none of them survived the cold weather off Cape Horn. I preserved one in a cask of spirits, and it may now be seen in the Museum of the College at Edinburgh; it is about the medium size."

The real depredations of the Pinta tortoise population took place during the mid-nineteenth century, when sealing ships based in Massachusetts were in the habit of stocking up with Islapagos tortoises, thereby insuring a supply of fresh meat while at sea. The tortoises of the smaller islands were favored for such operations because they were more accessible and cause they tended to be smaller, and thus, more manageable; the huge tortoises of Santa Cruz and Isabela islands were not heavily exploited until permanent settlements were established on those islands.

In the 1920s zoologist Charles Townsend undertook a detailed analysis of the logbooks of the American sealing fleet, and while each island had been raided many more times than indicated in the records it came to Townsend's attention, research nevertheless gives an idea of the intensity of tortoises exploitation and also the point in history which their populations collapsed. For example, a single ship, the Abigail, collected 142 tortoises on a visit to Pinta in 1837, and sixty-seven were collected by the Hector in 1843. Thirteen were known to have been collected by two ships in 1848, but early this was the last of the big hauls as no subsequent ship's crew was able to locate more than six individuals.

When Captain Cookson visited the land in 1875, he found only four tortoises after an extensive search. He notes: "Tortoises were never, I believe, very abundant on Abingdon Island; our searching party found four..."

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on the island. They were on the high ground; and it was a work of great labour getting them down to the boats. The distance was about twelve miles; but the ground was exceedingly rugged, and covered with thick brush, through which a trail had to be cut for the entire distance. The large tortoises found on this island weighed 20 pounds, and the smallest 15 pounds.”

Thirty years later the tortoises were, if anything, rarer still. Rolf Beck, perhaps the most energetic of the Galápagos explorers and tortoise collectors who ever lived, wrote in 1901:

So far as is known, Testudo abingdoni, the Abingdon Island, is practically extinct.

We secured two specimens in 1901, but on another trip, after thoroughly hunting over the ground where tortoises were formerly common, only a single fresh track was discovered, where a lone tortoise had passed a few months before. The part of the island where this species lives is fairly easy to travel over, and therefore it was not a difficult matter for the hunters with their dogs to make a clean sweep. While these tortoises are about forty square miles of surface area, not over seven or eight are suitable for tortoises, and for some of the other species the proportion of suitable ground is still less.

Beck had an exaggerated idea of the total area of Pinta Island (twenty-two square miles) but he was right in concluding that only a small part of it was suitable for tortoises. Zoologist-explorer Edmund Heller wrote of the Pinta tortoise in 1901:

Probably now nearly extinct. None set by us in June 1899, on the northwestern slope of Abingdon. The northern and northwestern slopes of the island were explored by us from sea level to summit of highest peak without finding even a trace of the present or past existence of Testudo. What tortoises now remain on the island are probably confined to the moister and greener southern slopes where both the Albatross and Petrel secured their specimens.

The last record of live tortoises on Pinta—until Joseph Vagvolgyi found the single survivor in 1972—was in 1906. The California Academy of Sciences expedition aboard the schooner Academy, spent a full year in the archipelago and several days in September 1906 were spent on Pinta. Three tortoises were found. The field notes taken by J. R. Slevin include the following entry for September 21:

Went in after the tortoise which Beck found September 19. It was about a mile or two above the green zone on the southern slope of the mountain. Up there it

...Nikon Binoculars
nually raining or foggy throughout morning, but clears off in the afternoon. It is capital tortoise country, every-thing being green, with plenty of water and cactus. The three tortoises taken were fat, and showed the effects of good feeding. We saw no other signs, and they probably are very rare on Abingdon Island.

The stomach of the one collected contained grass and cactus. Beck found an old shell and a few bones where the tortoise probably had lain and died. We carried these two, and they are in fairly good condi-

The Cookson specimens, three tortoises collected were all males (all were killed for scientific specimens). In fact, there was no one female tortoise from this island to be found in any museum collection. This was a young individual noted by Rollo Beck in 1901 and listed in the collection of Walter Tschida, a celebrated and wealthy collector of giant tortoises, at Tring, Hertfordshire. The Academy party noted 1957, 1959, and 1963, while the tortoises collected appeared to be fat and in good condition, they were very rare, and no females were found of any individuals other than the three collected.

Somehow a minuscule population of tortoises lingered on Pinta through the end of the twentieth century. The apparent failure of the population to increase undoubtedly served from the virtually complete extermination of females by whalers. Males preferred the smaller females because they were easier to carry; also, females were probably easier to find because more of them would be at lower elevations, at least during the nesting season. On the other hand, giant tortoises live a great part of time—probably more than a century—and since the habitat has been essentially undisturbed since 1958 or 1959, the Pinta Island population did not die out completely for half a century after the California Academy expedition, Pinta returned unvisited by scientific parties was probably little visited by any other. In 1957 a joint Galápagos expedition by UNESCO and Life magazine was undertaken. Biologists Rob-son and Irenius Eibl-Eibesfeldt climbed part of the way up the island. They did not find tortoises, but were not ashpore for very long. What optimistically, the two men reasoned that since the island is seldom visited by man and was only free of introduced animals, tortoises must still be present and...
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might well recover. They even found what looked like an old tortoise trail.
A recovery of the tortoise population on Pinta Island might have taken place, but a year or two later, disaster struck. A Galápagos settler from the island of San Cristóbal introduced three goats to Pinta, hoping to establish a population of these animals that would provide fishermen such as himself with red meat when fishing in the vicinity of the island. The introduction succeeded beyond his wildest dreams. In March 1963 biologists E. Curio and Peter Kramer camped for three weeks on Pinta and found the goats to be locally numerous. In May 1964 Miguel Castro, a native of the Galápagos who had for years studied the tortoise populations on a number of islands, and biologist David Cavagnaro came on Pinta for nine days searching for tortoises. They found that the goats had already adversely affected the vegetation of the lower areas on the south side of the island where the tortoises were supposed to live—indeed it is about the only suitable area for tortoises, much of Pinta being relatively fresh, unvegetated lava.

Castro and Cavagnaro found no living specimens, but chance to look into a deep fissure in the ground shortly before they left the island they found the remains of a dead tortoise. They spent the next two days looking in similar fissures and found skeletons of twenty-seven more tortoises. Undoubtedly, the goats, by feeding on all the low-growing vegetation in the lowlands, had forced the tortoises to climb higher in search of food; at the higher altitudes, where the treacherous fissures were obscured by thick grass, the tortoise, had tumbled in one by one and died.

It was 1971 before the Ecuadorian Park Service, which oversees operations of Galápagos National Park, was sufficiently organized and funded to embark on a program to eliminate the goats from Pinta. By then the goats had reached plague proportions. Although the tortoises appeared to be extinct, the extermination campaign was still necessary because the island harbored numerous endemic plant species that were also severely affected by the goats. In the course of repeated visits to Pinta in 1971, 1972, and 1973, 33,052 goats were killed and left to rot. The program has continued ever since, but as of June 1975 there were still an estimated 10,000 to 15,000
After Vagvolgyi's dramatic revelations, I realized that the time had come to look for a Pinta tortoise myself, even though I was in the Galápagos, not to look for tortoises, to investigate sea turtles. Time in the islands was precious, and I could not drop everything for a tortoise hunt. Nevertheless, it was important to me to visit shorelines of as many islands as possible, including Pinta, to search for sea turtle nesting areas. Pinta is rarely visited by scientists today because the journey is an expensive, two-day boat charter from Darwin Station base on Santa Cruz Island, so when I learned that party led by Ole Hamann, a Danish ornithologist, was leaving in two weeks to spend five days on the island, I quickly arranged to share his charter.

Galápagos navigators eschew equipment more sophisticated than a compass because it cannot be spared in the islands; they usually navigate by the simple technique of pointing the boat in approximately the same direction and hoping that an island will come into sight before the current has gone past. But as we slowly chugged north, with dolphins cavorting in our bow wave, the day remained clear, and we saw the long, low profile of the Marchena Island to the right, and Pinta straight ahead, before Inés Island vanished behind us.

A party of park wardens had been at work shooting goats on Pinta before we arrived; they were going back to Santa Cruz in our boat the next morning. Ole Hamann was able to contact them by radio. After a long conversation, during which I admired his fluent Spanish with a strong Scandinavian lilt, he came over to me, his face beaming. "They have found a tortoise—a large mate!" he announced. The fulfillment of my dream, to see a live tortoise on Pinta Island, was imminent; it was marginally clouded because it had been found by someone else, but this egotistical worry faded since this large individual clearly could not be the Vagvolgyi found. Thus there was hope that a potential breeding stock existed.

For the remaining hours, I paced the boat as we drew closer to Pinta. The island showed a broad, evenly sloping profile, with a central peak, a}

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A tortoise, Addri, Terminalia Xanthopsis, eventually crumbled to dust. A little farther down the slope, we found tortoise bones—first the skull, neck bones, and carapace fragments of what had most likely been a large male tortoise; then the intact bony carapace of another individual that presumably was a mature female, judging by its small size and fully closed shell sutures. These shells must have been only a few years old. The shell of the female owed machete marks across the ridges where the belly shell had been moved; she had been killed by a poacher. The utter senselessness of it almost reduced me to tears. We were iness to the final extinction of a magnificent and wonderful form of animal life. Instead of poaching one, we captured more numerous tortoises on a more accessible island like Santa Cruz—or, better still, obtaining his death from one of the goats that gobbled the island's vegetation, we used the single tortoise, had turned it over and hacked apart with his machete.

We carried the shell down the mountain and brought it back to the Darwin Station. This specimen, in better condition than the single shell from Pinta that the station already possessed, was only the second female shell known to exist.

The last faint hope that remained was that Vagvolgyi's "small, not yet saddle-backed" tortoise could still be found. Each time the wardens went back to Pinta, they looked for but found no traces. They concluded that it must have moved out of the area; even if the tortoise itself caped their view, it surely would have left some of the distinctive, star-shaped droppings that abound in tortoise country. But none were to be found.

A year later, the promised copies of Vagvolgyi's photos finally arrived. They were good pictures, but tragic tales: the tortoise was obviously the adult male that had been taken the Darwin Station. Vagvolgyi must have compared its size with that of the huge tortoises of Alcedo or...
Santa Cruz, and its degree of dorsal saddling with the Hood Island tortoises at the Darwin Station; by any standards other than these, it was a large tortoise and strikingly saddlebacked.

There is therefore little question that the Pinta tortoise now resident at the Darwin Research Station is the last of its kind; no further trace of tortoises has since been found by the wardens during their intensive goat-shooting expeditions to Pinta. At first, the tortoise was housed in a large, lava-walled enclosure between a group of Santa Cruz tortoises and the breeding colony of Hood Island tortoises. He was rarely seen, since with only a single tortoise to graze on them, the grasses and shrubs in the enclosure grew densely.

The last Pinta Island tortoise has since been promoted from solitary confinement. The Darwin Station has broken a rigid taboo, one which forbids the placing together of tortoises from different islands, and has placed two female tortoises of unknown (but not Pinta) origin in the enclosure with him. The purpose is to insure that he suffers no sexual dysfunction from inactivity, as is known to occur in some animal species. Ultimately, a mate will probably be selected from a neighboring population; that of Volcan Wolf on the northern end of Isabel Island is geographically the closest to Pinta, and since that subspecies is known for its extreme variability in shell shape, it should be possible to find a reasonable morphological facsimile of a female Pinta tortoise. There is of course no certainty that eggs from such a cross would be fertile (there is still doubt as to whether the various, isolated Galápagos tortoise populations are subspecies or species), and there are other potential problems, such as the possibility that the female tortoise retained sperm from past matings in the wild (female chelonians of some species are able to lay fertile eggs years after male contact), but it is hard to suggest anything better.

Each time I have been to the Galápagos in recent years I have made a point of visiting this animal, but he hides under his shelter most of the time, and lurches back as fast as his skinny legs will carry him when dragged out for photographs. He may survive another year or even another century, but then, inevitably, the curtain will fall on the history of the tortoises of Pinta Island.

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New theories devised by physicists make for interesting speculations about the early universe

Physicists and astronomers assume, as a working hypothesis, that the laws of nature that appear to apply here and now—on the earth in the year 1977—apply throughout the universe, have applied for all times past, and will apply throughout the infinite future. Stated boldly like this, such an assumption appears all but absurd—much too naïve. Indeed, it would be extremely exciting if that assumption could be shown to be wrong; if it were to turn out that new laws of nature do come into effect on the cosmic scale. So far there is no evidence for anything like this.

It should be noted that this idea—that the laws of nature are universal—is relatively recent in the history of science. The ancient Greeks, for example, were persuaded that celestial objects followed entirely different laws from those governing terrestrial ones. Planets, according to the Greeks, moved uniformly in perfect circles as befitted the perfect celestial "essence" of these objects. The word "quintessence" is derived from the idea of a fifth essence, to be sharply distinguished from the four local essences—earth, air, fire, and water. The change in attitude can be traced to Galileo, who discovered—with the then newly invented telescope—that there were spots on the sun and "blemishes" on the moon, indicating that these objects were not essentially different from the local commodities. However, the first scientist, to my knowledge, to present a truly "universal" theory was Newton.

According to Newton, gravitation was supposed to act universally, with the same force, among all objects in the universe. Despite the jokes made about it, I think that this is the real significance of the story (which seems to be true) about Newton and the falling apple. If an apple on a tree falls because of gravitation then one might imagine an incredibly extended tree reaching from the earth to all corners of the heavens, to the moon, the sun, and so on; and if one were Newton, one might speculate that these objects must also be falling under the influence of the earth's gravitational force. The moon would then be "falling" toward the earth, but fortunately, gravity is not the only force acting on it. The gravitational force is counterbalanced by a centrifugal force that keeps the moon up there, so we have nothing to worry about—from that quarter, anyway.

From our present point of view, the force of gravitation is the weakest force that we know about. If we take two protons, for example (a proton being the nucleus of the hydrogen atom), and let them interact with each other, the interaction will be influenced by other forces, all much stronger than the gravitational force. The strongest of these forces is the nuclear force, which at short distances causes the two protons to attract each other. Then there is the electric force, about a hundred times weaker than the nuclear force, which is responsible for chemical interactions and, in this case, repels the two protons mutually. In a large atomic nucleus there is a contest between these two forces, and the stability of many of these nuclei is a consequence of the fact that in this contest strong, attractive force wins. Many atomic nuclei, however, are not stable, and this brings into play yet another force that physicists call weak force. The bulk of my remarks will concern this force and some of the new ideas about it. But first I would like to explain, very briefly, why, at least in our daily lives, a gravitational force although the weakest of all known forces, appears to play the dominant role.

The explanation, fundamental to this book, has to do with the universal character of gravitation. Every mass in the universe attracts every other mass gravitationally. The attractions pile up as one moves from bulk matter. A body such as the earth is nearly electrically neutral—positive and negative charges all cancel each other out so the electric force does not play an important role for example, in determining planetary motions. The nuclear force, on such a short range, it only comes in to play in the tiny atomic nuclei; here the gravitational force wins by default.

As I have mentioned, many—fact, most—atomic nuclei are unstable. They tend to break up spontaneously. Some give off electrons (negatively charged particles), some light quanta (particles of light), some break up into lighter nuclei as the nucleus of the helium atom. These phenomena are known popularly as the radioactivity of nuclei. Each of these disintegrations is interesting to the physicist, but I want to concentrate only on those disintegrations, or decays, in which electron—very the smallest unit of matter that can carry an electrical charge—are produced. These are called beta decays by physicists. The primal beta deca
The decay of the neutron. The neutron is the electrically neutral counterpart of the proton in the atomic nucleus. A free neutron, outside a nucleus, is unstable. It breaks up spontaneously into a proton, an electron, and a curious particle called the neutrino.

The discovery of the neutrino is worth some comment since it illustrates how scientific thinking works. Beta decays were first observed in heavy nuclei, and it was noticed that when the electron emerged from these objects it had varying energies.

From this observation physicists could conclude, by using the laws of conservation of energy and momentum, that another particle also had to be emitted. (The Austrian physicist Wolfgang Pauli made that suggestion in the early 1930s.) But this particle was undetectable in experiments—it could not be found. Nevertheless, physicists insisted it had to be there. The first real theory of beta decay, developed in the early 1930s by Enrico Fermi, included this object as a necessary ingredient. The neutrino interacts so weakly with other matter that it was not until 1953 that the American physicists Clyde L. Cowan, Jr., and Frederick Reines were able to detect it directly in experiments using nuclear reactors (in which an incredible number of neutrons are produced). The neutrino, as far as we know, has no charge and no mass. But it is there.

The Fermi theory of beta decay works very well provided one does not question it too hard. When used to compute very detailed answers, all those answers, unfortunately, turn out to be infinite instead of finite. In that sense the theory is like a pinball machine that functions well, provided

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one doesn't push it too much; when one does, it lights up "tilt." This was the situation in physics until some five years ago when an explosion of new theoretical ideas occurred, which has turned out to have consequences not only for beta decay but for the cosmos at large. I will try to give a flavor of these ideas, but in the interest of economy I will omit the names of the discoverers. (I am reminded of what Isaac Stern is supposed to have replied when asked to name the greatest violinist in the world. He responded that he preferred not to answer the question because "they are all my friends.")

For arcane reasons that will serve no purpose to go into here, the new theories are collectively called gauge theories. There is a class of such theories and they all have one thing in common: they predict the existence of new particles that have not yet been seen in the laboratory. One is not too disturbed by this since it took some twenty years before the neutrino was seen. The new particles are of various kinds. There may be new heavy electrons and new heavy neutrinos, and some preliminary evidence suggests that these objects, at least, are beginning to turn up in experiments done with the most powerful particle accelerators now available to physicists. In addition, the theories predict new mesons. The exact definition of what a meson is has changed over the years; at the moment, the term is used somewhat loosely to describe various sorts of objects. For our purpose it suffices to say that a meson is a particle that is not like an electron or a neutrino or a proton or a neutron. It is also not like a "quark," which, if it exists, would have a family resemblance to a proton or a neutron. In fact, in the modern view, the nucleus of the proton and neutron are thought to be made up of these hypothetical quarks.

Even before the explosion I referred to, physicists believed that such mesons must exist. Beta decay, for example, was seen as a two-step process in which the neutron, say, first decayed into one of these mesons, called the W particle by physicists—"W" standing for weak—and the W particle, in turn, decayed into an electron and a neutrino. These older W particles were electrically charged and very massive. In the new theories they are joined by electrically neutral counter-parts that are thought to be even more massive. The fact that these objects are so massive explains why they have not been seen in accelerator experiments. There is just not enough energy available in the present generation of accelerators to produce them. New accelerators are now on the drawing board and when these are constructed it is hoped that the W particles will be produced and detected.

There is, however, very strong indirect evidence for the existence of these heavy neutral W particles. The neutral W mesons can decay directly into pairs of neutral neutrinos and, conversely, neutrinos can transform into each other by the emission of one of these W mesons. This latter process has been observed at the huge accelerators in Geneva, Switzerland, and at our own National Accelerator Laboratory in Batavia, Illinois. Observation of this process has given physicists a good deal of confidence in the whole scheme. I should also point out that these new theories do not yield bad infinities so that the "tilt" problem appears to have been resolved.

One of the most interesting aspects of the new theories is what they have to say about astronomical and cosmological phenomena. First, a general philosophical observation, which takes me back to my introductory remarks. All of these speculations are based on the premise that our local science is really universal. No one has been to a star, to say nothing of voyaging backward in time to the beginning of the universe. We do these things in our minds and with instruments here on earth, and we marvel at the apparent coherence of the enterprise.

As already noted, one of the crucial features of the new theories is the interaction of neutrinos with neutrons and protons and, hence, with matter in general, by means of a neutral weak meson. According to these theories, these interactions can pick up, much as the gravitational interaction adds up the effects of a vast number of different masses. A bundle of neutrinos coming into contact with heavy matter can produce a pressure on this matter. This, it is conjecture, is an important mechanism for producing stellar supernova explosion. In this case, the heavy matter is the iron nuclei in these stars and the neutrinos are generated in the cooling process that makes the stars radiate...
the first place. Under the right circumstances, these neutrinos can proce
duce enough pressure to blow the
ars apart. Experts still disagree as to
all of this works in detail, but the
ggested role of the neutrinos bears
nting.
Finally, these new theories make
king predictions about the early
iverse. By now, most physicists
nd astronomers agree to assert that
iverse began with a cosmic ex-
bion some 10,000 million to 20-
illion years ago. To review the
idence for this would require a sep-
 essay, but it looks convincing,
est to me. The physics that ex-
ins the universe following the
pse of the first one-hundredth of a
cond after the explosion is treated
fectly well by the old Fermi theory
nd other fairly simple general ideas.
nt during the first one-hundredth of
cond, the temperatures were so
th — several million million de-
ces — and the particles were in such
ose contact with each other that the
uation resembled, in a general
y, what takes place in very high-
ergy collisions among particles
uced in today’s accelerators.
 Springer thing about these collis-
s is that, as the energy gets
er, they appear to be describable
ller and simpler physics. This
 can be explained, it turns out, by a
ature of the gauge theories that goes
nder the fancy name of asymptotic
dom. In this domain, the particles
ave, in some sense, as if they were
ne of each other. Hence, at the
temperatures of the kind mentioned
ove, it is thought that the universe
isted of free quarks and mesons
ht rattled around until the whole soup
oled off sufficiently to enable
mer nuclear particles to form. The
arks then got trapped inside the
icles and some of the intricacy we
erve today was frozen in. The uni-
se, it appears, has gotten more
plex as it has aged.
nt is clear that physics has come a
ng way since Newton watched an
le fall in his garden but it is far
om clear where the voyage is lead-
. There are always surprises. That
one of the few things about this sort
science one can be sure of.

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**PUBLIC OPINION**

Box N-4044 Long Island City,
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Palm Readings

Date-bearing trees arrived at these shores less than a century ago

The most elegant midnight snack on cord is the secret spread that Porphyro prepares for his sleeping beloved, Madeline, in Keats’s archaic poem, *The Eve of St. Agnes*. The mosel has gone to bed hungry, following the ancient custom that virgins fast on St. Agnes Eve will dream their future husband. In this case, the suitor comes by stealth to her bedside in “silver twilight,” like a dream, and sets out a sweet table of exotic cam foods:

... candied apple, quince, and plum, and gourd;
With jellies soother than the creamy curd,
And lucent syrops, tint with cinnamon;
Manna and dates, in argosy transferr’d
From Fez; and spiced dainties, every one
From silken Samarcand to cedar’d Lebanon

Like the stained glass in the windows Madeline’s chamber, Porphyro’s nun shines with rich colors and connotes further to the hallucinatory feel the scene with its luxurious, sweet, and rich oriental fruits and spices. It is a meal never seen before or after. Each item in it does, of course, actually exist in the real world. Even manna occurs, unimhibited, as a sweetish exudate of the European ash, in flake form. And other glace fruits and jellies crop up or less often in our eating experience (although cinnamon-flavored may occur only as an accidental, idish experiment revolving around rye toast). But Porphyro’s menu is truly only a symbol of sweetness, a metaphorical match for the lovely Madeline. And even she doesn’t eat it.

Nowadays, unlike the postfeudal era, with fresh fruit of some kind always available and sugar a commonplace, we have to summon a special imaginative effort to share Porphyro’s delight at so cloying a collection of food. But, taken individually, glacé fruits still strike us as special. And dates, whose sweetness is natural, still seem a bit out of the way, like medieval sweetmeats.

Dates have never been absorbed into the diet of our life. Except a few fully naturalized dates — date-nut bread, date bars, and various date puddings — we only dabble in dates. While certain desert Arabs have been known to subsist almost exclusively on a combination of milk and dates, we have not advanced much beyond Madeline and Porphyro in normalizing our relations with the fruit of *Phoenix dactylifera*.

The first date palms were imported to the United States in tubs on shipboard from Egypt in 1890 and transplanted successfully at Salt River Valley, Arizona. Date palms travel well. It takes only a few years for a tree to grow from seed or sucker to maturity. Eventually, a mature plant may stretch up, nearly straight, a hundred feet, and it may easily produce more than one hundred pounds of the one- to three-inch-long berries with grooved seeds that we call dates. Since palms bear dates for as much as a century, it may still be possible to eat dates grown on the original American trees.

Date history goes much farther back, of course, beyond history itself, to some primordial date grove, probably in the Near East. There, cultivation is relatively simple, since the desert climate provides a temperature of 100°F or more. The only catch is that *P. dactylifera* is dioecious, that is, some trees bear male flowers; others bear females. As a result, hand-pollination is a necessity, according to standard sources, which do not explain why insect pollination apparently does not work with dates. Perhaps bees just don’t like the taste of date pollen. At any rate, date growers must climb to dizzying heights on mature trees and tie the male inflorescence onto female flowers.

After successful pollination, two of the three ovaries on each female flower atrophy, while the third develops into a hard, green fruit, which eventually turns yellow or red and may remain hard or turn soft, depending on the variety. Fruits grow in clusters weighing twenty to forty pounds, which will ripen off the tree like bananas.

Fresh red or yellow dates are reportedly available in this country in Greek and other Levantine specialty markets, but I have never seen any, except in Moroccan souks. If you locate some, they can be boiled and then preserved in a sugar syrup. Along the Persian Gulf and in India, green dates are also boiled and then fried in oil or, it is said, pounded to a paste together with grasshoppers.

Commercial dates in this country are cured and dried. California produces in excess of twenty million tons a year. An additional fifteen to twenty million tons are imported. Connoisseurs assert that the best dates in the world grow in the Hasa district of eastern Arabia, where the waters of hot springs coax the fabled Khalesan variety to ripeness. The Middle East continues to be the leading date-growing area. By one estimate, the Basra district in Iraq has eight million date-bearing palms. Even in ancient times, the same region was so preeminent in date production that the Greeks called the date palm *phoenix*, the Phoenician tree. The date itself was called *daktylos*, which means “finger.”
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2 tsp. cornstarch, 2 tbsp. water


Place wild rice on serving platter, top with duck breasts; cover and keep warm. Blend cornstarch in water until smooth. Add brandy liquid to mixture in skillet. Stir and cook over low heat until thickened. Spoon sauce over duck breasts and wild rice. Serves 4. Superb!

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Chinese desserts, eight-treasure rice (baofan). They are one of the eight treasures hidden in the glutinous rice of its legendary pudding. For more proc- tresses, there is a superbly refined light Brazilian date and peanut pudding (see recipe below). Almost every other nut, from walnuts to pecans, has been combined with dates in a pudding somewhere. But for those who think pudding is too heavy, date milk drinks are a frothy California alternative. Alcoholic date drinks, from mild, mented “wine” to fiery, distilled, wine-flavored arrack, round out the list of alternative date options.

You could, of course, dispense with taking altogether and jump millions, coping raw dates, the natural candy 6 percent sugar as glucose or fructose, except for the semimisht Deglet variety, which contains sucrose) to your mouth, while repeating the words of the prophet Muhammad: “Honour your maternal aunt, the palm, it was created from the clay left over after the creation of Adam (on whom be peace and the blessings of God).”

Brazilian Date Pudding

Based on a recipe of Ottilia Jansen de Andrade’s (Brazilian Cookery)

1 1/2 cups sugar
1/2 cup shelled, unsalted peanuts
1/2 pound pitted dates
6 eggs, separated
1/2 cup milk
1 cup heavy cream, whipped
1 cup strawberries or raspberries

1. Line a 2-quart (8-cup) metal mold with caramelized sugar. (Tinned charlotte molds with little handles are ideal for this.) Put 1 1/2 cups sugar and 3 tablespoons water in the mold. Heat directly over moderate heat until the sugar caramelizes. Plunge the mold for an instant into a pan of cold water and then tilt and rotate the mold so that the sugar flows evenly over the inner wall of the mold. You should be able to coat the entire interior of the mold before the sugar cools to a standstill. Invert the mold and set aside.

2. Preheat oven to 350°. Set a pan of hot water deep enough to come halfway up the mold (when the mold is immersed in it) on the middle level of the oven.

3. Combine remaining 3/4 cup sugar with peanuts, dates, egg yolks, and milk in a blender. Purée. Then transfer to a mixing bowl.

4. Beat the egg whites until stiff but not dry.

5. Lighten the date-peanut mixture by stirring a cup or so of the beaten egg white into it. Then fold in the rest of the egg white.

6. Turn the pudding mixture into the prepared mold. Set the mold into the pan of water in the oven. Bake for 40 to 50 minutes, until a metal skewer will pierce the center of the pudding from top to bottom and come out clean. During baking, inspect the water around the pudding. Lower heat to 300° if it starts to simmer or boil. Also lower heat to 300° if the top of the pudding browns too quickly.

7. Let cool completely. Run a thin knife around the side of the pudding and invert onto a serving plate. Do not expect this surprisingly light dessert to hold its shape with the same glassy solidity you would get from a créme caramel.

8. Spread whipped cream over the top of the pudding and garnish the whipped cream with the berries.

Yield: 8 servings

Raymond Sokolov’s most recent cookbook is The Sauce’s Apprentice, a guide to French sauces.

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The Roots of Hunger


Many would have us believe that world hunger is a regrettable but inescapable phenomenon caused by powerful forces over which we have little control. According to this view, the changing climate, the irreversible acceleration in the rate of population growth, and diminishing amounts of land on which to grow crops all make a solution unlikely. In this situation, the United States has a moral obligation to mitigate the misery by shipping its food and agricultural technology abroad.

That is one way of looking at the "problem" of 450 million malnourished human beings, but it is not Susan George's way. She places the blame on us—that is, on our inadequate human institutions, wrong priorities, bad planning, and nationalistic or corrupt government policies. The situation, she contends, did not just happen naturally. She quotes Bertolt Brecht: "Famines do not occur; they are organized by the grain trade." And she quarrels with the passive form of the statement we often read: "prices are rising." Somebody made them rise, she insists.

How the Other Half Dies is a polemical book, written from a strong personal point of view and steadily critical of the institutions that have failed so spectacularly to make any real dent on global malnutrition in our time. But in other respects it is optimistic. Once it is understood that the problem is man-made there is less reason for debating whether George gives short shrift to the notion that climate and population growth have doomed the world to starvation. She maintains that the problem is manageable provided politicians and corporate power structures can be forced to do what is necessary to correct deficiencies in the system.

A few years ago many of these ideas would have seemed radical. But the years after the world food crisis of 1974, analysts with no connection to the politics of the Left have also begun to question many of the old assumptions about hunger. No less a body than the august National Academy of Sciences concluded after extensive investigations that producing more food is not the answer to malnutrition. A study that was conducted for the Academy stressed that poverty and the employment and inadequate distribution systems are at the root of hunger.

This summer, the United States had a thirty-million-ton stockpile of wheat left over from the 1976 harvest because nobody wanted to buy it. Yet malnutrition is severe in countries only a few hundred miles away, such as Haiti and Central America.

This is the dilemma that George investigates. She does not say that scientists should halt their research on plant genetics, hybridization, photosynthesis, and other important areas of food production. She does say that her book is a political book and that the material in it should be used as political ammunition.
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by Dan Morgan

Heresis, cheap irrigation systems, and new systems of fertilizing crops. But George insists that the real problems are structural and political, not scientific and technological.

Contrary to the popular myth about the world running out of food, governments in wealthy countries often promote and pursue a policy of "planned scarcity" to keep the incomes of their farmers at "reasonable" (read high) levels. That is not true in the European Common Market, where rich price supports, subsidies, and protective duties enable European farmers to produce wasteful surpluses that seldom reach hungry people. Yet in the great wheat-growing countries—the United States, Canada, and Australia—ninety million more tons could have been grown in the three years preceding the food crisis. The governments planned it that way. They compelled or provided incentives to farmers to idle vast acreages to prevent overproduction. A few years later, in the summer of 1977, overproduction is again the number one problem of the great planners, and the stage is set for new cutbacks in acreage and, eventually, for another world food crisis.

In the United States, planning in agriculture began in the era of the New Deal when farmers were in a truly desperate predicament. As George points out, there have been refinements in planning techniques, but there is no international system in place (and remarkably little political pressure to...
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create one) to prevent the ruinous cycle of “boom and bust” in the world wheat economy.

If the rich countries are part of the production problem, the developing nations are anything but blameless. It takes food grains such as wheat and rice to feed people, but in many countries vast acreages have been given over to growing cash crops that feed animals or people in distant, wealthy markets. Bananas, tea, cocoa, jute, tobacco, and groundnuts cover enormous tracts in countries where malnutrition levels are high. In the Philippines, 55 percent of the land is devoted to growing cash crops (mainly for export); in Mauritius, 85 percent.

The kind of crops being grown is not the only problem. Large landholders are still dominant in the land-tenure systems of numerous countries. Although they have the best access to bank loans, capital for buying new equipment, and information about modern agricultural techniques, they are inefficient producers of food, tending to invest as little money as possible in farming modernization.

Given the nature of the world hunger problem, there is something astonishing about the developments that have taken place in agricultural trade in the last thirty years. Whole farm economies have been reorganized to serve export markets, rather than to deal with the problem of malnutrition at home.

One of the worst pockets of malnutrition in the world is in northeastern Brazil. Yet the most dramatic agricultural story in Brazil involves the growth of soybean cultivation and the processing of soybeans into animal feed. Multinational agribusiness companies have invested heavily in the Brazilian "soybean miracle." The miracle has been good for the Brazilian economy and balance of payments. Brazil has become the world’s second largest exporter of beans and of the processed meal that farmers in Europe feed to their poultry, hogs, and cattle. The multinationals are taking advantage of the worldwide need for rich sources of protein. But that need has little to do with feeding hungry people. It arises from revolutionary changes in people’s diets all over the world. Europeans and Japanese now line up at fast-food emporiums to gobble hamburgers or enjoy Kentucky fried chicken. Broiler industries have grown rapidly in affluent western Europe since the early 1960s. It takes huge quantities of corn and soybeans to feed the livestock and poultry that are the basis of the fast-food trade.
is development has been good for business and good for the grain trade (which has doubled its international food shipments since 1972). But these shifts have left virtually untouched those segments of society that lack money to buy food (let alone eat at a fast-food restaurant) or that are out of reach of the food-distribution networks operated by traders and merchants.

As George notes, land used for feijao (black beans) or for rice has been converted to soybean cultivation in Brazil. Real estate prices of farmland suitable for growing soybeans have shot up, and the likelihood is that smaller, unorganized farmers will gradually be eliminated by wealthier farmers who can afford to buy more and more land. The real planners of the radical shifts in tanning and eating have been corporate corporations. George asserts that the surplus capital of agribusiness conglomerates is a much more powerful force for setting agricultural policies in countries than are government treasuries. In 1967, the chairman of the Bank of America had this prediction for tackling world hunger: a profit-oriented approach to increasing food production in the less developed countries provides the only chance for real progress and declination. A decade later, however, he is nothing to suggest that agribusiness has the fundamental answer to the initial problem of malnutrition.

He resists the reality that food is just her commodity and agriculture is a necessity. We invest wheat and grain special, Biblical qualities. Wheat, and religion would seem to be a y, above the probings of investigative journalists and systems analysts. George reminds us that wheat prices paid to most of the same forces as water and petroleum. Politicians and corporations, who have license to control the food-supply system, Teally have more to do with changewheat prices than does drought.

The structural problems have been avated by the well-meaning efforts of wealthy countries, she contends. United States has given food aid rously in years when its own uses were large. But there is no or any disagreement between agultural economists that the massive food-aid shipments to south Asia, Indonesia, and other places in 1960s had a not altogether beneficial effect on indigenous farmers. The United States staved off famine in India and 1960s, but probably created a false sense of security and discouraged Indian planners from investing more in agriculture. (Instead, India built up its armies and constructed an atomic bomb.)

George cites the green revolution as an example of flawed agricultural engineering on a global scale. She is hard on the Rockefeller and Ford philanthropic establishments for not seeing the drawbacks to new, high-yielding seeds developed in one place and superimposed on farmers elsewhere. The work on developing new seeds must proceed, but with much greater sensitivity to farmers’ needs for easily adaptable hybrids. The results of the green revolution have been disappointing. In the inflationary spiral caused by the 1973-74 energy crisis, many farmers who had introduced new seeds on the assumption that they would have plenty of cheap fuel to run water pumps and cheap fertilizer to apply to the crops, were severely set back. It is interesting that China, which has roughly achieved food self-sufficiency, has not adopted any of the seeds developed at the International Rice Research Institute in the Philippines.

George treats very large, complicated subjects with a spirtually, provocative style. Her special contribution, and the reason the book deserves a wide audience, is that she forces us to discard simplistic notions about the hunger problem. She is opposed to “the brainwashing of innocent bystanders.” Population is one subject that especially irks her. Populations explode for rational reasons since people have no incentive to reduce the number of their children. As long as wealth is badly distributed, the poorest segments of society will continue to raise large numbers of children as useful adjuncts to the family labor pool. The problem is not lack of food but lack of adequate social policies.

George calls her book a “plea for rationality and social justice.” It is not a plea that is likely to be enthusiastically heeded by politicians. Agriculture is perhaps the most sensitive political issue in the world today, World hunger cannot be ignored or explained away as a side-effect of population growth. Its existence is an indictment of modern civilization and a rebuke to us all.

Dan Morgan covers agriculture and the hunger problem for The Washington Post. His book on multinational grain companies and the politics of food will be published by Viking Press next year.
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**Additional Reading**

**Andean Weaving** (p. 48)
*Peguche: A Study of Andean Indians,* by Elsie Clews Parsons (Chicago: University of Chicago Press, 1945) is a detailed ethnography of the Otavalo Valley. This book is the result of Parsons’ field work from 1940 to 1941 in Otavalo and in the neighboring town of Peguche. Another major study of the people of this region is *The Awakening Valley,* a richly illustrated black-and-white photographic essay on the Otavaleños by John Collier (author of Visual Anthropology: Photography as a Research Method) and a local ethnographer, Aníbal Buitrón (Chicago: University of Chicago Press, 1949).

There is an excellent chapter, "Weavers of Otavalo," by Frank Salomon, in *Peoples and Cultures of Native South America,* edited by Daniel R. Gross (New York: Doubleday & Co./Natural History Press, 1973, $5.95 in paperback), which gives a concise summary of ethnographic knowledge up to date. This book also contains an extensive bibliography on the greater subject of South American Indians.

**The Auroras** (p. 60)

More detailed are three works which will either satisfy readers’ curiosity or send them to other sources by way of bibliographies. *Physics of the Aurora and Airglow,* by J. W. Chamberlain (New York: Academic Press, 1961), is a classic source for description and explanation. More recent and more comprehensive is A. Vallance Jones’s *Aurora* (available in paperback from Reidel Publishing Co., Hingham, Mass., for $24.00), which includes up-to-date bibliography as well as satellite photographs. *Keoeeti; The Story of the Aurora Borealis,* by William Percy published in 1963 by Pergamon Press, New York, introduces Eskimo and Scandinavian mythologies that evolved around the aurora since first set eyes on it.

**Monk Seals** (p. 78)

Documented Caribbean monk sightings since the time of Christ and Columbus appear in *Extinct and Vanishing Mammals of the Western Hemisphere with the Marine Species of*
Regeneration (p. 84)


Pinta Island Tortoise (p. 90)


In 1964, the Galápagos International Scientific Project, an expedition of more than fifty scientists, descended on the islands in helicopters. An issue of Pacific Discovery (vol. 18, no. 5) is dedicated to reports from the expedition and the opening of the Darwin Research Station. Particularly interesting is John R. Hendrickson’s “Reptiles of the Galápagos” (pp. 28–36), with good black-and-white photographs and a bibliography on page 37.

For Joseph Vagvolgyi’s pictures and account of his locating the last Pinta tortoise consult his 1974 article in Pacific Discovery, “Pinta Tortoise: Rediscovered” (vol. 27, no. 2, pp. 21-23).

Pamela Haas
Celestial Events
Thomas D. Nicholson

Sun and Moon  The sun is in the constellation Virgo until the end of October, moving into Libra in November. During this part of its easterly path through the stars, it drifts rapidly southward, shortening the days and lengthening the nights, lowering the diurnal path it follows from sunrise to sunset. It moves past Spica, in Virgo, about October 17. But on October 12, it keeps a date with the new moon to produce a solar eclipse (see below).

The moon is a morning object in early October, rising late at night and remaining in the morning sky. It is at last-quarter phase on the 5th, and new moon occurs on the 12th. By the 15th or 16th, you will see the early crescent moon in the western sky just after sundown. Thereafter it will come into view higher and fatter each night and remain in the sky longer. First-quarter moon is on October 19, and full moon (the hunter's moon) is on October 26. A morning object again in early November, last-quarter is on November 3, new moon on November 11.

Stars and Planets  Mercury is the only naked eye planet in the evening sky in October. It moves to the east (left) of the sun on the 18th and remains an evening star (but poorly placed for viewing) through November. The other four planets are morning stars, generally quite bright and well situated for viewing.

Jupiter and Mars rise before midnight and are quite high in the south in the dawn sky. Both are in Gemini. Jupiter, the brighter of the two, is well to the west (right) of the twin stars Pollux and Castor. Mars (to the left of Jupiter) moves into line with Pollux and Castor on October 16 and then moves away to the east. Saturn and Venus rise well after midnight. In the dawn sky, Venus — the brightest object you will see, except when the moon is present — is lower in the east. Saturn is in Leo, higher and to the right, and near the bright star Regulus.

October 4-5: The waning gibbous moon moves past Jupiter and Mars in the morning sky.
October 8-10: The morning moon is now moving past Saturn and Venus — closer to Saturn on the 8th and 9th, to Venus on the 10th.
October 12: There will be a solar eclipse today, visible from much of the North Pacific Ocean, most of North America, and part of South America. A total eclipse will occur in a narrow path of the Pacific and in northern South America. In North America, the eclipse will be partial, occurring shortly after noon along the west coast, in late afternoon along the east coast. It will last about two hours.
October 15: The moon is nearest earth (perigee).
October 18: Mercury, in line with, but beyond, the sun, enters the evening sky.
October 21: The Orionid meteor shower reaches maximum. An observer may expect to see up to 25 shower meteors per hour after midnight, some quite bright.
October 24: Jupiter, approaching opposition from the sun, becomes stationary with respect to the stars and begins to move westward (away from Gemini, back toward Taurus).
October 31: The moon is farthest from earth (apogee).
November 3: Saturn has been approaching Regulus in Leo. Today it passes the star and moves away to the east. The bright object near the moon is Mars.
November 4: The relatively weak (15 per hour) and dim Taurid meteors reach maximum.
November 5-6: The object near the moon is Saturn.

★ Hold the Star Map so the compass direction you face is at the bottom; then match the stars in the lower half of the map with those in the sky near the horizon. The map is for 11:15 p.m. on October 1; 10:20 p.m. on October 15; 9:30 p.m. on October 31; and 8:15 p.m. on November 15; but it can also be used for an hour before and after those times.
Eskimo Tales
by Dorothy Harley Eber

Arctic authors are subject to the same literary jealousies as their southern colleagues.

At least once a year a writer can count on reading a newspaper column or magazine article on the notable nastiness of writers, not necessarily toward each other but toward each other's books. During the past two or three years, the literary section of the Sunday New York Times and the Canadian magazine Saturday Night have carried such items. It is a perennial theme, but just how ubiquitous, I learned in the Canadian Arctic.

For part of the past six summers I have been interviewing elderly Eskimos living in Cape Dorset on Baffin Island, tapping their reminiscences in order to write oral histories of their traditions. I quickly learned that passions rage on the Hudson Strait as violently as in warmer climates. Just the same it was a surprise to discover that a literary reputation can be bad-mouthed in the Arctic as thoroughly as if the locale were New York.

The first clue came from Echaluk, an elderly widow, who popped out of her prefabricated house in front of my interpreter and me, as we trudged along with our tapes, recorder, and other paraphernalia, and announced, "Pitseolak never caught a goose."

This was abrupt, but I recognized the reference to the goose. It concerned a passage in the book that Pitseolak and I had recently published. I replied mildly, "Oh, really. She says she did." But afterward, when I analyzed Echaluk's remark, I realized it was loaded—an attack on my collaborator's credibility. Echaluk was really saying that Pitseolak had exaggerated her age (upward; old age in the Arctic is something to be proud of) and therefore in the early days of the century when the Eskimo had few guns, Pitseolak was just a baby and unlikely to have been a good witness to the old-style goose hunts she described:

Four people would corner a goose and my parents would tell me to run up behind it hooting and shouting and put my foot on its neck. I'd run and I'd catch the goose and I'd stand there waving my arms like a bird. Sometimes we'd all have headaches from shouting and yelling.

On my first summer visit to Cape Dorset, Pitseolak, a disarming personality and a remarkable graphic artist, had given me wonderful glimpses of "the old way." She had a gift for homey detail that made life in the now vanished igloos and skin tents vividly real—and somehow familiar. In daily interviews, she talked about how to sew kayaks, the games she played as a child, the problems of a wealthy hunter with four wives: "Sometimes it would get quite dark and that poor man would still be building the igloos!"

Pitseolak's willingness to answer hundreds of questions with great good temper and often considerable passion meant the work on her oral biography went easily and was always highly rewarding. Still, our collaboration had its unusual aspects. I had explained that people in the south (Montreal) thought she and I could put together a book, but one day—just before I packed to go home—my interpreter said, "Pitseolak wants to know what you are going to do with all this material?" Pitseolak was familiar with the Bible and with her grandchildren's school books but there all reading matter stopped.

What were books for? Our young interpreter did her best. "People in the south spend all their time reading!" Pitseolak knew this was no sense. Her reply was immediate "When do they eat?" But eventual our book, illustrated by Pitseolak and in an Eskimo-English bilingual edition, was published, and Pitseolak made her first trip down from the Arctic to stay at the Montreal Ritz as guest of the publisher. ("How do you like it here?" "I feel very much at home, thank you.") During her visit she ate in restaurants, moved about on escalators, handled the press with aplomb, and seemingly was up only once by the mysteries of the literary world. When the publisher showed her around his warehouse she worried that she would have to sign all the books.

When Pitseolak got back to Cape Dorset, the Hudson's Bay post copies of our book. By the time I rived the next summer and settled in interviewing other elderly Dol people who had distinguished themselves in the graphic arts, residents of the community were familiar with contents—and not slow to make comments. Not only had Pitseolak added several years to her age; she was also guilty of unseemly boasting about her lifestyle in the old days. "Pitseolak's husband was not rich—he never had eight dogs. Pitseolak's husband's igloos—couldn't even get into her husband's igloos." And there were many with a nasty personal ring: "standards of housekeeping in family were never very high."

The matter of the goose was certainly a sore point. The widow Echaluk, reportedly once a hunter with own team, was a person who had to be taken seriously. "If Pitseolak caught a goose," she declared, "was a very small goose." Eid
Blue insect.
Felt pen, 1970.
and his son Udjualuk—who sometimes came with me on interviews to interpret—went out on the tundra and tried to catch geese in the way Pitseolak described. They reported they couldn’t run fast enough to catch a goose free on the grass. You had to have stone pens. Obviously, Pitseolak didn’t know what she was talking about. She had been too young to really know about the old ways. “She should have said she didn’t know about these things when she was questioned,” one critic informed me.

Despite this critical reaction, the book had not hindered my chances of getting further interviews. I am often asked, “Aren’t the people afraid to talk to you when they know everything is being recorded?” But this particular summer, this did not seem to be the case. People I interviewed often seemed quite relieved when they realized I had done with chitchatting and turned on the tape recorder. Some who had tape recorders of their own would help me tune the levels and would pause and gesture meaningfully when the tape ran out. Many of the old people I talked to believed that the old stories should not be forgotten. Books were a good idea, they seemed to feel, even if Pitseolak’s venture into print was stirring up a storm.

At first I worried about Pitseolak’s feelings. On one visit I gingerly brought up the matter of the goose. Pitseolak insisted she had caught, not one, but two geese on the grass. (I did not ask her if they were very small geese.) She also told me more about her journeys in the umiaks—the huge skin boats with sails made from intestine—which, although seen in the Cape Dorset area until the Hudson’s Bay Company arrived in 1913, had also been disputed. She remembered sitting in her mother’s amautik, or amaht (a special pouch in a woman’s parka), and playing with her mother’s braids as they traveled in the great boats. Once there was an accident, and her mother, who was pregnant, fell over in the umiak and miscarried. On the whole, Pitseolak appeared unconcerned although she knew she had criticisms. “Pitseolak does not tell lies although some people say she does,” she remarked. Perhaps Pitseolak felt that publication was worth the criticism and difficulties it frequently brings. Royalty checks arrived occasionally; the Royal Canadian Academy of Arts made her an academician (she showed me the diploma and explained, “I got it for being a good artist”); a large corporation asked her to make a drawing for an advertisement; more people wanted to buy her beautiful “old way” pictures (the Smithsonian Institution is currently circulating an exhibition of her drawings); new sources of income opened up. The interpreter remarked one day, “Pitseolak says she is really grateful she was able to buy that small refrigerator. She has it beside her bed and now she can get good cold water whenever she wants.”

Another charge I frequently heard was that Pitseolak had not told “all.” She had not, for instance, mentioned a relationship with the Bay Company man in Cape Dorset. To this I generally replied, as pointedly as possible, that few of us would want to reveal all. But to tell the truth I have never been really interested in the Bay man although I have always loved to hear Pitseolak talk about her husband, Ashoona, who died too soon. Whenever we meet nowadays his name generally comes up:

When Ashoona came to the camp I didn’t know why he came. I didn’t know he came for me. I thought he’d just come for a visit—until he started to take me to the sled. I got scared. I was crying and Ashoona was pushing and sometimes picking me up to try to put me on the komatik (“sleigh”). Anyone trying to get married would often have to carry the girl! At that time the young girls used to be really afraid of the men—frightened to go to bed with them. The first time I was sleeping beside my husband his breath was so heavy, his skin so hard. But after I got used to my husband I was really happy; we had a good life together. The first time we went to Netsilik [a large, distant lake] we were all alone for a year and Ashoona delivered my son Kumm war- tok. With my mother to help. When my husband died at Netsilik even though I had relatives, it was as if my whole family had died—I had no one anymore. Ottoche, my youngest son, was in the amautik. He was the only one who didn’t learn how to hunt from his father. Ashoona taught his sons to hunt before he died. After Ashoona died at Netsilik, when the geese were coming south and flying over head down here past Cape Dorset, I used to think, “These geese have been with Ashoona back in Netsilik. They’ve been at Ashoona’s grave.” When it was really dark and I could hear the geese overhead, I’d go outside and I’d yell. “Goodbye, goodbye!”

The most vocal of the critics was another Pitseolak, although no relation—Peter Pitseolak, a former camp boss generally regarded as the region’s official scribe. The name Pitseolak, which means “sea pigeon,” is a popular one in south Baffin Island. A most remarkable man, Peter Pitseolak was an accomplished photographer and considered it a failure that his people had become literate only at the turn of the century. “We were stupid; we should have thought of writing on sealskins!” For years he had kept—in neat syllabics (the system of writing the missionariable)—notes on births, deaths and important happenings in the camps. There was more, much more, Peter Pitseolak suggested, that could be better told. “Don’t believe everything some other Pitseolak tells you,” he warned.

Months later when I was back in Montreal, the post delivered a long mailing tube. Out of it came page after page of syllabic manuscript—Peter Pitseolak’s own story, as far as I know, the only written autobiography of any length by an eastern Arctic Eskimo of his generation. Shortly, with a grant from the Canada Council’s Explorations Program, I returned to Baffin Island to interpolate the written material with oral biography. It was a memorable experience. Peter Pitseolak did indeed have much to tell and was eager to tell it; he had a powerful mind and a great storehouse of knowledge. To interviews with Peter Pitseolak we a joy to do—and as stimulating, think, for the interpreters as for me.

But as we worked, I detected son background static. Eleeshushie Peter Pitseolak’s half-sister, into her eighties and perhaps ten years his senior, was gravely suspicious of the stories her younger brother was passing along and also felt the method which Peter Pitseolak had chosen for some of his material confirmed a bias on his character. “He was always lazy boy,” she remarked. “He was always in bed. When the adults were talking on the sleeping platform in the igloo he would sit there. Though he might appear not to be listening, was listening all the time.” And the day I finished checking the tap and packed my bags and walked to the airstrip, I again encountered formidable widow Echaluk. “Pe Pitseolak does not remember as much as he thinks he does,” she remarked darkly.

I was forewarned; still, a letter received in Montreal, just as the manuscript on which Peter Pitseolak an had collaborated was ready to go the printer, brought startling new
The work was accomplished in the nick of time—he died four months after we finished the interviews.) A cultural committee of three elders had been formed in Cape Dorset, and because the members felt Peter Pitseolak might remember things differently from how they actually were, he would be willing to help by picking the manuscript. Of course I was appalled. The desire to censor is apparently strong in man. But not overly so strong, work in Cape Dorset evinces me, as man’s desire to communicate. After some thought, I wrote back, paraphrasing words attributed to Harry Truman: Clever men can never agree.

Now I am awaiting results. Hasn’t the competitive notion that there is a story to tell more honest, more beautiful, more deserving of respect than the tale told by a rival sent many a chronicler to the typewriter? It is my hope that the three members of the cultural committee, finding themselves in strident disagreement with the published reminiscences of the two Pitseolaks—and, I think I can safely predict, with each other—will set down their own versions of events. If they do, and three separate syllabic manuscripts result, those cultural committee members will merely have become part of the same literary tradition as their colleagues south of the Arctic.

Dorothy Harley Eber is a Canadian journalist who has produced two oral biographies, Pictures Out of My Life and People From Our Side.
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Peru’s **Golden Treasures**, an exhibit more than 200 gold pieces spanning 800 years of Peru’s largely unknown history, will be on display in Gallery 77 from October 5 through December. Indeed will be such delicately wrought objects as a minutely detailed pair of gold gloves from the Chimú culture; backrest of a litter, magnificently orated with small gold figures; a unique gold neckpiece in the shape of a new on with monkeys playing along its outer edges; and numerous masks, necklaces, and vessels. The artifacts are of the collection of the Museo Oro Peru in Lima. The collection was begun in the 1930s by Miguel Mujica, a Peruvian concerned that much of his country’s golden heritage was disappearing at the hands of robbers, whose tombs of offerings to the dead placed in them thousands of years ago.

The exhibit will also include archeological artifacts from the American Museum’s Peruvian collection. There will be examples of Paracas mantles, which were used to wrap mummies, as well as displays of clothing, pottery, shells, and musical instruments, all discovered in tombs of Peru’s various ancient societies.

Beginning in October, the Education Department will sponsor six series of unlimited enrollment **Evening Lectures**: Archeology of Ancient Egypt; Magic and Witchcraft; Social Behavior of Animals; The World of Birds; Wildflowers of the North; and Insects: Earth’s Most Successful Animals. Each series will be presented either by members of the Museum’s scientific staff or by experts from other museums or universities. The cost ranges from $20 to $35 for individual series. For information about length of each series and registration call (212) 873-7507.

On October 13, the Museum membership Office will present a program devoted to **The Bowhead Whale: Monarch of the Seas**. The event will include a screening of In Search of the Bowhead Whale and a discussion by Scott McVay of the Environmental Defense Fund. In 1973, McVay led an expedition to the Bering Sea to study and photograph the behavior of this rare whale, and record its sounds. An offshoot of the expedition was the filming of the bowhead’s spring migration along the northwest coast of Alaska from Point Hope to Point Barrow.

The bowhead used to be so numerous in the Arctic Ocean that it was commonly referred to as “the whale.” For 300 years, the species—the only baleen whale that lives year-round in the Arctic—was ceaselessly hunted by Europeans for its oil. Now, only a handful remain in the Bering, Beaufort, and Chukchi seas off Alaska and Siberia. These are hunted only by Eskimos, who rely on the bowhead’s meat, blubber, and bones for subsistence.
Letters

Lightning Strikes Again

Richard E. Orville’s otherwise excellent article “Bolts from the Blue” (June/July 1977) had one major flaw. He states, “the charge delivered to the earth’s surface in a lightning flash is only about 20 coulombs, enough to operate one 100-watt bulb for just over 20 seconds.” Horsefeathers! The one coulomb per second (one ampere, to those who find amperes more comfortable) is for current supplied across a voltage drop of 110 volts. The energy is given by the product of charge and voltage: thus a 100-million-volt discharge of 20 coulombs supplies 2,000,000 joules—enough to keep a 100-watt (110 joules per second) bulb burning for 20 million seconds or more than 5,500 hours, or about 23½ days. In other words, each lightning flash supplies more than 55 kilowatt-hours. If it were possible to tap this source of energy, it would be quite useful, and not merely a laboratory curiosity.

Mark E. Kaminsky
Trinity University
San Antonio, Texas

The Author Replies: The above calculations are correct. Unfortunately, virtually all this energy is dissipated into heat, light, and thunder in the atmosphere and is not available for use at the ground. But let us ignore this loss and assume, as Mr. Kaminsky has, that 55 kilowatt-hours are available and can be tapped as a source of energy.

How many lightning flashes are needed to meet the electrical requirements of a home? My four-bedroom house used 900 kilowatt-hours in a recent month and would therefore need the energy from twenty lightning flashes to meet my yearly electrical needs. A typical flash density in our area for thirty thunderstorm days per year is about ten flashes per square mile per year. So if I collected all the energy from lightning flashes to ground in two square miles the electrical energy needs of my home would be satisfied.

If this seems impractical, I could meet a fraction of my electrical needs by erecting a 325-foot tower near my home and using the electrical energy from lightning striking the tower. Research indicates that most lightning within a 650-foot radius of the tower would hit it, and that this would amount to at most one strike per year. This would supply, according to our assumptions, 555 kilowatt-hours or a continuous power supply of 55 watts. Of course the available power would be much less since in all our calculations no account has been taken of the energy losses in the lightning channel and of the inevitable losses in the storage area. It would appear that lightning as a practical energy source is not useful and will, in fact, remain a laboratory curiosity.

The Grizzly Grapple

I read Christopher Cauble’s article, “The Great Grizzly Grapple” (August/September 1977), early this morning and, in a rare burst of intellectual energy, would like to make a comment. The killing of Stony Bear, purely and simply because she might have cubs and then might become overly protective, is certainly an act that should not have been carried out. No one in my family has ever been mauled or killed by a bear, so I presume I am somewhat biased in favor of bears; but following this line of reasoning in regards to the human race brings up so many possibilities that it boggles the mind.

Garth E. Fort, M.D.
Nashville, Tennessee

Mr. Cauble gave a fairly unbiased report on the situation concerning the grizzly bear in our National Parks; that is, until the last paragraph of the article. His statements are a bit extreme and will probably not be met with enthusiasm from the nonbiologist segment of our society.

The offensive segment of his last paragraph is: “... if we can yawn and accept the reports of tens of thousands of deaths from automobile accidents and mishaps in the home, can we not tolerate the exceedingly rare death due to a grizzly bear?” We found this sentence offensive because of its inaccuracy. People aren’t taking highway accidents lightly; as shown by safer highway design, traffic laws, and enforcement. People aren’t outlawing highways because of traffic accidents, and they aren’t just sitting back and letting them occur.

Let us close with comment. No! Mr. Cauble, the public will not just yawn and allow their children or themselves to be mauled and killed by grizzlies, more than they will tolerate car accidents. We personally have confidence that an acceptable solution to this problem will be found.

Jack and Rosalie Seim
Campbell, California

I was not very pleased with the article, “The Great Grizzly Grapple,” but I did appreciate the author’s effort to bring a matter this serious to the attention of the public.

I was both outraged and appalled by what the National Park Service has been doing over the years to the grizzlies and very much concerned about the public’s reaction to the plight of the animal.

Considering that the ratio—approximately three out of every 1,600,000 persons visiting the Glacier area was attacked by bears — of bear/people incidents is extremely low, I think the odds favor the public. As was pointed out in the article, the public seems immune to deaths caused by motor vehicles. I fail to understand the outrage a grizzly who attacked someone when that animal has probably been bothered to death by people in his home - parks. These are not tame animals that they ever become so. But people fail to understand nature and feel that they have to tame everything as long as it falls into their controlling patterns. Man can’t control it—he doesn’t want to and around. I find this quite sad and immensely frightening for all of us.

Mr. Cauble wrote that the grizzly has been hunted for years in the Bob Marshall Wilderness Area, and that the bears don’t seem to be as aggressive as seems obvious that the hunted animals are, in fact, running for their lives again refuse to believe we have the right to put such fear into these animals.

We owe it to the animals, those together in these parks and living off the mercy of man, to allow them to live in peace. If I honestly thought that these parks were created strictly for man’s purpose, I would never step foot in

132
people who fear these animals should never stay out of the parks (there are as in which one can camp all over the United States without being bothered by wild animals) or sanction a few laws strictly for wildlife. Should they choose to trespass, they and they alone, would be responsible for the sequences.

Carolyn Pierce
Medford, Massachusetts

I have just read "The Great Grizzly Apple." It seems a pathetic sign of absurdity of our "civilization"
the National Park Service is killing grizzly bears not for what they've done, but for what they might be capable of doing. The Walker decision ranks one of the most disgusting ever decided.

Areas become designated as national parks because of the extraordinary and unique qualities of nature that are found in certain localities. This includes flora and fauna as much as the geological formations. Preservation of these conditions should be of premier importance.

A policy restricting the feeding or nursing of wild animals should be initiated in the national parks. As Clifton J. Martinka pointed out, the public's familiarity with, and feeding of grizzlies has produced a disastrous change in the bear's behavior patterns. Prescriptions should also be taken to prevent incredibly idiotic tourists from posing with their children with bear cubs for photos, while the huge mother bear is thirty yards away as I have witnessed in Yellowstone National Park. In Wyoming I also saw a group of people feeding bears candy bars, Hostess Twinkies, Jumbo Jacks, french fries, and Kool-Aid—in short, nearly anything they could find that resembled food. These are usually the people that claim the loudest when an animal attacks them.

For the specific "grizzly bear problem" (actually people problems), I propose the following solutions:

Education of the public as to the existence of wild animals—we must be disinfected.

Close the parks having a "grizzly bear problem" for five years. This will allow the bears to become dependent once more upon their own abilities to obtain food.

3. Then open the parks to shuttle-service tours, but with no unsupervised camping or hiking for an additional five years. During this time the bears can again become accustomed to the sight of humans, but without expecting handouts.

4. When the park opens for camping, have all campers sign National Park Service responsibility waivers and acknowledgements that they camp at their own risk.

Make it a privilege not a right to enter our national parks.

William Stout
Hollywood, California

Aside from bears caged in zoos or performing in a circus, I had never seen a bear in its habitat until a few years ago, when I had been on a fleeting visit to the Rocky Mountain National Park. As I stood on the paved roadway overlooking the vast valley below, I spotted what first seemed to be a hiker, but in fact was some species of bear. It was awe-inspiring to see this denizen going his way of centuries past in this vast and isolated area that is maintained as a "mental tranquilizer for frazzled city citizens" by their payment of Federal taxes.

But our national parks must be kept safe for those who use them routinely or for that once-in-a-lifetime camping trip! Just as the Indians learned the meaning of our "thunder stick," so must the bears. If they can learn the perfection of their circus performances, they must equally learn to respect the taxpayer or be put in a position less dangerous to him.

The loss of life of one park visitor is not worth the value of all of the bears in our national park system.

Greater creatures than bears trud our wilderness areas until environmental changes caused their demise, and our costly preservation of these park areas and our right to use them safely constitutes an "environmental change." Bears don't vote or pay taxes — the people do!

F. Coleman Greene
Pawling, New York

My name is Matthew Clay. I'm eleven years old, and I'm a reader of Natural History. I'm writing because you made an era [sic] in our August/September 1977 issue. On page 75 the bear standing against the car is a black bear not a grizzly.

Matthew Clay
Portsmouth, Rhode Island

The "grizzly" shown on page 75 of your August/September issue is definitely not a grizzly, but a black bear. On page 77 the bear described as a "young grizzly" is almost certainly a black bear as well. However, all the other bears pictured in "The Great Grizzly Grapple" are genuine grizzly bears!

Henry B. Green
Tarrytown, New York

Community Problems

Mary Ann Borrello and Elizabeth Mathias ("Botanicas," August/September Natural History) are obviously sensitive and careful observers. They are also capable analysts of their observations as shown in their fine exposition of the interrelated sources of Puerto Rican religious practices.

Their evaluation of their findings, however, is reactionary in its implications. The spiritualist and animist rites do not, in fact, solve any of the Puerto Rican's problems. A community suffering from unemployment and the social disruptions it causes, illiteracy and the multiple barriers it creates to economic advance, excessive population growth and the resultant inability to nurture the child's mind and body — such a community needs to learn, to organize, and to seek rational, long-range solutions to its problems.

As long as religious, social, and anthropological opinions encourage reliance on supernatural means of problem solving, the community is discouraged from learning rational solutions to social problems. I believe that the expensive and wasteful practices described in "Botanicas" are symptoms of a terrible social problem.

Brucia Wittfoth
Framingham State College
Lexington, Massachusetts
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Seville
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WHEN IT POURS, IT REIGNS. WATERFORD
Authors

Can Animals Anticipate Earthquakes? Evelyn Shaw
Some seem to sense faint signals of impending tremors.

This View of Life Stephen Jay Gould
The Telltale Wishbone

The Sighting at Pine Knot Alton A. Lindsey
The last wild flock of passenger pigeons may have passed in presidential review.

Why Slugs Squabble C. David Rollo and William G. Wellington
Slugs aren't sluggish about sex, shelter, or food.

The Gregarious but Contentious Walrus Text and photographs by Fred Bruenmer
These once-plentiful giants are increasing their numbers.

The Fresh Air-Clean Water Exchange F. Herbert Bormann
and Gene E. Likens
The economic values of natural vegetation are usually ignored.

Fecund Mouffon Text and photographs by Raúl Valdez and Leticia V. Alamia
Unlike their American counterparts, Asian wild sheep continue to thrive.

Street Dwellers Alan M. Beck and Philip Marden, photographs by Joan Roth
They are urban hermits.

A Matter of Taste Raymond Sokolov
The Quality of Coriander

A Naturalist at Large John Eastman
Walking the Railroad

Bios Arthur W. Galston
Guayule Bounces Back

A Special Announcement
Hall of Reptiles and Amphibians

The Market

Celestial Events Thomas D. Nicholson

Sky Reporter Stephen P. Maran
Ring Galaxies

Book Review Paul B. Sears
Troubled Waters

Announcements

Additional Reading

Cover: Near an ugly, or hauling-out place, a bull walrus floats in the shallows off Round Island in Bristol Bay, Alaska. Photograph by Fred Bruenmer. Story on page 52.
It's just a wonderful car. True, we had a big advantage, we started with a wonderful car and made it even better.

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Jacques Cousteau's life is a history of adventure, excitement, and mystery. But none of his many expeditions has ever been as unique as the new one Cousteau embarks on this year aboard Calypso.

"The Cousteau Odyssey."
Four hour-long specials begin on November 22nd with "Calypso's Search for the Britannic."

Cousteau and Britannic survivor, eighty-six year old Sheila MacBeth Mitchell, return to the sunken luxury liner to find the reason for its disaster.

Early next year, "The Cousteau Odyssey" in two hour specials explores a new theory about a lost civilization that has held the imagination of people everywhere.

"Calypso's Search for Atlantis. Parts I and II."
An extraordinary journey that puts the indelible stamp of Cousteau's genius on a legend that is sure to keep inspiring men for all time.

Later, Cousteau's never-ending search to learn from the past takes him to an island buried by a volcanic eruption 200 years before the birth of Christ.

"Diving for Roman Plunder." A fantastic story of Grecian art treasures stolen by the Romans and recovered from under the sea by Cousteau.

The production of "The Cousteau Odyssey" specials for PBS is made possible by a grant from Atlantic Richfield Company to KCET, Los Angeles, expressly for the funding of the broadcasts. The specials are produced by Captain Cousteau and Philippe Cousteau in association with KCET.
Both C. David Rollo, left, and William G. Wellington, right, are associated with the Institute of Animal Resource Ecology at the University of British Columbia. Rollo, a doctoral candidate, is particularly interested in the homing and competitive behavior of terrestrial mollusks. He has studied snails in Ontario cornfields and recently contributed to a mollusk survey of southern British Columbia.

Wellington is director of the institute and professor of plant science and resource ecology at the university. He has contributed frequently to *Natural History*, generally on the impact that individual differences in animal or insect behavior have on survival of the local populations. His most recent article was "Life at the Cloud Line" (October 1976), about animal and insect adaptation to mountain weather.

F. Herbert Bormann and Gene E. Likens are the originators of the Hubbard Brook Ecosystem Study of the mountains of New Hampshire. One of the oldest and most intensive ecosystem studies in the world, the work conducted under its auspices has produced volumes of information on the ecology, chemistry, hydrology, and general biology of eastern forests. As principal investigators at Hubbard Brook, Bormann and Likens are hoping to determine more about the relationship between forests and lakes and the effects of air pollution on forest growth. The authors report that part of the study's success is due to their working well together—they have not had a serious argument in thirteen years. Bormann, above, is professor of forest ecology at Yale University; Likens, below, is professor of ecology at Cornell University.

A writer, photographer, and author on the human and animal life of the north, Fred Bruemmer spends almost as much time in the Arctic as he does at home in Montreal. Over a thirteen-year period, he has visited most of the areas where walruses are still found: Spitsbergen; northern Greenland; many of the Canadian high arctic islands; Hudson Bay; and Little Diomede Island in the Bering Strait. On Little Diomede, the subject of his last article for *Natural History* ("Life on a Cold Rock," March 1977), he noted the migration of Pacific walruses.
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We believe you will find The Christian Brothers Tinta Cream Port is a wine worthy of the finest occasion — to be sipped after a great meal, or to be opened for your best friends.

Because of the scarcity of the grape, and the leisurely time it takes to develop, Tinta Cream Port is not always available. Should you have trouble finding it at your wine merchant's, you may write to me.

Brother Timothy FSC
Cellarmaster
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“...I became interested in the natural history of Asia at the age of fourteen,” writes Raul Valdez, an assistant professor at New Mexico State University. Part of that interest recently reached fruition through his field work on the behavior and ecology of mouflon sheep in Iran, a subject on which he is writing a book. Valdez has also conducted research in Mexico, Honduras, Nicaragua, and El Salvador. His plans call for doing ecological studies of native and introduced ungulates in New Mexico.

Coauthor Leticia V. Alamia is biologist with the Texas Park and Wildlife Service. In her capacity as research ecologist with the Iran Department of the Environment, she assisted her husband, Raul Valdez, on his wild sheep studies from 1971 to 1975. Her past work has included an investigation of the nesting activity of white-winged doves in the lower Rio Grande Valley of Texas. In her spare time, Alamia is a serious natural photographer.

Alan M. Beck is director of New York City's Bureau of Animal Affairs. That division of the Department of Health handles the city’s problems concerning all animals except rats. This past summer, while other New Yorkers talked about the heat wave, the blackout, and Son of Sam, Beck worried about a rising bat population, and called for a bat alert to avert cases of rabies. His last contribution to Natural History was “The Life and Times of Shag, Feral Dog in Baltimore” published in October 1971.

Now at the Behavioral Science Foundation in St. Kitts, coauthor Philip Marden came to New York from Hampshire College in Amherst, Massachusetts, to do a senior research project on a primate population. Beck suggested that Marden observe instead his neighborhood’s street dwellers.
Polaroid's SX-70 Alpha 1

The SX-70 Alpha 1 Land camera has the most advanced optical and electronic system integrated into one camera. The SX-70 is the world's only folding single-lens reflex camera. Its four-element glass lens offers razor-sharp focusing from infinity to 10.4 inches. You see details clearly, even in dim light, because the SX-70 has one of the brightest SLR viewfinders in photography. Its electronics automatically calculate all exposures, using a unique variable shutter and aperture combination which even makes split-second flash corrections. The SX-70 Alpha 1. So advanced, it frees you to do the creative thinking.

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Can Animals Anticipate Earthquakes
by Evelyn Shaw

When dogs start to howl and cattle to bellow; when rats run the streets and catfish jump from ponds... watch out!

Unusual behavior by animals as divergent as ants, parakeets, sardines, and yaks has been noted in many countries prior to the onset of earthquakes. Some of the behavior, as reported from China, Japan, the United States, Guatemala, and Italy, took place weeks before the quake, some only hours or minutes.

Observers recalled that chickens and pigeons barked at entering their coops; cattle bellowed mournfully and refused to graze; dogs howled in chorus all over town; rats scurried from their hideouts and marched fearlessly through houses; catfish leaped out of their ponds; horses neighed, trembled, and ran wildly around their corrals; and snakes slithered from their hibernation holes only to freeze to death on winter ice.

Russian scientists, who have recently become interested in using animal behavior to predict all kinds of natural disasters, report that before tremors and storms, shrimp crawled on dry land, ants picked up their eggs and moved in mass migrations, and pheasants chorused an alarm. Furthermore, a Soviet geophysicist has claimed that human beings, too, may have a disaster-warning mechanism and cited 1948 medical reports from one area indicating a dramatic upsurge in heart complaints among patients whose cardiograms were normal. Within two months, an earthquake devastated the region and the heart complaints subsequently disappeared (perhaps the patients were dead?).

In 1964, the year of the great Alaska earthquake, Kodiak bears emerged from hibernation two weeks before their normal winter sleep would have ended and headed for the hills. In 1975, in California, an earthquake of 6.0 on the Richter scale, struck the Oroville region, a rural area about eighty miles northwest of Sacramento. Two days later, a visiting reporter was overwhelmed by accounts of anomalous behavior of farm animals, seen minutes, as well as weeks, before the event. A scientist attached to the Max Planck Institute of Berlin visited northeastern Italy after the disastrous Friuli earthquake of 1976. While there he was told innumerable tales of strange animal behavior, such as fowl refusing to roost, cattle panicking in their barns, mice and rats leaving their hiding places, and cats moving out of the area.

Finally, a man in San Francisco reported the odd behavior of pet bullfrogs that had metamorphosed just two weeks earlier. The frogs were housed in an aquarium attached to a water faucet by a copper wire. One Sunday, the man noticed that the frogs had increased their jumping activity and were hopping about more than usual. But he was particularly baffled the next day when he heard the young frogs croaking loudly at noon and then saw them swimming in clockwise circles. That evening at 7:45 an earthquake of magnitude 4.7 on the Richter scale struck the Bay area. Normally, frogs vocalize as adults. Males croak during the reproductive season and occasionally before an oncoming storm. Females sometimes grunt when they are captured or are otherwise disturbed. Consequently, the vocalizations of the young frogs was out of the ordinary and may have been a reaction to some otherwise undetected physical stimulus.

These reports, no matter how widely separated their places and times of origin, share certain attributes in common: increased animal irritability and vocalization, restlessness, and greater activity often leading to migrations. Although anecdotal in nature, the tales have enough substance to cause the People's Republic of China to take them seriously. The Chinese have distributed publications to farmers and rural residents instructing them what to watch for in their animals so that every household can join in observation and "the people's war against earthquakes" will be won. The government of the People's Republic claims that the location and time of origin of about fifteen earthquakes has been successfully foretold in recent years. The predictions have relied heavily on bizarre behavior among domestic animals, which can be easily observed without technical equipment or special training.

The Chinese are particularly proud of their prediction of the major earthquake in Haicheng on February 1975. The town was totally destroyed but very few persons were killed, even though a million lived near the quake's epicenter, because the population had been evacuated. Foremost among the precursory events of the earthquake was the discovery in mid-December that normally hibernating snakes had left their holes and frozen death on the ice. In the month preceding the major tremors, the earthquake also became more intensive as "hundreds thousands" of people reported unusual animal behavior, centered on an area that later proved to be the quake's epicenter.

Dramatic though these anecdotal accounts may be, a geophysicist at the California Institute of Technology has pointed out that concomitant physical events, such as rapidly changing ground tilt, drops in water level, and changes in the earth's geomagnetic field, could also lead to successful prediction. For all their success in predicting the Haicheng earthquake of 197
Some people set their sights higher than others.

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She says I never give her flowers.

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Chinese could not predict a much more devastating quake on July 28, 1976, which leveled the much larger city of Tangshan, and killed an estimated 750,000 to 850,000 persons.

Reports of anomalous animal behaviors associated with earthquakes are not new; in China they date back to masties of 3,000 years ago. And in seventeenth-century Japan, giant catfish were thought to be caused by earthquakes as they churned their massive bodies within the earth’s core. These mythical episodes were chronicled by the artist Ishiki-e in his colored woodblock prints. Although in the realm of folklore, such beliefs are founded on facts.

In the 1930s, earthquake swarms occurred with such regularity in Japan that several scientists were able to test the sensitivity of catfish to earthquake precursors. Working at the Asamushi Marine Biological Station, two researchers discovered a correlation between the response of catfish to a mechanical stimulus and the subsequent occurrence of an earthquake. The fish were kept in aquariums filled with water drawn directly from a local creek. The aquariums were installed on boulders on which the researchers operated three times a day. Their studies showed that if the catfish did not react to the tapping, no earthquake tremor would occur; but if they did respond—jumping—a slight tremor would be in evidence, usually six to eight hours later. The researchers claimed a correspondence of 80 percent between the fish reaction and the occurrence of earthquakes, indicating sensitivity to slight seismic disturbances.

Subsequent Japanese experiments with catfish were aimed at discovering whether the fish responded to electrical as well as seismic stimuli. Electrodes were inserted into the fish in the aquariums and the electric fields surrounding the fish were manipulated. Some relationship seemed to exist between catfish sensitivity to minute electrical changes, on one hand, and microamperes, and changes in the earth’s electric field associated with the occurrence of earthquakes.

Another Japanese scientist of the 1930s examined the relationship between daily fish catch and seismic activity in Izu Province, southwest of Tokyo. By carefully scrutinizing six years of catch data he reported a positive correlation between abundant catches of horse mackerel and seismic activity. He proposed that seismic shocks may have induced more fish to enter the fishing grounds or may have altered the migratory pattern of plankton or affected the chemistry of seawater as a result of disturbances to the sea floor. One Japanese ichthyologist was surprised to find the stomachs of sardines, normally upper-layer dwellers, engorged with bottom-adoring diatoms a day before the great Sanriku earthquake of 1933. Three days after the earthquake, the sardines’ stomachs were once again filled with their normal diet of upper-layer plankton. Furthermore, the catch of a rare deep-sea fish some hours after the earthquake led to the belief that seismic disturbances on the sea floor were triggering the upward migration of bottom dwellers.

With earthquake prediction in mind, a new look was taken at data collected at the Stanford Outdoor Primate Facility (SOPF) for the purpose of studying long-term changes in chimpanzee behavior associated with maturation and hormonal variations. Several intriguing deviations in behavioral frequencies were found to have taken place one day before a mild earthquake occurred in the vicinity of the facility, located close to the San Andreas fault. Observers reported a “significant elevation of restlessness,” as well as significant increases and decreases in the time the chimpanzees spent in certain areas of the facility. Similarly, a day before another earthquake, increased restlessness was also observed, but in that case space-utilization changes occurred only on the day of the quake. Although of slight magnitude, these earthquakes were apparently sensed by the chimpanzees about eight hours before they took place.

Chinese scientists in Peking have been probing the prediction potential of pigeons. They report that tiny ellipsoidal bodies in pigeons’ legs are sensitive to vibrations of very small amplitude, a fraction of a micron. These tiny bodies are connected to each other by clusters of nerves. That these bodies might detect earthquake precursors was shown in experiments in which some pigeons had the nerves to these structures severed and other pigeons were kept intact. Prior to an earthquake of magnitude 4.0 Richter, the unaltered birds flew about wildly, while those whose nerves were severed seemed to be unaware of the impending quake and remained calm.

"Today, Stanley and Livingstone would fly with us, I daresay."

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Provocative as these results may be, they have not yet been verified in this country.

Since the probability that any animals would be subject to intense seismic stimuli during their lifetimes seems fairly remote, it is difficult to believe that they have developed specific systems for the recognition of earthquake cues. Their sensing of precursory earthquake phenomena is probably effected through sensory detectors that are used primarily to gather information about daily environmental changes in their respective milieus.

Assuming, then, that no specific earthquake detectors exist, and that detection takes place through available sensory equipment, one major problem in ascertaining what particular stimuli animals react to is that the cluster of physical components involved in earthquakes is not necessarily identical from one earthquake to the next. Earthquakes have individual characteristics: modifications occur in acoustic waves, air-pressure levels, the tilt of the land, electrical conductivity, electromagnetic fields, electrostatic discharges, gas emissions, groundwater level, and temperature, for example, but these events do not always appear in identical patterns. The time of onset, frequency, duration, and magnitude of each may vary, as well as which particular physical events are present. To confound the experimenters further, physical changes that take place are often of such small magnitude that they fall within the range of normal fluctuations regularly experienced by the animal. To detect such changes would require the animal to distinguish an earthquake signal from an array of background “noise,” perhaps through a filtering system. Moreover, animal responses tend to differ according to the season, time of day, age, and previous experience. Thus, given that we do not have complete information about animal detection capabilities, and that our knowledge of the physical events preceding earthquakes is also incomplete, we can only guess as to what the animals are actually sensing.

Animal sensors that discern light, sound, odor, touch, and temperature are well known. Less well known are sensors that detect changes in the earth’s magnetic field. That they exist is currently being revealed by scientists studying orientation, navigation, migration, and homing among birds, bees, and other species. For those who believe in animals as earthquake predictors, the discovery that some animals distinguish small shifts in magnetic fields is very exciting since it has long been thought that variation in geomagnetic fields is intimately involved with earthquakes.

The earth’s geomagnetic field is measured in units known as gammas. One gamma (which is a very weak field) is one fifty-thousandth of the total average terrestrial field. At the earth’s surface, the geomagnetic field is variable. When analyzing the sensitivity of animals to earthquakes it is therefore important to remember that within their normal daily foraging adventures, animals may be sensitive to magnetic field variations that vary by as much as several hundred gammas. More important perhaps is the diurnal variation of thirty to fifty gammas that results from the interaction between the earth’s magnetic field and charged particles in the solar wind. Thus the small changes of one to ten gammas recorded in local magnetic fields before earthquakes are within the range of normal daily fluctuations. Although the amplitude of these normal fluctuations may be small, we do not know their frequencies. With these constraints in mind, let us examine research that reveals the capacity of some animals to detect magnetic field changes, but does not indicate what their magnetic sensors may be.

Basically, the research technique consists of altering magnetic fields—braving the field to zero or otherwise altering it artificially. The behaviors changes considered to be indicators of the awareness of magnetic change consist of the animals pointing, turning, and moving in a direction different from control animals, in a manner more or less consistent with predictions made by the experimenter.

During the early 1960s, a biologist at Northwestern University recorded the directional responses of mud snails planarian worms, protozoans, and fruit flies to manipulated fields with variations in magnitude comparable to those of natural terrestrial magnetism. The animals’ behavioral changes were consistent, but rather subtle, and the results were not at first generally accepted. Since then, however, other researchers have achieved more convincing results, and many animal behaviorists now believe that some animals are indeed sensitive to weak magnetic fields.

In the early 1970s the sensitivity of honeybees to magnetic fields was demonstrated by the work of German scientists who had studied with Nobel laureate Karl von Frisch. As long ago as the 1920s, von Frisch established that hon
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eybees communicate the distance and direction of food supplies to members of their colonies by means of dances. The direction of the dance within the hive relative to the angle of the sun informs fellow hive members of the direction of nectar-laden flowers; the duration of the waggle in the dance indicates the distance.

Using that information as a model, two German investigators discovered what seemed to be an "error." The direction of the dance was always a little off, yet the bees found the food with unerring accuracy. Obviously, some factor in addition to the position of the sun was involved. The researchers tracked the diurnal variations in the strength of the earth's magnetic field and found that the so-called errors in the bees' dances corresponded to those magnetic changes. If the earth's magnetic field was artificially reduced to zero within the hive, the researchers showed that the direction of the dance followed the route they predicted from the model. Moreover, the bees evidently sensed magnetic fluctuations as small as ten gammas, again well within the range of normal fluctuations in terrestrial magnetism. The bees' magnetic detectors, however, remain unknown.

Homing pigeons similarly sense changes in the magnetic field and may use the information for orientation on overcast days. A research team at Cornell University found that although the sun's position is the main directional cue, pigeons still navigate successfully on cloudy days. Small bar magnets attached to the pigeons' backs had no effect on their navigation on sunny days but caused confusion and interfered with typical directional choice when the birds were released some distance from home on cloudy days. Researchers at the State University of New York, at Stony Brook actually forced a new orientation, rather than merely disrupting the expected one, by attaching electrical coils to pigeons. When the current flowed counterclockwise in the coils of some birds and clockwise in the coils of others, the birds headed in opposite directions from each other. It thus appears that cues from the magnetic field may be used as directional guides when the sun is hidden.

In other research at Cornell involving indigo buntings, the birds shifted their orientation as the magnetic field was deflected. This tendency disappeared as the migratory season waned; then the birds ignored information from both natural and artificially deflected magnetic fields. A European scientist and his associates also demonstrated magnetic field sensitivity among European robins. The birds selected migratory directions according to the magnetic field as well as the season. Working with ring-billed gull chicks, an ornithologist at Northern Illinois University disrupted their preferred south-southeast orientation inside a circular arena when the normal magnetic field was changed. If it was increased to forty gammas or more — that of a moderately severe magnetic storm — the tendency to orient directionally was reduced. Nevertheless the ornithologist was careful to emphasize the tenuous nature of such experiments since they tend to generate disturbances and disorientation, but do not necessarily force the birds to choose another heading and do not affect all the birds.

Recent field studies, however, seem, at least indirectly, to reaffirm the laboratory results. One field project visually tracked nocturnally migrating passerine birds and correlated their loss of accuracy in orientation with disturbances in the magnetic field. But the investigators cautioned that magnetic field disturbances may not directly affect the birds but may act through such intermediaries as weather patterns, which are also modified by the earth's magnetic activity.

Another field study found that man-made electromagnetic field fluctuations caused turning or changes in altitude among nocturnally migrating birds. Evidently, the birds rapidly detected the low-frequency fluctuating electromagnetic field (in the other studies reported above, the fields were constant). Tracking with radar, the investigators recorded the flight paths when the antenna system was off, was on, and during changes of current. The greatest deviation from linear paths occurred when the antenna was on or was changing currents. Although cautious about these results, the investigators believe that birds detect low-frequency electromagnetic variations within a few seconds and that orientation at night can be altered by the local electromagnetic field.

Evidence thus accumulates that birds are capable of sensing small fluctuations in magnetic fields. Animal behaviorist William T. Keeton of Cornell University, who conducted the experiments on homing pigeons, believes that experimental refinements may eventually demonstrate that birds and bees are capable of detecting changes in magnitude as small as one gamma, well below the amplitude of the earth's field. In addition, Keeton points out that homing pigeons sense small shifts in barometric pressure and can also detect extreme low-frequency sounds — physical events that are associated with earthquakes.

Although the studies of birds and bees were not directed at detecting sensitivity to earthquakes, they suggest fruitful directions for further inquiry along that line. Recent research on the sensory perception of fish has also been directed toward earthquake prediction. Nevertheless, fish, like birds and bees, have sensory capacities that may permit them to react to earthquake precursors. Fish have special sensory equipment called the lateral line system, an arrangement of canals that run down the fish's flanks. Its basic function is to detect changes in nearby water movements and low-frequency vibrations. When fish sense the vibrations, the sensors have developed a new function, that of electrorception.

This rather remarkable attribute allows for the detection of extreme small changes in voltage. All fish produce constant bioelectric fields around their bodies, and some marine animals are acutely sensitive to these fields. Sharks and rays, for example, have minute saclike receptors called ampullae of Lorenzini, which they use to point their prey. A series of well-controlled experiments has shown that sharks and rays can detect a flatfish submerged in sand simply by distinguishing its bioelectric field, when all visual, chemical, and mechanic cues were masked. Electrodes emit the same voltage as a flatfish elicited the same hunting behavior. Endowed with electrorceptors, catfish also have the talent, locating live goldfish in the absence of all stimuli except bioelectrons.

Granted that many animals seem to be acutely sensitive to various premoritory events associated with earthquakes, the basic question remains: how can this behavior be put to use in earthquake prediction? Can we learn just what stimuli particular species are reacting to? Can we then design instruments of comparable discrimination and sensitivity? And even with such instruments, do the premoritory events take place sufficiently in advance of major tremors to make long-term predictions, and the concomitant evacuation of large populations, a realistic possibility? Only further experiments will provide the answers.

Evelyn Shaw is a biologist who teaches animal behavior at Stanford University.
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When I was four I wanted to be a garbageman. I loved the rattling of the cans and the whir of the compressor; I thought that all of New York's trash might be squeezed into a single, capacious truck. Then when I was five, my father took me to see the Tyrannosaurus at the American Museum of Natural History. As we stood in front of the beast, a man sneezed; I gulped and prepared to utter my Shema Yisrael. But the great animal stood immobile in all his bony grandeur, and as we left, I announced that I would be a paleontologist when I grew up.

In those distant days of the late 1940s, there wasn't much to nurture a boy's interest in paleontology. I remember Fantasia, Alley Oop, and some fake-antique metal statues in the Museum shop, priced way above my means and not very attractive anyway. Most of all, I recall the impression conveyed in books: Brontosaurus, wallowing its life away in ponds because it couldn't support its weight on dry land; Tyrannosaurus, fierce in battle but clumsy and ungainly in motion. In short, slow, lumbering, pea-brained, coldblooded brutes. And, as the ultimate proof of their archaic insufficiency, did they not all perish in the great Cretaceous extinction?

One aspect of this conventional wisdom always bothered me: why had these deficient dinosaurs done so well — and for so long? Therapsid reptiles, the ancestors of mammals, had become diverse and abundant before the rise of the dinosaurs. Why didn't they, rather than dinosaurs, inherit the earth? Mammals themselves had evolved at about the same time as dinosaurs and had lived for 100 million years as small animals in the interstices of a dinosaur's world. Why, if dinosaurs were so slow, stupid, and inefficient, did mammals not prevail right away?

A striking resolution has been suggested by several paleontologists during the past decade. Dinosaurs, they argue, were fleet, active, and warmblooded. Moreover, they have not yet gone the way of all flesh, for a branch of their lineage persists in the branches — we call them birds.

A year ago, I vowed that I would not write about warmblooded dinosaurs in this column: the new gospel had gone forth quite adequately in television, newspapers, magazines, and popular books. The intelligent layperson, that worthy abstraction for whom we write, must be satisfied. But I relent, I think for good reason. In nearly endless discussions, I find that the relationship between two central claims — dinosaur endothermy (warmbloodedness) and dinosaurian ancestry of birds — has been widely misunderstood. I also find that the relationship between dinosaurs and birds has provoked public excitement for the wrong reason, while the right reason, usually unappreciated, neatly unites the ancestry of birds with endothermy of dinosaurs. And this union supports the most radical proposal of all — a restructuring of vertebrate classification that removes dinosaurs from Reptilia, sinks the traditional class Aves (birds), and designates a new class, Dinosauria, uniting birds and dinosaurs. Terrestrial vertebrates would fit into four classes: two coldblooded, Amphibia and Reptilia, and two warmblooded, Dinosauria and Mammalia. I have not made up my own mind about this new classification, but I appreciate the originality and appeal of the argument.

The claim that birds had dinosaurs as ancestors is not so tumultuous as it might first appear. It involves no more than a slight reorientation of a branch on the phylectic tree. The very close relationship between Archaeopteryx, the first bird, and a group of small dinosaurs called the coelurosauras has never been doubted. T. H. Huxley and modern-century paleontologists advocated a relationship of direct descent and derived birds from dinosaurs.

But Huxley's opinion fell into disfavor during this century for a simple, as apparently valid, reason. Complex structures, once totally lost in evolution, do not reappear in the same form. This statement invokes no mysterious directional forces in evolution, but merely asserts a claim of mathematical probability. Complex parts are built from hundreds of genes, interacting in complex ways with the entire developmental machinery of an organism. Dismantled by evolution, how could such a system be built again, piece by piece? The rejection of Huxley's argument hinged on a single bone — the clavicle, or collarbone. In birds, including Archaeopteryx, the clavicles are fused to form a furcula, better known to friends of Colonel Sanders as a wish bone. All dinosaurs, it appeared, had lost their clavicles; hence, they could not be the direct ancestors of birds. A unimpeachable argument if true. But negative evidence is notoriously prone to invalidation by later discovery.

Still, even Huxley's opponents could not deny the detailed structural similarity between Archaeopteryx and the coelurosaurian dinosaurs. So they opted for the nearest possible relationship between birds and dinosaurs — common derivation from a group of reptiles that still possessed a clavicle, subsequent loss in one line of descent (dinosaur and strengthened and fused in another (birds). The best candidates for co
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mon ancestry are a group of Trias-
thecodont reptiles called pseudosuc-
chians.

Many people, on first hearing that
birds might be surviving dinosaurs
think that such a striking claim must
represent a complete discomfitatious
of received doctrine about vertebrate
relationships. Nothing could be furthe-
ner from the truth. All paleontologists
advocate a close affinity between di-
nosauurs and birds. The current debate
concerns about a small shift in phylogen-
etic branching points: birds either branch
from pseudosuchians or from the de-
sendants of pseudosuchians—the coelu-
rosaurian dinosaurs. If bird
branching at the pseudosuchian level
they cannot be labeled as descendant
of dinosaurs (since dinosaurs had not
yet arisen); if they evolved from coelur-
rosaurs, they are the only surviving
branch from a dinosaur stem. Since
pseudosuchians and primitive di-No
one is suggesting that hummingbird
evolved from Stegosaurus or Tricerata-
ops.

The issue, thus explicated, may now
seem rather ho-hum to many readers
although I shall soon argue (for a differ-
ent reason) that it isn't. But I want to
emphasize that these twists of gene-
alogy are of utmost concern to profes-
sional paleontologists. We care very
much about who branched from whom
because reconstructing the history of
life is our business, and we value our
favorite creatures with the same loving
concern that most people invest in their
families. Most people would care very
much if they learned that their cousin
was really their father — even though
the discovery carried few insights about
their biological construction.

Yale paleontologist John Ostrom has
recently revived the dinosaurian theory
He restudied every specimen of Ar-
chaeopteryx — all five of them. First of
all, the main objection to dinosaurs had
already been countered. At least two
coeleurosaurian dinosaurs had clavicles
after all, so they are no longer debarred
as progenitors of birds. Secondly, Os-
trom documents in impressive detail the
extraordinary similarity in structure between
Archaeopteryx and coelurosaurians. Since
many of these common features are not
shared by pseudosuchians, they either
evolved twice (if pseudosuchians are
ancestors of both birds and dinosaurs)
or they evolved just once and birds in
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re still alive? Or, to put the question more operationally, shall we classify dinosaurs and birds in the same group, with birds as the only living representatives? Paleontologists R. T. Baker and P. M. Galton advocated this course when they proposed the new vertebrate class Dinosauria to accommodate both birds and dinosaurs.

A decision on this question involves basic issue in taxonomic philosophy. Sorry to be so technical about such a hot subject, but severe misunderstandings can arise when we fail to sort formal questions in taxonomy from biological claims about structure and physiology. Some taxonomists argue that we should group organisms only by patterns of branching: if two groups branch from each other and have no descendants (like dinosaurs and birds), they

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must be united in formal classification before either group joins another (like dinosaurs with other reptiles). In this so-called cladistic (or branching) system of taxonomy, dinosaurs cannot be reptiles unless birds are as well. And if birds are not reptiles, then according to the rules, dinosaurs and birds must form a single, new class.

Other taxonomists argue that branching points are not the only criterion of classification. They weigh the degree of adaptive divergence in structure as well. In the cladistic system, cows and lungfish have a closer affinity than lungfish and salmon because the ancestors of terrestrial vertebrates branched from the sarcopterygian fishes (a group including lungfish) after the sarcoptes had already branched from the actinopterygian fishes (standard bony fishes, including the salmon). In the traditional system, we consider biological structure as well as branching pattern, and we may keep lungfish and salmon together as fish because they share so many features as aquatic vertebrates.

The ancestors of cows experienced an enormous evolutionary transformation, from amphibian to reptile to mammal; lungfish stagnated and look pretty much as they did 250 million years ago.

The traditional system recognizes unequal evolutionary rates after branching as a proper criterion of classification. A group may win separate status by virtue of its profound divergence. Thus, in the traditional system, mammals can be a separate group and lungfish can be kept with other fish. Humans can be a separate group and chimps can be kept with orangutans (even though humans and chimps share a more recent branching point than chimps and orangs). Similarly, birds can be a separate group and dinosaurs kept with reptiles, even though birds branched from dinosaurs. If birds developed the structural basis of their great success after they branched from dinosaurs, and if dinosaurs never diverged much from a basic reptilian plan, then birds should be grouped separately and dinosaurs should be kept with reptiles, despite the genealogical history of branching. So, we finally arrive at the central question and at the union of this technical issue in taxonomy with the theme of warmblooded dinosaurs. Did birds inherit their primary features directly from dinosaurs? If they did, Bakker and Galton’s class Dinosauria should probably be accepted, despite the adherence of most modern birds to a mode of life (flight and small size) not wonderfully close to that of most dinosaurs. After all, bats, whales, and armadillos are all mammals.

Consider the two cardinal features that provided an adaptive basis for flight in birds — feathers for lift and propulsion and warmbloodedness for maintaining the consistently high level of metabolism required by so strenuous an activity as flight. Could Archaeopteryx have inherited both these features from dinosaur ancestors?

R. T. Bakker has presented the most elegant brief for warmblooded dinosaurs in the April 1975 issue of Scientific American. He rests his controversial case on four major arguments:

1. The structure of bone. Coldblooded animals cannot keep their body temperature at a constant level; it fluctuates in sympathy with temperatures in the outside environment. Consequently, coldblooded animal living in regions with intense seasonality (cold winters and hot summers) develop growth rings in outer layers of compact bone — alternating layers of rapid summer and slower winter growth, just as trees. Warmblooded animals do not develop rings because their internal temperature is constant in all seasons. Dinosaurs from regions of intense seasonality do not have growth rings in their bones.

2. Geographic distribution. Large coldblooded animals do not live at high latitudes (far from the equator because they cannot warm up enough during short winter days and are too large to find safe places for hibernation). Some large dinosaur lived so far north that they had to endure several months of no sun all during the winter.

3. Fossil ecology. Warmblooded carnivores must eat much more than coldblooded carnivores of the same size in order to maintain their constant body temperatures. Consequently, when predators and prey are about the same size, a community of coldblooded animals will include relatively more predator (since each one needs to eat so much less) than a community of warmblooded animals. The ratio of predators to prey may reach 40 percent in coldblooded communities; it does not exceed 3 percent in warmblooded communities. Predators are rare in dinosaur communities; the relative abundance matches our expectation for modern communities of warmblooded animals.
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4. Dinosaur anatomy. Dinosaurs are usually depicted as slow, lumbering beasts, but newer reconstructions indicate that many large dinosaurs resembled modern running mammals in locomotor anatomy and the proportions of their limbs.

But how can we view feathers as an inheritance from dinosaurs; surely no Brontosaurus was ever invested like a peacock. For what did Archaeopteryx use its feathers? If for flight, then feathers may belong to birds alone; no one has ever postulated an airborne dinosaur (flying pterosaurs belong to a separate group). But Ostrom's anatomical reconstruction strongly suggests that Archaeopteryx could not fly; its feathered forearms are joined to its shoulder girdle, in a manner quite inappropriate for flapping a wing. Ostrom suggests a dual function for feathers: insulation to protect a small warm-blooded creature from heat loss and as a sort of basket trap to catch flying insects and other small prey in a fully enclosed embrace.

No theme has recycled through these columns more frequently than the effects of size. Archaeopteryx was a tiny animal, weighing less than a pound. It was a full foot shorter than the smallest dinosaur. Small creatures have a very high ratio of surface area to volume. Heat is generated by the body's volume and radiated out through its surface. Small warm-blooded creatures have special problems in maintaining a constant body temperature since heat dissipates so quickly from their relatively enormous surface. Shrews, although insulated by a coat of hair, must eat nearly all the time to keep their internal fires burning. The ratio of surface to volume was so low in large dinosaurs that they could maintain constant temperatures without insulation. But as soon as any dinosaur or its descendant became very small, it would need insulation to remain warm-blooded. We may view feathers as a primary adaptation for constant temperatures in small dinosaurs. Bakker suggests that many small coelurosaurians may have been feathered as well. (Very few fossils would preserve any feathers; Archaeopteryx is a great rarity of exquisite preservation.)

Feathers, evolved primarily for insulation, were soon exploited for another purpose in flight. Indeed, it is hard to imagine how feathers could have evolved if they never had a use apart from flight. The ancestors of birds were surely flightless, and feathers did not arise all at once and fully formed. How could natural selection build an adaptation through several intermediate stages in ancestors that had no use for it? If postulating a primary function for insulation, we may view feathers as a device for giving warm-blooded dinosaurs an access to the ecological advantage of small size.

Ostrom's arguments for a descent of birds from coelurosaurian dinosaurs do not depend upon the warmbloodedness of dinosaurs or the primary utility of feathers as insulation. They are based instead upon the classical methods of comparative anatomy — detailed par-by-part similarity between bones and contention that such striking resemblance must reflect common descent, not convergence. I believe Ostrom's arguments will stand no matter how the hot debate about warm-blooded dinosaurs eventually resolves itself.

But the descent of birds from dinosaurs wins its fascination in the public eye only if birds inherited the primary adaptations of feathers at warmbloodedness directly from dinosaurs. If birds developed the adaptations after they branched, the dinosaurs are perfectly good reptiles; they should be kept with turtles, lizards, and their kin in the class Reptilia. (I tend to be a triditionalist rather than a cladist in a taxonomic philosophy.) But dinosaurs really were warmblooded and if feathers were their way of maintaining warmbloodedness at small size then birds inherited the basis of the success from dinosaurs. And dinosaurs were closer to birds than other reptiles in their physiology, so we have a classical structural argument — not just a genealogical claim — for the formal alliance of birds and dinosaurs in a new class, Dinosauria. Bakker and Galton write: "The avian radiation is an aerial exploit of basic dinosaur physiology and structure, much as the bat radiation is an aerial adaptation of basic, primitivemammal physiology. Bats are not separated into an independent class merely because they fly. We believe that neither flight nor the species diversity of birds merits separation from dinosaurs or class level." Think of Tyrannosaurus and thank the old terror as a representative of his group, when you split the wishbone later this month.

Biologist Stephen Jay Gould's most recent book is Ever Since Darwin: Reflections in Natural History.
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The Sighting at Pine Knot
by Alton A. Lindsey

Was Theodore Roosevelt the last person ever to see free passenger pigeons?

The historic weather-beaten cottage gradually revealed itself through the leafless trees as my walk down the lane neared an end. My long search for Pine Knot, the old presidential hideaway in western Virginia, forgotten except very locally, was over.

It was early 1976. The bare oak trees stood becalmed in the thin April sunshine, gathering from it the energy needed for their spring explosion. The same solitude beloved by Theodore and Edith Roosevelt was still there. How much does this modest house remember of its distinguished owners? It seemed unchanged since the day of TR’s 1906 photograph, except that the cottontail rabbits he had bagged for the evening meal, which he would cook in one of the fireplaces within, were not now hanging on the west wall in the shade of the chimney. One felt that at any moment the brooding stillness might be broken by the creaking of saddle leather or by a rustling of fallen leaves from footfalls of a stocky figure strolling among the trees.

The president wrote his son Kermit in early June 1905, “Mother and I have just come from a lovely trip to Pine Knot. It is really a perfectly delightful little place; the nicest little place of its kind you can imagine. Mother is a great deal more pleased with it than any child with any toy I ever saw . . . .” The cottage and the surrounding fifteen wooded acres had been given her by longtime friends of her family, the Wilmers of adjacent Plain Dealing. TR hired Dick McDaniel to build two chimneys and fireplaces of native stone, so that a roaring fire at each end of the large downstairs room would keep the family warm on winter weekends. Later, another seventy-five acres were added and the family kept the whole ninety until 1941. The couple usually took breakfast on the porch to hear the morning bird chorus.

When John Burroughs spent four days at Pine Knot with the Roosevelts, he and TR identified seventy-five species of birds in the woods and fields. TR showed his friend two kinds new to Burroughs and learned two others from him. Oom John, as TR always addressed him, wrote after the president’s death that the latter had known the warblers in the trees overhead during that spring migration as well as he did himself. TR was especially expert on bird songs and calls.

Unlike today’s presidential retreat, Camp David, at Pine Knot both luxury and security were scarce. Roosevelt would not tolerate the presence of Secret Service people there. He had learned to take care of himself in the wild Dakotah Territory of the 1880s. He confided in Burroughs that he went armed and felt confident he could get the drop on any intruder. One night during a stroll, Burroughs heard something large rushing away from him through the woods. When he mentioned it to Edith Roosevelt the next morning, she whispered that it was doubtless one of the two agents who watched over the cottage secretly at night and hid in a nearby farmhouse in the daytime. Autumns, TR used to leave on wild turkey hunts as early as three in the morning and return after dark. Thus, the stage was set for a tragi-comedy in which a president of the United States shoots his own protector by mistake but, fortunately, the curtain never rose.

Roosevelt’s most memorable wildlife experience at Pine Knot was, unquestionably, one no longer possible for anyone. He sighted, and observed for some time, a flock of passenger pigeons already believed, even then, to be extinct in the wild. A few score of years earlier, it had been the most amazingly abundant of all North American birds, perhaps the most abundant in the world. Is TR’s identification of the pigeons really credible? If so, was he the last person ever to see free passenger pigeons? These questions will be considered after we have seen what sort of naturalist, ecologist, and ornithologist Theodore Roosevelt was. For his qualifications certainly bear upon the validity of his wild pigeon claim, included rather inconspicuously in his leading article “Small Country Neighbors,” in Scribner’s Magazine for October 1907.

While Roosevelt’s achievements in conservation are well known, the background that made them possible is not. He was not only one of our very few presidents who had a thorough education in science but the only one formally trained in the environmental sciences. From boyhood on, he became, in turn, a taxidermist, traveler, historian, author, hunter, law student, politician, rancher, conservationist, soldier, statesman, and explorer. But he was a naturalist from first to last, an important fact that seems to have been largely forgotten. The first and last letters he wrote were about birds, he wrote many technical publications on nature, and naturalists of his time considered him one of their number. He took camping trips in national parks with Muir and Burroughs.

Theodore Roosevelt’s parents lived in Manhattan, where Theodore was born in 1858. The father, a prosperous importer, was a founder of the American Museum of Natural History and assisted societies for the prevention of cruelty to animals. The boy’s Uncle Robert was an attorney and writer of outdoor books, who predicted that many game species would suffer extinction unless protected by law. Young Theodore, however, first became a naturalist through his own efforts.
On Photographing the Invisible

To the naked eye, it was a Swedish 80-øre postage stamp. A rarity, and very valuable.

The camera, however, told quite a different story. The stamp was a counterfeit.

Faint traces of tampering that were not visible to the naked eye were revealed when the stamp was examined under a microscope. Someone, somewhere, ingeniously altered the stamp by chemically removing a surprint. The stamp was worthless.

To the naked eye (left), the stamp was genuine. To the camera (right), it was a counterfeit. Note the faint, dark traces of tampering now revealed in the upper section.

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Braun North America is a division of The Gillette Company and exclusive marketer of Hasselblad cameras in the U.S.
I remember distinctly [TR wrote] the first day that I started my career as a zoologist. I was walking up Broadway, and as I passed the market ... I suddenly saw a dead seal laid out on a slab of wood. That seal filled me with every possible feeling of romance and adventure. ... I haunted the market day after day. I measured it [the seal] ... and at once began to write a natural history of my own, on the strength of that seal. ... I did get the seal’s skull and with two of my cousins promptly started what we ambitiously called the “Roosevelt Museum of Natural History.” My father and mother encouraged me warmly in this ... When I was thirteen I was allowed to take lessons in taxidermy from a Mr. Bell ... who had been a companion of Audubon’s.

Theodore built up an outstanding collection of museum skins of birds, which probably surpassed that of any other youngster in the country. Latin names were used for his labels and notebook records. His preferred reading was on animals, starting with a tome of Livingstone’s on Africa (where TR was to lead a year-long collecting expedition for the Smithsonian soon after leaving the White House). In 1871, the family visited the Adirondacks when the region was still primitive. TR kept a diary, not neglecting technical names of things he found there.

At fourteen, TR took his second trip across the Atlantic and visited Egypt and Palestine. The family took a houseboat 1,200 miles on the Nile where Theodore did his first significant collecting and taking of detailed note on nearly two hundred specimens. He learned the birds so well that he could name them on sight when he was next on the Nile, thirty-seven years later.

Young Roosevelt entered Harvard in 1876. He majored in biology, fully intending to make science his life work. Soon before graduating magna cum laude, he changed his career plans because biology was then dominated by the light microscope. “The sound revolt against superficiality had been carried to an extreme; thoroughness in minute had not been enthroned in a fetish; ... I had no more desire or ability to be a microscopist and section-cutter than to be a mathematician.” His first writing to see print was an account of Adirondack birds seen on a trip with a fellow student; his name first appeared...
Joverb, reputation

His western activities from 1883 to 1889 made into TR country forever the land now in Theodore Roosevelt National Memorial Park, a major part of the Little Missouri National Grassland, which includes the Badlands of North Dakota. Although he worked strenuously at ranching, the business aspect was less important to him than his outdoor observing, adventuring, hunting, and writing. He often said later that rich life had been the making of him. He wrote there his splendid trilogy of books on his western life and part of his year-volume history on the winning of the west. The Old West still lives in any of the thirty-eight books he proceed. This scholarly output should have corrected the popular image of a politician crashing about like a bull frog while flashing a toothy grin. For his reputation as a man of action was a self-truth; he was equally a man of intellect.

The three intellectuals who have occupied the White House were Jefferson, Theodore Roosevelt, and Wilson. TR had more humor and warmth than the other two combined. His uniqueness as an intellectual was that he had no weak opinions. Nevertheless, individual aggressiveness has seldom been better directed to the common good, for progress in conservation and social reform does not come about from bland leading the bland. Memorable slogans and metaphors came from his wilderness experience: the Bull Moose Party, the west African hunting over bush, “Speak softly and carry a big stick; you will go far,” and “The vote is as a rifle; its usefulness depends on the character of the user.”

The five national parks, sixteen national monums, and many national rest and game preserves established during his tenure endears TR to modern environmentalists. For the parks, he did not follow the idea of high-use conservation, more properly espoused by his lieutenant Gifford Pinchot. Roosevelt’s idea was more subtle—to preserve the highest-quality areas of each type with a minimum of development, and directed toward esthetic, scientific, and natural outdoor recreational use. He stated, “Nothing is more prael in the long run than the preservation of beauty.”

Those claiming today that TR was...
not a "preservationist" should review the history of Grand Canyon National Park. In 1903 when this area was vulnerable as a mere game refuge, he took long horseback rides in its rimland country and must have decided then to make it a national monument; this he could do without the approval of Congress. Then he made a speech that was far more preservationist than the way the canyon was eventually handled, and while it antagonized the local audience, it delights modern preservationists.

In the Grand Canyon, Arizona has a natural wonder which, so far as I know, is in kind absolutely unparalleled throughout the rest of the world. I want to ask you to do one thing in connection with it in your own interest and in the interest of the country—keep this great wonder of nature as it is. I hope you will not have a building of any kind, not a summer cottage, a hotel or anything else, to mar the wonderful grandeur, the sublimity, the great loneliness and beauty of the Canyon. You cannot improve it. The ages have been at work on it, and man can only mar it.

The great American presidents were those who saw their responsibilities to the future and acted on them. We hear pious talk deploring TR’s “big stick” methods, but in truth he practiced an enlightened ethic precisely where it is most important and most difficult to do so—toward the rights and needs of unborn generations. The environmental movement he started and the living wildlands he set aside from ordinary exploitation commemorate TR more suitably than his visage on Mount Rushmore.

After birding with Roosevelt at the White House grounds, at Pine Knot, Yellowstone Park, and Sagamore Hill, John Burroughs wrote:

I refer to his keenness and enthusiasm as a student of animal life, and his extraordinary powers of observation. He sees quickly and surely, not less so with the corporeal eye than with the mental. . . . The chief qualification of a born observer is an alert, sensitive, objective type of mind and this he has in preeminent degree. . . . His mind moves with wonderful celerity, and yet as an observer he is very cautious, jumps to no hasty conclusions.

Roosevelt’s passenger pigeon sighting was first reported in letters to the U.S. Biological Survey and to John Burroughs. The readers of Scribner’s Magazine learned about it five months later.

On May 18th, 1907, I saw a small party of a dozen or so passenger pigeons, birds I had not seen for a quarter of a century and never expected to see again. I saw them two or three times flying hither and thither with great rapidity, and once they perched in a tall dead pine on the edge of an old field. They were unmistakable; yet the sight was so unexpected that I almost doubted my eyes, and welcomed a bit of corroborative evidence coming from Dick McDaniel, the colored foreman at Plain Dealing. Dick is a frequent companion of mine in rambles around the country, and he is an unusually close and accurate observer of birds, and of wild things generally.

Burroughs and Roosevelt together questioned McDaniel about all aspects of his sighting of about forty-five of the birds six days before TR’s sighting. His observations agreed with the president’s in every particular. McDaniel was familiar with passenger pigeons from his youth, but had always called them “wild carrier pigeons.” Burroughs wrote at the time that, despite initial skepticism, he was now convinced that both men had seen passenger pigeons.

The only other sharp-tailed, dove-shaped bird that an ornithologist of TR’s capabilities could conceivably have confused with the wild pigeon is the mourning dove. But the birds seen by both observers were decidedly larger than the familiar dove. The latter averages four and a half inches shorter than the wild pigeon. Wingspread, the distinction most apparent in flight, is 17 to 19 inches for the dove and 23 to 25.5 for the pigeon. Other evidence was the flapping behavior at that time of year, the characteristic circling behavior of wild pigeon flocks, the red breasts, rapid flight, and lack of the whistling sound that marks mourning doves in flight.

In mourning doves, the pair-bond is strong in spring; the only possible flocking then would be by the young of the year, and these would not have had red breasts nor their full overall length. But pigeons spent the entire year in flocks, even in breeding. As a skilled wingshot, TR was better qualified than most ornithologists to judge the rapidity of flight, and as an expert in bird sounds he would surely have noticed the whistling noise if they had been doves.

Roosevelt could have gone back to Pine Knot for his shotgun to collect a bird for final confirmation, but he wrote, “Nothing could have persuaded me to shoot them. There were mourning doves in the field for me to compare them with, and I do not see how I could have been mistaken.” This direct comparison with doves clinched the matter for the ornithologists at the American Museum of Natural History, and they accepted the record according to a letter written later by Robert Cushman Murphy.

The last specimen authenticated as a collection was a single bird shot in August 1906 in Fairfield County, Connecticut. A small flock captured in 1878 had been established in the Cincinnati zoo, and eventually produced Martha, the last individual of what was once the most abundant bird of North America. She died there in 1914 at age 19—fifty-seven years after the Ohio Legislature had declared, “This passenger pigeon needs no protection. Wonderfully prolific. . . .”

Biologists scoffed at the plethora of alleged sightings by farmers and hunters, from about 1890 on, because so many laymen’s reports were based on mourning doves or on distant flocks of other birds, such as curlews. No claims after TR’s have been established to the satisfaction of ornithologists. His dozen or so birds were, so far as science and history can tell, the last free members of a species; a single flock of which the conservatisitic ornithologist Alexander Wilson in 1833 estimated to contain at least 2,230,270,000 birds.

There is no indication that the president tried to determine whether the very few subsequent newspaper stories of sightings by untrained observers were reliable. Neither did he push for the acceptance of his own sighting. But he never saw cause to doubt the accuracy of his identification of the Pine Knot flock, and allowed this incident to be reprinted in successive editions of his book Outdoor Pastimes of an America Hunter. He held to his original statements, the mildest expression of which was “I do not see how I could have been mistaken.”

Thus, Roosevelt probably never realized that his sighting was the last time a trained, qualified naturalist ever saw wild passenger pigeons. Whether he was actually the last human to see them will never be known. His distaste for going back for his gun to validate the sighting beyond any possible question should not deprive this lifelong naturalist of the most dramatic bird record of the twentieth century.

Alton A. Lindsey, who received the Entom Ecologist Award last year, is professor emeritus of botany at Purdue University and the author of numerous articles and books on plants, general ecology, and birds.
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Why Slugs Squabble
by C. David Rollo and William G. Wellington

Slugs prey on each other not only in courtship rituals but also in competition over vital food and shelter

Naked slugs lack the visual appeal of their decently clothed cousins, the snails. While slugs are denounced as slimy horrors to be squashed on sight, snails are depicted, in animated cartoons and children’s books, as cheerful little wanderers. As escargots, snails appear on all the better menus. But no sane restaurateur would feature their shell-less relatives, even as les limaces.

Evidently, mollusks without shells are not acceptable to our fastidious eyes. Unfortunately, what is beneath our notice may not only continue to thrive but may also do much damage that escapes our notice. Slugs destroy an astonishing range of crops and ornamental plants in fields and gardens around the world. Most of us pay so little attention to the way slugs operate that we often blame garden insects for damage caused by slugs.

At first glance, slugs seem totally unsuited for life on dry land. These unprepossessing creatures have no direct control over the rate at which they lose water to the surrounding air. And they lose further vital water in the slime they trail wherever they travel: a slug moves by rippling its flat, muscular foot over a layer of mucus that it constantly secretes from a gland beneath its head.

A bag of cold water that cannot even move unless it leaks should not be able to survive outside a bog. But slugs not only survive in dry places; they have become highly successful terrestrial animals, despite the fact that direct sunlight can shrivel them as fast as the dawn crumpled Count Dracula.

A few slug species have avoided the uncertainties of life on dry land by opting for totally subterranean habitats, but most live above ground. They survive by restricting their mainly vegetarian foraging to the dampest times of day, when they can safely travel to normally intolerable places. They can climb tall trees, dropping back to the ground on threads of slime, like slippery caterpillars.

On damp, cloudy days, terrestrial slugs will forage in daylight, but dry weather restricts them to nocturnal forays. An extremely precise internal clock guides their nighttime travels, prompting them to emerge when the evening air has become damp enough for safe travel and insuring their return to shelter while the predawn environment is still tolerable.

Many slugs have a highly developed homing mechanism, mostly related to their sense of smell, that allows them to return repeatedly to particular crevices. A slug can find its own shelter from more than three feet away by following the odor of its droppings within the crevice and, perhaps, by the scent of a special slime it exudes while resting. Slime trails leading away from a slug’s home may be quite devious, but homing trails are much straighter.

A slug that has strayed too far during its nocturnal forays to be able to reach its home before daybreak may follow another slug’s slime trail, much as a motorist blinded by fog may keep an eye on another automobile’s taillights. This kind of tracking may lead a homeless slug to another slug’s shelter, but will not guarantee the occupant’s hospitality. The resident may lash out violently and drive off the stray, which then must take its chances in the inimical light of dawn.

Previous descriptions of aggressive behavior in slugs have been limited to ritual displays associated with their mating. Both slugs and snails are hermaphroditic. Their mating is usually preceded by elaborate courting rituals that supposedly reduce the chance of hybridization. During courtship, partners of most species circle each other for long periods. At certain stages, the partners carry on bouts of ritualized lunging, biting, or sideswiping with their tails. A few slugs and several kinds of snails even produce calcareous

In a characteristic battle over food or shelter, a giant garden slug bares the flank of a smaller specimen, which tries to defend itself by using its tail to sideswipe the attacker.

William G. Wellington
A native of the Pacific Northwest, the banana slug, left, lays eggs that are nearly ten millimeters in diameter. Although this giant slug can attain a length of more than twenty-five centimeters, it is no match for pugnacious Limax maximus, a European species that is invading suburban forests. Above, a black garden slug contracts and rocks from side to side to fend off L. maximus.

or chitinous "recognition darts," which they shoot — like slow-motion cupids — into their partners. Some species, such as the giant garden slug, Limax maximus, climb plants and launch themselves into the air, finally mating while entwined in supporting strands of mucus.

However bizarre the methods of consumption may be, the ritualized aggression that precedes it is frequently accompanied by an even more startling display of the huge sex organs with which many slugs are endowed. The sight of a courting pair of slugs majestically circling one another and ceremoniously rasping small patches of skin from each other's flanks while they solemnly wave their enormous penises overhead puts the most improbably athletic couples of Pompeii and Khajraho into a more appropriate and severely diminished perspective.

With so much ritualized aggression to study in these soft-shelled mollusks' courtship displays, malacologists have not noticed more mundane incidents. Apart from a few casual observations of occasional biting or even cannibalism among slugs artificially crowded into confined quarters, articles on terrestrial slugs do not mention or describe day-to-day aggression between individuals. We have found, however, that aggressive acts between slugs of the same or different species are common, and have important effects on their abundance and distribution.

Deliberate attacks or head-to-head combat occur most frequently near shelter or on food. Any attack includes a predictable sequence of stages. The aggressor first touches the other slug with its optic tentacles, then rapidly withdraws them and touches the victim with its mouth. The aggressor then draws its head partially under its mantle, lifts the forepart of its body off the ground like a snake about to strike, and suddenly lunges forward, slashing downward with wide-open mouth. A slug's mouth contains a ribbon of small, filelike teeth, the radula, over which a plate-like chitinous jaw chops downward like a guillotine. When the aggressor bites down with its jaw, it also everts its radula so that its teeth scrape backward on its victim's hide.
The victim reacts in a variety of ways. Most often, it lifts its tail and redeswipes its attacker, then moves off at top speed. Some slugs, before they flee, exude a large puddle of thick mucus. The assailant, confusing the victim's smell with the real thing, may linger and aim several strikes at this puddle while the prey escapes relatively unharmed. But the assailant is not always fooled and may immediately pursue and repeatedly strike the victim, until it is badly injured or killed or until it somehow manages to creep out of range.

A slug struck on the front part of its body will protect itself by instantly retracting its head beneath its mantle, which it flares outward with a flapping motion. Slipping its front end hard against the ground makes a slug's body much broader and flatter and therefore much harder to bite. Some species, such as the gray garden slug, Deroceras reticulatum, are able to secrete a milky slime on the injured part. This slime is highly repellent, even to slugs spoiling for a fight. The most aggressive species, Limax maximus, hastily retreats after getting a mouthful, and tries to wipe off the slime on nearby objects.

Slugs' reactions in their intra- and inter-specific encounters include the same defenses they use when attacked by predatory insects. In fact, these defenses are usually much more effective against insects than against other slugs. For example, the common black slug, Arion ater, contracts into a hemispherical shape when it is pricked by any sharp object—a pin, the jaw of a slug, or the mandibles of a beetle. At such encounters, A. ater pulls its head under its mantle, humps its back, presses its mantle and the margins of its foot tightly against the ground, and rocks from side to side. A slippery, rocking hemisphere can resist the small mandibles of an attacking beetle, but is no defense against the guillotine jaw of a large Limax. Attacked by L. maximus, A. ater quickly abandons its pose and tries to escape.

If set upon from the rear, another slug, Prophysaon andersoni, can shed the tip of its tail, the way some insects and lizards shed appendages under attack. We have not yet seen Prophysaon shed its tail when attacked by another slug, but it does so when defending itself from one predatory snail, Haplotrema minimum.

Slugs also drive off insect enemies by flaring their mantles and exuding copious amounts of slime, which fouls predators' legs and mouths. They may suffocate the larvae of sciomyzid flies by excreting mucus that clogs the squirming attackers' spiracles. Deroceras reticulatum uses its milky slime to repel carabid and staphylinid beetles, as well as other slugs.

After one or more of these initial reactions to attack, most slugs attempt to escape at top speed. If forced to flee from their own or other species, small slugs are not appreciably slower than their larger elders and thus are not inevitably doomed upon attack. Rather than retreating, some slugs will turn on their assailants. Slugs that fight may acquire dueling scars but rarely suffer as much as victims that are repeatedly bitten in one or two places on their flanks as they crawl away from persistent attackers. The most pugnacious slugs we encountered, Limax maximus and Arion subfuscus, can inflict lethal wounds during pursuit, and we suspect that some slugs found dying on sidewalks after sunrise are attack victims, not merely strays caught by the morning sun.

Slugs' aggressiveness is certainly a seasonal phenomenon in southwestern British Columbia, where we found that L. maximus and A. subfuscus were most pugnacious during July and August, normally the drier period of summer in the Pacific Northwest. Shelter is important to slugs at all seasons of the year, but refuges that are sufficiently damp may become scarce during summer heat or drought. Whenever suitable shelter is in short supply, homing behavior is more obvious: more slugs promptly occupy, stake out, and return to the best shelters — those that are moist and closest to food.

Since shelter is vital to a slug's survival, it is worth fighting for; and as homing becomes more marked, aggression increases. In summer, L. maximus adults consistently drive other species and weaker individuals of their own kind out of shelters and away from food. They even disrupt mating by attacking the partners. Since other species of slugs begin to avoid shelters occupied by Limax adults, solitary Limax adults eventually occupy all shelters near the better sources of food. But as autumn approaches, Limax adults calm down considerably, and their aggressiveness disappears during the winter. In fact, in midwinter we often found large groups of adult and juvenile L. maximus sheltering together. These gatherings would have been impossible while the adults were still combative.

Although both adult and immature slugs homes to shelter, the adults also require shelter for their eggs, whereas the juveniles only rest there. Thus, the juveniles do not become as firmly attached to one place as their elders and are not at all aggressive. As summer waxes, adults' homing and aggressive responses seem to strengthen: at their peak, adult slugs will force larger juveniles to leave home, harrying them out of their birthplaces and into new habitats.

We know that homing has been observed in some marine mollusks, notably in limpets and octopuses. We also know that truly predatory slugs and snails exist on land and in the sea, but these are carnivores that attack other kinds of animals more often than one another. Our discovery of seasonally varying aggression and its linkage with homing behavior in largely vegetarian terrestrial slugs presents a very different view of their ecology and population biology and provides another way to generally assess the importance of aggression and territoriality in the population dynamics of animals.

The effects of aggression and territoriality on the numbers and distribution of animals are still not well understood. Many birds and mammals that display conspicuous individual behavior move so freely, and over such large areas, that it becomes too difficult and too expensive to study their populations. But even the most active slug has a home range only a few yards square. Slug populations are much easier to observe, and so these pugnacious gastropods may provide fuller answers to some important ecological questions.

After launching themselves from a branch, two giant garden slugs of the species Limax maximus mate in midair. They are supported by mucus strands, which can stretch for as much as forty-five centimeters.

© David Polko
The Gregarious but Contentious Walrus
Text and Photographs by Fred Bruemmer

Tightly jammed herds and tusk rattling are features of this huge marine mammal’s way of life.

On a rare calm autumn day, delicate, chimelike tones, as of distant bells, drift gently over Round Island in Alaska’s Bristol Bay. Incongruously, the melodious sounds emanate from some of the warty walrus bulls floating near the island. Just how they produce such sounds—heard most often among the ice floes of the Bering Sea during walrus courtship in late winter—is not known, but it is assumed that their large pharyngeal pouches act as resonators. The thousands of walruses on and near Round Island in summer and fall are all males, and the sounds may be from a few young bulls “practicing” for the next breeding season. Some swim leisurely in groups of from five to fifty around the island, propelled by the rhythmic, alternate strokes of their large rear flippers. A few sleep vertically in the water near the island, buoyed, as by built-in Mae Wests, by their inflated pharyngeal pouches. But most lie on favorite island beaches in dense, malodorous congregations. They show a distinct preference for company and contact, yet at the same time they display a great deal of hierarchical hostility. Disputes are frequent and noisy.

As a rule, walruses seem highly gregarious. There is ample space on Round Island, but nearly all the walruses prefer to lie together, tightly packed. After a storm, when most walruses leave the wave-lashed beaches for a while, or when they have been panicked into the sea by a low-flying aircraft, they swim back and forth along the coast, loath to haul out on an empty beach. Usually an old, massive bull makes the first move. Wheezing and snorting, he laboriously hauls his two-ton bulk onto the beach. He pauses frequently and appears apprehensive. This time, the warning cry of a gull sends him back into the sea. But once he has found a congenial spot and stretched out, his presence acts as magnet to other walruses. The small
lies "walk" ashore, pivoting their hind quarters forward in a Chaplinesque saddle, while the big bulls usually inch themselves forward in a sequence of slow, massive heaves.

The behavior of latecomers seems to depend on their social standing. Nailer animals come ashore quietly and try to insinuate themselves next to ready sleeping walruses. Big bulls vance with much more assurance and usually crowd right in, jabbing those at are in the way with their tusks. A rank animal will try to move and make space, but a bull of equal standing is more likely to rear up with a head thrown back, tusks held out horizontally. The two confront each other, feigning attacks or hacking downward and sideways with a speed surprising in animals so huge and bulky. Fights rarely last long. The weaker walrus backs off (in such a tightly packed group this is difficult and may result in a whole chain reaction of fighting), and the dominant one slumps down in the desired place. Severe injuries in these fights are infrequent. The walrus's skin, two inches thick, is extremely tough, but occasionally an animal bleeds from shoulder and neck gashes and twice I saw walruses that had lost an eye. Bulk, power, and tusk size seem to determine dominant status. Animals with short or broken tusks "regularly evince social inferiority to other walruses of the same size," biologist E. H. Miller observed during a study on the island.

For many hours, while the group establishes itself—usually with the most powerful animals near the center and subdominants on the periphery—there is constant jabbing and jostling, accompanied by a chorus of angry bellows and grunts. Once all are settled in an accepted order of precedence, they sleep soundly.

The herd consists mainly of adult bulls; most of them bear scars typical of the contests that take place between large males during the breeding season in February and March. After mating among the ice floes in the Bering Sea, the Round Island males begin their return journey to their traditional ugly, arriving there usually by May. ("Ugli" is the Eskimo term for a walrus hauling-out place; "uglit" is the plural.) The females with their young, the other adult bulls, and many immature males migrate northward to the rich shellfish banks of the Chukchi Sea. The Round Island bulls remain on the ugly through the summer and autumn; during this time their wounds heal and they molt. Bristol Bay is also apparently rich in shellfish, thereby providing the nonmigratory males with a dependable source of food.

Round Island, a part of the Walrus Islands State Game Sanctuary, is the site of one of the two remaining ugly on the American side of the Bering Sea and Bering Strait that are occupied on a predictable annual basis. The other ugly is on one of the Punuk Islands off the eastern end of Saint Lawrence Island. This hauling-out place is used mainly by adult females and immature individuals of both sexes during their southward autumn migration.

Once there were many such ugly on the Pribilof Islands (commercial hunters wiped out that walrus population by 1891), on Sledge Island near Nome, and on Besboro Island in Norton Sound. Of the thirty-three former ugly on the Siberian coast, where walruses once hauled out in groups ranging from a few hundred to many thousand, only two or three are still regularly occupied.

Unless they are exterminated or continuously disturbed, walruses will return to the same hauling-out place for centuries. Seahorse Point on Southampton Island in Hudson Bay was given its name in 1615 by the explorer William Baffin because he saw large numbers of walruses there. Walruses haul out at the same spot today.

In historic time, the southernmost walrus colonies were on Sable Island, one hundred miles east of Nova Scotia, on the latitude of Milan, Italy, and on the Magdalen Islands in the Gulf of Saint Lawrence. (During cold periods of the Pleistocene, walruses ranged even farther south and bared on the beaches of South Carolina and the Bay of Biscay.) In 1641, hunters from Boston obtained "four hundred pairs of seahorse teeth" on Sable Island, but by the end of the seventeenth century that colony had been exterminated. The much larger one on the Magdalen Islands vanished a century later; now
only the many island names containing the word *echouerie*, the old French word for walrus hauling-out places (for example, "Plage de la Grande Echouerie"), recall their long-ago presence.

The herds of Atlantic walruses (*Odobenus rosmarus rosmarus*), once probably numbering in the hundreds of thousands, melted away under the incessant pressure of more than three centuries of commercial hunting. In the Spitsbergen archipelago, where the hunt started in 1604, the Norwegian biologist Thor Larsen has seen only five walruses in ten years of recent travel. (There are some indications, however, that walruses in this area may be on the increase.) On the little island of Moffen, situated off the northern end of West Spitsbergen, the preserved bones of slaughtered walruses are heaped in such masses that, from a distance, they look like snowdrifts. In the Canadian Arctic, when whale catches declined toward the end of the nineteenth century, whalers augmented cargos by methodically wiping out most of the accessible walrus colonies for their ivory, oil, and skins. There are now only about 10,000 walruses remaining in Canadian waters. Another 10,000 survive along the Greenland coasts, and an estimated 6,000 live in the seas north of Norway and the Soviet Union.

The commercial hunt of the Pacific walrus (*Odobenus rosmarus divergens*), whose original population is believed to have been about 200,000, began only in the nineteenth century, but was so enormous (200,000 were killed between 1860 and 1880 alone) that by the 1920s only about 40,000 were left. Now both populations are increasing: those of the Atlantic walrus slowly; those of the Pacific walrus, in recent decades, quite rapidly. The latter now numbers at least 140,000.

As their populations increase, the walruses establish new hauling-out places and attempt to resettle abandoned ones. In southern Hudson Bay, the walruses haul out on a new, little-known, but growing uglit off the Ontario coast near Cape Henrietta Maria. In the northern Bering Sea, they attempted a few years ago to haul out again on Sledge Island but were spotted by Eskimo and shot for food. (Walrus hunting on and near this island is now forbidden.) Walruses tried repeatedly to reestablish their ancient uglit on Big Diomede Island (Ostrov Ratmanova) in the Bering Strait, but were shot at and panicked away by Russian border guards stationed on the island.

The latest reports from Soviet biologists, however, indicate that many of the traditional walrus uglits on the Siberian coast are again being used, although as yet only on an irregular basis. Since about 1970 the uglit on Big Diomede Island has been used regularly during the autumn migration. On the American side, the uglit on Sledge and Besboro islands are now being used irregularly by walruses on their northward and southward migrations.

On Round Island, walrus numbers are also increasing. From a few individuals at the beginning of the century (in 1935, eight were spotted), they increased to about one thousand in 1953, three thousand in 1972, and more than five thousand in 1975.

With the onset of winter the water in Bristol Bay freezes over. Most of the members of the herd then swim out into the Bering Sea where they will spend the coldest months of the year with the females that have returned from the Chukchi Sea.

Walruses are good, though slow, swimmers. Their cruising speed rarely exceeds four to five miles per hour, but when chased by boats they can surge forward for a limited time at about twenty miles per hour. They are, perhaps, the least "marine" of the marine mammals. While elephant seals, sea lions, and fur seals haul ashore primarily to breed and molt, walruses spend much of their time resting on ice floes or on their traditional land uglit.

A few bulls, usually big ones, remain in the vicinity of the Chukchi Sea shellfish banks all winter. They can smash through ice up to eight inches thick by ramming it from below with their heavy, dense skulls. When the ice cover increases and thickens, they move to leads or to areas kept ice-free by strong currents and usually rest near the floe edge. They can endure severe cold and have been seen sleeping on ice when the temperature was \(-35^\circ\text{F}\) with a strong wind blowing. Sheathed in a heavy skin and wrapped in a blubber blanket more than four inches thick on large bulls, they are well protected from the freezing air and the arctic water. The blubber is both insulation and energy reserve. At very cold temperatures the peripheral vascular system is constricted, and blood flow to blubber skin, and flippers is kept to an absolute minimum, thereby reducing loss of body heat.

Heat loss may be further reduced when walruses huddle together in tight groups. This thigmotactic behavior has been explained by scientists Francis L. Fay and Carleton Ray as an adaptation to preserve body heat. Whether single or in groups, walruses in cold air reduce surface exposure by assuming a "fetal position"—head drawn in, back arched, flippers pressed tightly against the body.

On warm summer days walruses have the opposite problem: they must dissipate heat. They still huddle together on the beach although this makes heat dissipation more difficult, but the no longer curl up. On the contrary, looking like bloated burghers on a hot beach, they sprawl, often belly upward, flippers flung out, to expose the maximum amount of body surface to the cooling air.

Walruses, covered by a short fur of half-inch-long hairs, are normally madder brown. Molting, which usually takes place between May and August leaves them nearly hairless, and after long immersion in the sea, they are peculiar bluish white or occasionally mottled gray. As they lie in the sun, their peripheral blood vessels dilate blood pulses through the vascular system of blubber and skin, and the gradually change color—from whitish to a flush of pink to russet and roan. When the temperature rises above \(60^\circ\), they become restless, sleep less soundly, and change position more frequently; on the rare days when it rises above \(65^\circ\), most seek relief in the cooling sea.

During the late winter courtship period, walruses emit a variety of sounds, which may be used to establish underwater territories. While female and immature animals crowd the floes

*Packed task by jowl, a herd of walrus bulls sleeps on a traditional uglit on Round Island, off the coast of Alaska. A late-arriving bull can set off a chain reaction of noisy disputes as he jockeys for position.*

54
Hard, fist-sized fibrous tubercles cover the neck, chest, and shoulders of old bulls. Chipped and broken tusks are common in these animals. The entire crown of these upper canine teeth consists of ivory.
the larger bulls patrol the water around them. The bulls emit the melodic bell sounds, click their teeth with such rapidity that the sound is like castanets being played, and whistle shrilly through puckered lips, usually just before diving. They rise abruptly near chosen floes, expelling air with such force that their snorts can be heard for a considerable distance.

In early spring, as the herds move slowly northward in the Bering Sea, walrus cows that mated the previous year give birth on the floes. The calves are about four feet long, the size of an adult ringed seal, and weigh about 120 pounds. They are covered with a coat of short, silvery gray hairs, which are exchanged for rusty brown ones after the postnatal molt at two months of age. Despite the calves’ size and weight, Ray and Fay have pointed out that they have “less than half as much physical insulation [hair and blubber] as other arctic pinnipeds of comparable size.”

Calves on their own are cold and shiver violently in the arctic air.

But, barring disasters, walrus calves are rarely alone. The mother-calf bond is extremely strong; for about two years they are nearly inseparable. The calf suckles frequently and grows rapidly on its mother’s rich milk, which contains about 35 percent butterfat and 12 percent protein. Within a year, the calf will be five feet long and weigh about 450 pounds.

In cold weather, the female hugs the calf to her chest, cradling it with her broad, two-foot-long front flippers to keep it warm. When swimming, the calf rides on its mother’s neck, clasping her firmly with its rough-soled flippers.

When danger threatens, the female sweeps her calf off the floe, holds it to her chest with her flippers, and dives. She defends it valiantly and, even when severely wounded, does not abandon it.

The high-pitched, desperate barking of a frightened calf arouses not only its mother to furious protectiveness but also impels nearby walruses to rush to its defense. Thus, although the reproductive rate of walruses is low, with cows bearing calves only at two- to three-year intervals, calf survival, due to intense maternal protection, is high.

Apart from man, walruses have few enemies. Powerful, long-tusked, belligerent, and reacting with fury when threatened, walruses are formidable antagonists. A very hungry polar bear may try to kill a walrus calf, but its chances of success are slim since the calf’s mother will rush to its defense. According to some reports, killer whales also hunt walruses, but the Polar Eskimo of northwestern Greenland claim that, on the contrary, killer whales are afraid of walruses and avoid all encounters. When a Polar Eskimo is hunting his small canoe and is surprised far from shore by killer whales, he cups his hands and bellows into the water, imitating the roar of an enraged walrus bull. The sound travels far in water, and Eskimo hunters have told me that killer whales promptly veer off.

The strong group cohesion of wal
Walruses tend to increase losses when they are hunted by man. When a group is attacked, rather than flee, the walruses until the water, bellowing with rage and attempting to assist wounded individuals. They try to support animals that have trouble swimming and appear to push severely injured companions as they try to haul themselves onto a floe. Yet walruses on floes only a few hundred yards away often pay little or no attention to the tremendous noise and confusion of such encounters. Females and young bulls in particular are highly aggressive, frequently attacking the boats of hunters with their tusks.

Northward migration from the winter feeding grounds in the Bering Sea to the summer feeding grounds in the Chukchi Sea begins in April and continues until July—the pace determined by the rate of breakup of the pack ice. Animals swim considerable distances before hauling out on the ice to rest. Herds of females, calves, and immature walruses are now in the vanguard, pods of young bulls follow, and lagging far behind and traveling at a more leisurely pace come groups of large bulls. By June most of the walruses reach the Bering Strait, riding the floes swept northward through the strait by the strong current flowing from the Bering into the Chukchi Sea.

During summer, the herds disperse. Females and young seem to prefer the region near Wrangel Island; mature bulls are more common near the shellfish banks along the Siberian coast. Others spread eastward along the Alaskan coast, but only a few pass beyond Point Barrow into the Beaufort Sea.

Floating on floes above the shellfish grounds of the Chukchi Sea, the walruses dive, feed, fatten, and rest. Although they prefer shallower water, they can dive to a depth of about 300 feet and can remain submerged for nine to ten minutes. The assumption has been that walruses rake up shellfish with their tusks, crush them with their molar, swallow the mollusks, and spit out the shells. Scientists now speculate that the walrus dives to the sea bottom, roots in the muck like a pig searching for truffles, detects shellfish with its 400-odd, quill-like vibrissae set in highly innervated, sensitive mystacial pads, and sucks off the siphons and feet of cockles and clams with its strong, mobile lips.

In the Bering Strait region, they frequently feed on nearly fist-sized whelks that sit tightly in their whorled shells. The walruses apparently extract them easily; in their stomachs one finds no shells, only the fleshy bodies of the gastropods and a multitude of opercula. However it is done, a walrus is able to feed quickly and efficiently. Its full stomach weighs about 100 pounds and may contain the remains of 3,000 or more highly nutritive shellfish. Clams are their main and preferred food, but they also eat other benthic fauna—marine worms, sea cucumbers, shrimps, and marine snails.

While this is the diet of the vast majority of walruses, a few live on meat. These are the “killers,” or “rogues,” which figure prominently in
the lore of Eskimo from Siberia to Greenland. They are waifs, according to the Eskimo, animals that lost their mothers while still young. First they fed on carrion, then developed a taste for meat and began to kill and eat seals. The appearance of such rogues is distinctive. The shoulders and forelimbs appear unusually large and powerfully developed; chin, throat, chest, and tusks are amber colored by oxidized seal oil. Their tusks tend to be long, slender, and sharp. A rogue walrus, say the Eskimo, swims quietly up to a sleeping seal, enfolds it with its powerful front flippers, crushes it, rips the skin with its tusks, and sucks off the blubber and some of the meat. The livers of rogues, like those of the primarily blubber-eating polar bear, contain exceedingly high amounts of vitamin A. When eaten by man, the liver of such walruses can cause severe poisoning or even death due to hypervitaminosis. Rogue walruses, again like polar bears, are also likely to be infested with trichinae. In 1947 in Greenland, 300 people contracted trichinosis after eating such walrus meat and 33 died.

Although rogues are rare (about one in a thousand walruses, according to Fay), other pinnipeds are usually nervous in the vicinity of walruses. There is a small rookery of northern sea lions on Round Island, on the opposite side of the walrus beaches. Whenever walruses swim close past this rookery, the sea lions get the jitters. They roar loud warnings, follow the walruses' progress attentively, and relax only when they are well past their beach.

In late September, ice begins to form in the Chukchi Sea, the vast ice masses of the polar pack press southward, and the walruses begin their return migration to the Bering Sea, passing through the Bering Strait from mid-October to later December.

The exodus also begins on Round Island. A few walruses remain on or near the island all winter and they may be joined by some of the migrants from the north, but most disperse into the Bering Sea. Only when the ice vanishes in spring do those males that disdain to migrate to the Chukchi Sea return to the island to loaf on its beaches.

Using its broad, rough-soled flippers, a walrus heaves its massive bulk ashore. A herd ready to haul out on an empty beach is extremely cautious. Usually an old bull leads the way; not until he is settled will the others follow suit. During this time, the slightest disturbance can cause the animals to stampede back into the water.

This ugly on Round Island is used by more than 5,000 walruses.
The Fresh Air—Clean Water Exchange

F. Herbert Bormann and Gene E. Likens

Forests remove pollutants from the environment at no cost to man. Solar energy powers the woodland cleansing machine.

To the untrained eye, forests appear static; in reality, they are sites of intense activity. Each year, millions of gallons of precipitation, trillions of calories of energy, and vast tonnages of gases flow into each square mile of a forest. Thousands of plant, animal, and microbe species use these elements to live and reproduce, regulating the flow of water, energy, and nutrients through the ecosystem. Forests, with their complement of animal and plant species, provide immensely important benefits to humans—modifying streamflow and erosion, filtering the air and water that constantly flow through the landscape, and releasing sediment-free water to underground and surface water supplies. Stands of trees also modify...
local climate by moderating temperatures and humidity. Through investigation of what enters and what leaves a forest ecosystem — and under what circumstances — a vivid, instructive picture emerges of the intense activity that goes on in a forest. A drainage stream, for example, can be viewed as analogous to the bloodstream of an animal. The stream can be used to keep tabs on the health of the forest.

The areas we study are small (30 to 100 acres), heavily forested watersheds in the mountains of central New Hampshire. We measure the precipitation entering these watersheds and determine its chemical content. From this we can calculate the approximate amount of a specific nutrient that enters a particular watershed each year. Since the only way most nutrient substances can leave these watersheds is by being washed out by small streams, we measure the amount of streamflow and its chemical content and then calculate the pounds of each nutrient leaving the watershed during a year. From these data we construct nutrient budgets.

In a well-developed forest, large quantities of nutrients move about freely between vegetation and the soil, but very little is lost from the ecosystem in drainage water. We have measured small losses of calcium, sodium, and magnesium. At first glance it appears that the ecosystem is running downhill, but these losses are made up by the chemical breakdown of rock particles.
through weathering. For example, only 2 percent of the calcium contained in, and circulating between, plants and soil leaves the ecosystem in stream water each year and that amount is replaced by the weathering of rock.

We had assumed that since streamflow is very low in summer, owing to water evaporation through plant leaves, but very high during spring snowmelt, concentrations of dissolved nutrients in the stream water draining from the watersheds would be high in summer and low in spring. Instead, nutrient concentrations remained about the same. This finding revealed a most important principle: a forest regulates the chemical quality of water percolating through it into streams or underground.

The qualities of mature forest soil are often the result of developmental processes occurring over hundreds or even thousands of years. Weathering, decay, and animal activity build up organic matter, silt, and clay, which contain the stores of nutrients necessary for plant growth. These are concentrated in the upper foot or two of most soils. Bulldozing and blacktopping destroy or disrupt nutrient cycles and thereby diminish the filtration capacity of the land.

Forest and other wildland soils are important filtration systems between polluted rainfall and human water supplies (streams and groundwater). We have discovered two important functions of the forest ecosystem in this regard. Measurements over a ten-year period indicate that the amount of nitrate (a naturally occurring compound of nitrogen that is also one of the end products of automobile exhaust) is increasing in rainfall. The addition of nitrate to streams and lakes can contribute to their eutrophication or to the accelerated growth of certain organisms with a consequent loss of water quality. Our
nutrient budget data show, however, that most nitrate is being held within the forest ecosystem and is not reaching surface and groundwater supplies. Rainfall is also becoming more acid as a result of the increasing use of fossil fuels, which introduce sulfur and nitrogen pollutants into the atmosphere. Over all of the northeastern United States, rainfall is now largely a mixture of water and sulfuric and nitric acids. This condition may worsen as the nation responds to the energy crisis by relaxing air-pollution standards, but our data indicate that the forest ecosystem removes much of the acid from rainwater; consequently, the stream water draining from the watersheds we studied is about thirty times less acid than rainwater.

Natural soils also remove a wide array of other pollutants from precipitation filtering through the soil, including dissolved heavy metals such as lead, zinc, nickel, copper, and manganese, some radioactive isotopes, and pesticides such as DDT. For example, some of the rain falling on New Hampshire forests exceeds national health standards for the lead content of drinking water, yet stream waters flowing from these forests have extraordinarily low lead contents.

Soil and forest vegetation also remove a variety of particulate and gaseous pollutants from the air. As wind passes through the trees, very fine particles of certain pollutants stick to leaves and branches, and gases, such as ammonia, sulfur dioxide, ozone, chlorine, and hydrogen fluoride, are absorbed and chemically detoxified. Sulfur budgets we constructed suggest that vegetation may be especially efficient in removing this element from the ambient air. Recently, we have shown through laboratory experiments that the microorganisms in forest soil have a phenomenal capacity for absorbing carbon monoxide, a common pollutant from the air and biochemically converting it to harmless carbon dioxide. These experiments show that forests can improve the quality of air for humans. This, like water filtration, is done at no cost to man. Solar energy powers these processes.

A word of caution is necessary, however: the air and water filtration capacity of forest ecosystems is not un

An average of a million gallons of rainwater fall on each acre of land along the eastern seaboard of the United States. Rainfall, particularly over the northeastern states, is loaded with a mixture of nitric and sulfuric acids and carries high concentrations of such dissolved heavy metals as lead, nickel, and copper.

Ammonia, sulfur dioxide, ozone, carbon monoxide, chlorine, and other gases, along with particulate pollutants, flow into forests that are downwind from industrial operations and urbanized areas.

Very fine particles of some airborne pollutants adhere to the leaves and branches of trees. Quantities of many gaseous pollutants are absorbed and chemically detoxified by the trees and other plants. Most pollutants that enter the forest ecosystem eventually reach the ground where they are either bound up in the soil, chemically altered by microorganisms, or become nutrients for the trees.
limited. Forest vegetation and soils can absorb and tolerate a modest amount of pollution and continue to function more or less normally for a period of time. Eventually, however, they will come to equilibrium with pollution loads and lose their storage function or pollution-induced damage may drastically alter the ecosystem.

Dramatic examples may be seen near heavily polluted industrial areas such as Ducktown, Tennessee; Palmetto, Pennsylvania; Magna, Utah; and Sudbury, Ontario, where pollution from melting plants has devastated natural ecosystems and biological regulation and cleansing of air and water flows has been essentially lost. Early symptoms of forest ecosystem destruction resulting from widespread automobile-caused air pollution are evident over thousands of square miles in the Los Angeles basin, where, in the surrounding mountains, millions of trees are dead or dying. A forest ecosystem should be seen, not as a license for additional pollution, but rather as a natural sponge with finite capacity.

An average of approximately one million gallons of water fall each year on each acre along the Atlantic seaboard. Yet this water's huge potential to wear away the land and to pollute surface water supplies with sediments is rarely realized because forests control the erosive capacity of falling and flowing water. This regulation of the erosion cycle by vegetation is one of the keys to maintaining quality water supplies and healthy streams and lakes.

Our data from New Hampshire show that even though the forests we studied occur on steep slopes, each year they lose, on the average, only a few tons of eroded material per square mile. Studies from other areas suggest that rates of erosion for a variety of eastern deciduous forests are equally low. As a result of this regulation of erosion, water flowing to streams and groundwater from forested or other well-vegetated land is virtually sediment free and can be used by man with minimum treatment costs.

The enormous stabilizing force of forest ecosystems is best seen when contrasted with areas undergoing urbanization, where poor planning — usually combined with careless construction techniques — commonly produces erosion rates several thousand times greater than those for a well-developed forest. A rate of 140,000 tons of eroded material per square mile per year was reported from one construction site near Baltimore.

Massive erosion of upland construction sites results in serious degradation of aquatic ecosystems — streams, lakes, reservoirs, and estuaries. Sediments derived from erosion can change the physical character of stream channels, causing changes in bottom deposits, erosion of channel banks, obstruction of flow, and increased flooding. Sedimentation can fill natural ponds and reservoirs. Finer sediments reduce water quality, adversely affecting public and industrial water supplies and recreational uses. Turbid water, another result of increased erosion, reduces light penetration into water. This, in turn, reduces plant photosynthesis and may lower dissolved oxygen supplies, leading to changes in the natural flora and fauna. Coupled with these effects is the possibility that pollutants normally filtered out by soil and vegetation might find their way directly into human water (and air) supplies.

In areas moving toward urbanization, little thought is given to the natural functions of vegetation; the useful work of nature is totally undervalued or ignored. The urbanizing region is not seen as a highly interactive mosaic of natural and developed land with some optimal proportion necessary for quality urban life. Powerful, but one-sided, arguments for profit, growth, and favorable tax rates generally outweigh arguments for leaving land in a natural state. The resultant proportions and distribution of natural and developed land are therefore artifacts of the marketplace.

What are the optimum proportions of developed and natural land? A study carried out in Georgia has estimated that two and a half acres of agricultural land, two acres of natural land, and half an acre of residential-industrial land are needed for each citizen. Obviously, optimum proportions are debatable and will vary according to local conditions, but it would seem prudent to maintain natural vegetation on all lands where the environmental costs of construction are especially high. These would include flood plains, wetlands, steep slopes, and areas with thin soils, erodible soils, or poor drainage.

When land is overdeveloped, the functions of natural systems have to be replaced with costly, fuel-consuming, technological substitutes. Larger and more elaborate sewage-disposal and water-treatment plants are needed. Air conditioning and filtration become a necessity rather than a luxury. Streams must be piped, channels dredged, and flood controls installed. Man-made facilities must substitute for natural recreation areas. The additional facilities necessitated by poor planning represent a huge and unnecessary expense to the tax-paying citizen.

Although arguments for the preservation of natural land in regions undergoing development are most often based on the need for recreation areas, wildlife preserves, and parks, a more basic argument exists, namely, the biologic and economic health of man.
Fecund Mouflon

Text and Photographs by Raul Valdez and Leticia V. Alamia

High reproductivity is a key to the success of these Asian wild sheep

Sheep are among the most common large wild animals in Asia. They have survived despite constant hunting pressure and the extensive environmental impact of humans, who for millennia have occupied much of the wild sheep’s range. Other animals on the Asian continent have suffered disastrous consequences, so the survival of wild sheep is a testament to their adaptability. Wild sheep in North America, with a shorter history of exposure to humans, have not fared nearly as well.

Based on body form and habitat preferences, wild sheep in Asia are divided into three basic species: Asiatic mouflon, argali, and Siberian bighorn. Mouflon, which we studied in Iran, also live in many areas of Turkey, Iraq, and Oman, and range into Soviet Turkmenistan, through Afghanistan, Pakistan, and northern India. (Another species of mouflon occurs in Europe.)

Mouflon differ, physically and ecologically, from their Siberian and North American relatives. Bighorn try to escape from their enemies by using their short, powerful legs and strong, muscular bodies to climb precipitous rock slopes where predators cannot follow. Mouflon, with their long, slender legs and graceful, supple bodies, flee from predators by running over the undulating, broken pastures they prefer.

Older Asiatic mouflon rams are more successful breeders than young males. Because of their dominance, they are able to segregate estrous females from a herd. Their refined courting technique also saves energy.

Mohammad Reza Shah National Park contains one of the most scenic wild sheep habitats in Asia. Situated in northeastern Iran, approximately forty miles from the Soviet border, it straddles both deciduous forests and upland sagebrush–bunch grass communities. Urial sheep — a subspecies or geographic race of mouflon — inhabit the gently rolling grassy steppes in the park. Lush growths of sagebrush, ephedra, wild alfalfa, festuca, and wheat grasses provide excellent forage. Dense stands of junipers cover the slopes of ravines; sheep avoid these as well as other forested areas.

The ten thousand urials in the park make up the most numerous and conspicuous population of large mammals in the park, but there are many others. Roe deer and red deer primarily inhabit the forest, although the latter occasionally wander into sheep habitat. Wild pigs prefer the humid forest floor where they root for vegetation and acorns, but during the spring and fall they move out onto the upland steppes to graze. Wild goats inhabit the precipitous, rocky slopes and ridges that sheep usually avoid.

Wolves and leopards are common in the park; both are major predators of ungulates. The leopard is a solitary predator, but Iranian wolves hunt much like their North American counterparts, usually moving in packs of three to six. Brown bears are basically forest dwellers, but to supplement their largely vegetarian diet, they occasionally wander into sheep habitat and prey on newborn lambs. Red foxes feed mainly on rodents, but they prey on wild sheep during the lambing season when the tiny newborn lambs can be easily overcome by a small predator.

Lambing in the park takes place in early May after a gestation period of 150 to 160 days. Ewes seek the best areas for lambing, mainly the lower, warmer altitudes that are not subject to
chilly rains and snowstorms, which can occur on the uplands as late as May. Ewes also prefer warm, southern slopes associated with rocky, broken areas that afford cover and protection for the newborn lambs.

Prior to parturition, ewes live together in groups. Just before lambing, however, a pregnant female will leave the group and seek an isolated place in which to give birth to a single lamb or twins or, rarely, triplets. Lambs weigh about six to seven pounds at birth. Within a day they are able to follow the mother, albeit for short periods of time. When a potential predator is sensed, the lambs drop to the ground in an attempt to avoid detection. When they are four or five days old, lambs can keep up with their mother, and ewes and their lambs now rejoin the group.

Ewes spend a leisurely summer feeding on grasses and shrubs and nursing their young. Lambs are weaned at about four months of age, when they weigh about forty pounds. By October both the ewes and their offspring have grown their winter coats in preparation for winter.

During the spring, summer, and most of the fall, rams live in bands apart from the females. Rams frequent the higher, cooler elevations while the ewe—a lamb groups remain at lower elevations. In October the rams begin to show interest in the ewes. In anticipation of the mating season (late November and early December), the rams come down to the areas preferred by ewes. By November the rams are mingling with the ewes. The larger rams begin to test ewes to see if they are in estrus, wandering from herd to herd in search of a receptive female.

Despite the seemingly random interaction of rams and ewes, there is a definite rank system involved in these encounters. Generally, the larger, older rams— at least five years of age—participate in mating. Whenever a younger male approaches a ewe, an older ram usually comes forward and drives him away with a threatening gesture, such as a twist of the head. Sometimes the older rams need only to present themselves in front of the younger rams in order to chase them off.

Older rams have a more refined courting technique than their younger competitors. Such a ram will approach a ewe in a low-stretch position, walking toward her from the rear with his head held at the level of her rump. He may occasionally rotate his head sharply right or left, with the chin toward the recipient, or touch the ewe with a quick kick of a foreleg. A courted ewe usually responds by squatting and urinating. The ram smells the urine, then performs a lip curl.

When a ewe comes into estrus, a large ram immediately segregates her from the main herd. The guarding ram prevents any others from bothering the ewe during this period of several days, especially younger rams who may attempt to steal her. Copulation takes place during this time of segregation.

Younger rams are less refined in their mating efforts. They are aggressive and bullying. Their approach to a female is not the slow, deliberate walk in a low-stretch position; instead, they run up behind a ewe, twisting and kicking, and succeed in making her scamper off. When a younger ram does steal an estrous ewe from an older male, his frenetic and inappropriate attempts to mate on the run only result in preventing the object of his attentions from feeding and resting. Such action lasts only until an older ram runs off the young suitor. The behavioral mechanisms through which older rams are dominant over younger ones may have evolved to protect the ewes from such unnecessary stress, conserving the energy of both sexes during the breeding season.

The rut peaks in early December, when snow usually blankets the summer pastures. By mid-December, the sheep begin to form large, mixed herds that concentrate in the lower valleys where they spend the winter. They do not leave these areas until the snow cover melts, which could be as late as March. At this time the rams and ewes again separate. The ewes remain in the lower valleys, at elevations of five to six thousand feet, in preparation for lambing, while the rams move back to the high pastures.

The ewe—a lamb relationship of Asiatic mouflon shows a cursorial adaptability. North American bighorn often form nursery bands in which one adult female remains with a group of lambs while the rest of the ewes may wander several hundred yards away to feed. Such a situation has never been observed among wild sheep in Iran, where each lamb stays with its mother. In a species adapted to running from danger in gently rolling terrain, the lambs would be at a disadvantage in a nursery band. Confronted by predators, a group of lambs could be easily scattered and separated from the attending ewe. Mouflon lambs are therefore always close to their mothers and ready to run with them whenever alarmed. Nursery bands of bighorn are in less danger since they are seldom far from steep rocky terrain where the lambs can elude predators by climbing.

Among the major predators of mouflon in Iran are wolves, leopards and cheetahs. Leopards are restricted to mountain terrain; wolves are common in most types of habitat, including mountains, plains, deserts and forests. In Asia, leopards occur in significant numbers only in northeastern Iran. They inhabit steps and desert plains, where they rely on their speed to catch gazelles, and broken terrain to mountainous areas, where they feed on sheep. Leopards use their stealth to ambush or stalk sheep, then make a quick spurt to catch their prey. Wolves usually chase sheep until they can bring their quarry down with a biting attack.

In reproductive capacity, Asiatic sheep surpass North American bighorn. Bighorn give birth to one young per year; mouflon twin regularly. In studies conducted on one sheep population in Iran, more than 40 percent of the ewes were found to twin; among ewes four years and older, more than 50 percent twinned. This high reproductive potential can result in a rapid population increase after a period of decline.

A juvenile mouflon frolics on Kabudan Island in Lake Rizayeh, Iran. Running is the primary defense of both mother and young. When a predator threatens, they flee together over the rolling terrain.

Leopards are common in many of the mountainous areas of Iran that support wild sheep populations. Solitary hunters, leopards capture sheep by stalking or ambushing their fleet prey.
An excellent opportunity to study the population dynamics of wild sheep was afforded us on Kabudan Island, the largest of fifty-two islands in Lake Rizaiyeh in northwestern Iran. Kabudan covers an area of 7,600 acres and supports a population of Armenian sheep, another subspecies or race of mouflon. These animals were introduced from the mainland during the latter part of the nineteenth century, but hunting and competition from goats and domestic sheep that also grazed on the island limited the growth of the wild sheep population.

In 1967 the island was declared a wildlife refuge; with the removal of domestic animals by wildlife authorities and the curtailment of hunting, the wild sheep population quickly built up in numbers. The first count in 1969 revealed a population of 2,500 sheep. By 1970 there were an estimated 3,000 wild sheep on the island. That was more than the available vegetation could support. In succeeding winters the sheep suffered serious die-offs, and by 1972 the population numbered fewer than 1,000. It has remained at that level for the last three years. Nevertheless the quickness with which the population had previously built up is evidence of the high reproductivity of these sheep.

Wild sheep populations in Asia are parasitized with lungworms, liver flukes, and various other intestinal parasites. These parasites do not affect the sheep except in stressful conditions, such as overpopulation or severe winters. In these circumstances lambs usually suffer the highest mortality. During the first sheep population crash on Kabudan Island, more than 90 percent of the lamb crop died over the winter.

The introduction of domestic sheep and their diseases probably contributed to the decline of North American wild sheep populations. North American bighorn (Dall's sheep and the Rocky Mountain bighorn) have been separated from their Asiatic ancestors for thousands of years. During this separation, bighorn may have lost their immunity to some sheep diseases or simply did not evolve defenses against pathogens and parasites that appeared in Asiatic sheep after the two groups separated. Once the North American bighorn came into contact with domestic sheep, which were derived from Asiatic wild forms, they quickly succumbed to their diseases.

In Iran most wild sheep and domestic breeds have always lived in proximity and have coevolved some measure of tolerance to diseases and parasites.

In all of Asia, Iran probably supports the largest populations of wild sheep. There are several reasons for the paradoxical situation of the existence of large populations of wild sheep in a country where other large mammals have been decimated. One is that Iran is very large and, up to twenty years ago, had a relatively small population of about twenty million people. Wild sheep found refuge in the rugged mountain massifs and isolated, lightly populated areas. Another reason is enlightened wildlife conservation measures: Iran passed its first conservation law in 1956. Now the Iranian government supports a wildlife preserve system encompassing nineteen million acres and hundreds of game officers.

Many of these preserves contain excellent wild sheep habitat. Probably the most important reason for the large numbers of Asiatic wild sheep, however, is their tolerant and adaptive nature. Protection alone did not insure their survival. Despite many protective programs in the United States, wild sheep populations have failed to make a significant comeback. But because of their high reproductive capacity and ability to live in proximity to domestic breeds, Asiatic wild sheep can easily maintain their numbers or recover from heavy losses due to a catastrophe.

Asiatic wild sheep have a promising future. The esthetic and recreational values of wildlife are being recognized, and several other governments have now established wildlife populations. Hardy and tenacious, the sheep will thrive so long as they are not overhunted and provided their habitats are afforded some measure of protection.

The rut is over by mid-December, and mixed herds of mouflon have moved to lower valleys to spend the winter. They will return to upland pastures in spring, after the snow cover has melted.
Little is known about New York City's durable street people, and they themselves do not explain their homeless lives.

On a hot, humid Indian summer afternoon in New York City, the streets of Greenwich Village bustle with crowds. From sidewalk stands, long-haired craftsmen sell earrings and pottery to tourists in pantsuits and open-collared shirts; neighborhood couples hurry from butcher to baker to greengrocer, buying the weekend’s groceries; teenagers carrying portable radios hang out in groups on the street corners. Traffic on the Avenue of the Americas (Sixth Avenue), one of New York’s major thoroughfares, is heavy: many New Yorkers are escaping to the country for one last warm weekend. The traffic hardly slows as cars weave to avoid an elderly, unkempt woman who is slowly crossing in the middle of the block, seemingly oblivious to danger. She pushes a shopping cart overflowing with bags, bottles, pieces of cloth, broken appliances, and clothes. Despite the ninety degree heat, she is wearing three thin cloth coats and two sweaters. Eventually, she reaches the other side of the street, leaves her cart at the curb, and sits on the steps of a bank to rest. Some amazed passersby point her out to their companions; others recognize her and nod a greeting; some give her a coin or two, although she is not actively begging. Throughout the afternoon, she smokes the remnants of cigarettes she has found. As dusk falls, she retrieves her cart and pushes it down the block. She checks a few trash cans, picks up food and a few objects that she wants, and puts them in her cart. Finally, she settles down in the doorway of a closed shop, where she will spend the night, shielded from the weather and from view.

This is how Lea (a pseudonym) spends most of her days and nights. She is what New Yorkers call a “bag lady,” although not all such people are women and not all carry everything they own in bags. Bag ladies are the most noticeable members of an urban subculture that spends most of its time on the streets. For people like Lea, at least for the time we knew them, the streets were their work, their recreation, and, in fact, their homes. Therefore, we called them “street dwellers.”

Identifying an individual as a street dweller is a subjective and inexact task. We depended on physical appearance, behavior, and presence in the same general area over a period of days or weeks. People who carried excessive or inappropriate belongings for an extended period of time, dressed poorly, or who dressed unseasonably (many are probably anemic, and may wear several topcoats even during the summer) were considered candidates for study. So were people who spent an excessive amount of time in one place or a few places in the same area and people who rumbled through garbage, even if they were not encumbered by their belongings. Harry (another pseudonym), whom we always saw on the same block, told us that although he did spend all day and most nights on the street, he stored his possessions with a sympathetic merchant. Most street dwellers, however, had no storage and carried their possessions with them, usually in shopping bags, sometimes in canvas sacks, and less often in suitcases. One man’s suitcase was so heavy that it had to be dragged along the ground, but most people packed for portability. Five of the people we studied used standard shopping carts, as Lea did, or supermarket baskets.

Most street dwellers’ belongings are the staples of daily life — blankets, clothes, shoes, umbrellas, soap, pots, pans, and eating utensils. Like most of us, bag people are attached to some useless belongings — broken radios, scraps of fabric, toastasters, electric clocks — even though they have no access to electricity. Lacking attics, basements, empty file boxes, and closets, street dwellers collect bags. We often observed people going through trash, scattering garbage on the street in order to retrieve empty bags. Perhaps they want to be prepared in case they find something of value.

Street dwellers are not found in all New York neighborhoods. They prefer moderately dense middle-income areas, such as Greenwich Village, perhaps because here they do not risk the reprisals they are subjected to by private homeowners in wealthier neighborhoods or the street violence of low-income areas. The Village is traditionally a bohemian community known for its young, integrated population, tolerant of nonconformist behavior and appearance. The geographic area, comprising large avenues and narrow back streets, is lined by small shops, restaurants, and for the most part, townhouses and low apartment buildings. The streets are never entirely empty. Some parts of the area have numerous coffeehouses, restaurants, and off-Broadway theaters, and are actually busier at night.

During our study, from October to December 1975, we observed street dwellers only in the Village’s public places. At no time did we interfere with their activity, and we were prepared to abandon our observations if there was any evidence that we were doing so. In fact, however, subsequent interviews with some street dwellers revealed that...
we were never even noticed. After completing field work, we interviewed officials at public shelters in the Village and several people who managed food programs used by street dwellers.

We also tape recorded interviews with the three women who we considered Lea, and one man, Harry — about their backgrounds, way of life, and health. They were fully informed of our purpose and were paid for their services. But although their comments gave us some information about their present life-style, they provided little insight into our subjects’ pasts or motivations: these people clearly did not have a totally accurate view of reality.

Lea could not precisely describe her background or how she came to live as she does, as indicated by our interviews.

I was an actress; I had a daughter but lost track of her. I lost my glasses so I cannot write. I’m divorced. I was married to a bishop in the church. He had a head injury. I don’t date. I used to write love letters. I’m going to cut it out, altogether. I also worked for the Treasury Department, but I haven’t turned in anybody lately. You get $120 per year and more every time you turn in a bad person. I was after counterfeiters and people passing bad checks.

Years ago, Lea had a canary. Now, she has everything she owns with her.

Harry said he had been in the New York area for the last five years and on the streets for the last six months. He spent some time on the Bowery, but found “a better class of people up here.” He comes from Santa Barbara, California, where he was a miner. “I did work in the garment center when I first got here.” He has an illegitimate son — “a bastard, if you know what I mean.” He does not date either.

Date! With whom? On the Christian charity [handouts] I receive? I’m strictly a loner. I once got public assistance for a while, but then they reduced my budget. It went to arbitration and they reduced my budget even more. Now I won’t ever go back. I am a Republican. Republicans have bank accounts, government issue [money]. Republicans are management; Democrats are labor. So, I am a Republican.

During our study, we identified fifty-three street dwellers: forty-one men and twelve women. We observed nine people on ten or more different days. From three to seven days we saw thirteen people, and saw thirty-one only once or twice. Each woman was observed for an average of nine days, and each man for an average of three and a half days. Four of the nine people we saw most frequently either reappeared after we were well into the study or disappeared before it was completed. Often, people would be seen several days in succession, then disappear for some time. Since more than half were seen only briefly, we believe that some portion of the population takes to street dwelling only temporarily. Many social service workers we interviewed agreed that some street dwellers take on this role only during short periods of unemployment or between stints as temporary laborers, migrant workers, dishwashers. Others, like Lea, have been known and recognized as permanent neighborhood fixtures for years.

Determining age by appearance is never easy, and our age estimates had to be based on subjective impressions. We never saw street dwellers younger than twenty years of age, probably because in this country, very young vagrants are invariably picked up by police. More than 60 percent of our observed population was forty to sixty years old. About
percent were over sixty and 20 percent under forty. Our population averaged forty to fifty years old, and, in general, the women appeared older than the men.

While we observed them, street-dwelling men spent 60 percent of their time sitting, women 80 percent. Since women moved around less (and we did see individual women more often than men), women may have smaller ranges than men. A New York City medical examiner confirmed our general observation that the majority of the street-dwelling population is male. He thought that the public assumes street people are female because “women stand out more. You expect to see male drunks and derelicts.” We believe that women have smaller home ranges, and local people see them more often and are more aware of them.

Because we wanted to draw an accurate picture of street dwellers’ ecology, we tried to determine how they coped with their harsh environment—exposure to heat and cold, lack of food and shelter, illness. Male and female street dwellers reacted quite differently to temperature extremes. We observed significantly more men on the streets at higher temperatures (65° to 75°F) and significantly fewer at lower temperatures (30° to 45°). Men were more active as the temperature increased. In contrast, women were most active between 45° and 55° and were least active between 65° and 75°. Assuming that a decline in the number of people visible on the streets meant that they were spending more time indoors or at least in a sheltered area, we found a lower tolerance for heat, but a higher tolerance for cold among women compared with men. Perhaps women were less willing to use the indoor alternatives, such as hotels or public shelters. (The neighborhood offers far fewer facilities for women.) Not surprisingly, the number of visible street people did not seem related to times of day: street dwellers do not “go home” at day’s end. They seek shelter in response to weather, not the hour.

For street-dwelling people, finding places for shelter and for sleeping is not difficult. We saw them in doorways, telephone booths, restaurant entrances, subway stations. Father Lott, priest of a local church, told us that “street people generally come into church more to escape the cold than to wor-

ship.” Harry said that some Village building superintendents allow street dwellers to rest in their basements, and that some token-boat attendants let them use subway stations. The New York subways are a vast complex of subterranean stations that are relatively warm and dry and may provide food and toilet facilities. Symbiotic relationships can develop between street dwellers and the rest of urban society. For example, Harry was permitted to sleep in a truck owned by a lighting-fixture store. Perhaps the merchant was simply magnanimous or he may have thought that his truck would be safer if someone was in it.

There are city-run shelters for both men and women near our study area. The men’s shelter has room for several hundred men and places hundreds more in numerous low-cost, multiple-occupancy hotels, locally known as “flophouses.” The women’s shelter, on the other hand, can house fewer than fifty people and requires a higher order of personal hygiene standards than the men’s shelters. During our study, no street dwellers we observed appeared to be sleeping at these facilities. They usually slept in the open, in parks, or along busy streets. Three women spent nearly all their time within a few blocks of each other along a very busy stretch of Sixth Avenue. Two of them told us that they chose the area because they thought it was safe: in other parts of the city, they were harassed by storekeepers or assaulted by young hoodlums. Like the streets, Village parks are well populated all day long and therefore are relatively safe. Harry recalled that the police would chase him and fellow “parkmates” out of Washington Square Park when it closed. If he and the others returned a short time later, however, they could sleep in peace for the rest of the evening.

Both street dwellers and neighborhood people said that parks are more popular for sleeping during the warmer months of the year, while doorways, building halls, basements, subways, and public shelters are favored during colder periods. Lea preferred the outdoors all year round, insulating herself in winter with up to seven layers of newspaper under her coat. “I had eight coats but they stole them.” (She never explained who “they” were.) In cold weather, Harry pursued a nomadic existence on the subway: he would ride
for a while, get off to find something to eat in a station, then get on a train again. “I go to Washington [D.C.] for the winter. I take the dog [Greyhound bus].” In a heat wave, such as the one New York experienced last July, Lea took “spoon baths in the fountain.” Harry said, “I take it slow.”

Street dwellers get their food and water from a variety of sources: food programs, sympathetic pedestrians and merchants, and food refuse found on the streets and in trash cans. Some, including those we interviewed, were able to obtain enough money to purchase food.

Although some street dwellers actively solicit charity, others sit passively where they are well known and are often given money. A street dweller whose range is small becomes so much a part of the daily routine of the area that residents and local merchants provide food or money. With familiarity comes sympathy. Perhaps charity is encouraged by street dwellers’ recognition of their patrons. The patron’s act of charity is less anonymous and, therefore, more appreciated.

In Greenwich Village, many private, public, and religious organizations regularly provide free meals. These organizations include private, mission-like services supported by donations and small membership fees, men’s and women’s shelters maintained by the city, and church-sponsored food programs. Many of the street dwellers we observed used these services, but only sporadically. Frequenting the services probably requires more social interaction than some street dwellers desire. Basically loners, they are suspicious even of one another’s company.

Some of our study population picked up discarded food and beverages from trash baskets in public parks and garbage cans on streets, but less frequently from restaurant and apartment garbage. We saw ten people eating food taken from garbage, and two ate such food almost exclusively. Most often, they found bread and rolls and such take-out items as rice and French fries and, less frequently, parts of sandwiches. For drinking, they relied on public water fountains, discarded cans and bottles of soda, and discarded liquor bottles. Unlike the derelicts found further south in the Bowery area, Village street dwellers were not often seen drinking alcoholic beverages.

To ascertain whether street dwellers are really dependent on discarded food and clothing, we compared their scavenging activities with times of garbage collection. There were three different garbage districts within our total study area. In two districts, collections were made on the same three days a week. After the day of collection, when discarded resources are at their lowest, we made 2.5 street dweller observations per hour. On other days, at least twice as many dwellers were counted. 1.9 street dwellers per hour. Activity often indicated that the garbage was consistently greater after the garbage was removed and decreased as discarded resources began to accumulate until the next collection day. As resources became less available, street dwellers had to expend more effort. This relationship between collection day and scavenging was observed in all three collection districts, although street dwellers did not necessarily go outside an area after a collection day more than on any other days. Apparently, there is always enough food to be found in an area’s garbage. After collection, however, street dwellers need more time to find it.

Because they rely on discarded food for nutrition, street dwellers risk all kinds of health problems. Discarded food does not necessarily guarantee a balanced diet — some street dwellers are overweight because discarded food is often starchy — and lack of refrigeration increases the chance of food poisoning. Going through garbage, street dwellers can incur nasty cuts from cans and broken bottles. And there are unexpected problems: once, while searching through trash cans, Lea was knocked down by a garbage truck. As scavengers, street dwellers constantly compete with bacteria, flies, rats, and dogs. The quality and amount of food varies, and often a street dweller can find nothing edible.

Far from being continually ill, however, street dwellers complain of few ailments. When asked about her health, Lea told us that the Treasury Department gave her a first-aid kit along with her gun and badge. She has had to hock the gun. Her major health problem is that her legs fall asleep. Father Lott, who runs one of the food and shelter programs that attract street dwellers, told us with some pride that during the flu season, street people showed up for services while many
Middle-class parishoners were absent. According to a medical examiner, most people who die on the streets are alcoholics and heart-attack victims. Exposure cases usually survive. For alcoholics, the most common cause of death is cerebral arteriosclerosis, the hardening of the brain’s arteries that results in senility. No one cares for mile-wide people.

If they do not want to be harassed, street dwellers must avoid washing, urinating, and defecating in public. Here are, in fact, many public washrooms in shelters, parks, subways, and public bathhouses, as well as pay-toilets in some Village hotels. Lea routinely used subway pay-toilets to wash herself and change her clothes, but she refused to remain in any of the open shelters because they required her to change her clothes. Street dwellers were observed both urinating and defecating somewhat discreetly in parks and on streets—as do people who are not street dwellers, especially at night when the public toilets are locked. Solidarity among street people is unknown. For the most part, they rarely interact with one another or with the general public. Often, their contact with the public is limited to people who acknowledge them with a nod or give them a coin; a brief conversation might follow. Once we did see a group of street dwellers, all men, gathered around a subway entrance, talking and sharing food and wine; the drink seemed to catalyze the socializing. We never saw a female group. Lea, however, told us that she occasionally slept with several other women in doorways. This atypical group was formed for warmth or protection: “I sleep with the girls and we share the blanket.” She does not know the names of the other “girls” who scatter hither and yon the next morning. Sometimes one will come back with a black eye.

Street dwellers did congregate at the various food programs in the area, but socializing was limited to “pass the ketchup” or conversations about the food or the service. Here we saw some hostility among street dwellers: they are uncomfortable in group situations, although they can cope when necessary. Street dwellers are a reminder of the durability of the human species. Most of them are protected from the elements by only the most primitive insulation. They eat society’s food wastes and live with little emotional support or human communality. They are urban hermits, people who have chosen or have been driven to cut themselves off from the physical comforts and human contact that most of us take for granted. Street dwellers do not pose any inordinate threat to public health, although they themselves may be more susceptible to communicable diseases such as tuberculosis.

Generalizations about street dwellers are risky: some of them will spend their whole life on the streets; others will remain on the streets only until they get a job or in some way give their life more direction. Some spend only their days out of doors. Some are more ambitious than others. After we interviewed Harry, he realized we needed him and immediately raised his price.

Some street dwellers are not very different from the average jobholder. One street woman sat and passively begged in front of the same subway entrance every day. She slept in a room farther uptown, but because that neighborhood was too dangerous to “work,” she commuted daily by bus. For the present, street dwelling was her chosen profession.
The Quality of Coriander

By Raymond Sokolov

The seeds, leaves, and oil of this parsleylike plant have been used by cooks since ancient times.

The delicate green-leaved vegetable floating in the broth looked like parsley, but its pungent aroma rose from the bowl and filled my nose. New flavors don’t come along every day, so I asked the Vietnamese women who had prepared their national soup, called pho, for the name of the herb. “Coriander,” they said. At first, I thought there must be some misunderstanding, one of those cross-cultural confusions that constantly arise when people from one place try to translate the ingredients used by cooks from somewhere else into their own culinary language. Coriander, I was sure, was a seed—a small, round brown seed that cropped up most frequently in Indian recipes.

We were both right. Coriandrum sativum has both seeds and leaves. Indeed, it also has little white flowers, which grow in delicate clusters that look like tiny parasols blown inside-out by the wind. So do garden variety, curly-leaved parsley (Petroselinum crispum) and flat-leaved Italian parsley (P. hortense). They are all part of a large and economically important family of plants with similar inflorescences. The Umbiliferae number more than 2,900 species, including celery, carrots, parsnips, fennel, and a large number of herbs and spices: cumin, caraway, dill, anise, chervil, angelica, lovage, and myrrh. Like coriander, they contain alkaloids, essential oils and resins used by cooks from ancient times to the present to flavor food.

The similarities between, say, carrot tops and cumin leaves or between dill and fennel seeds are so obvious that the umbellifers were the first family to be recognized by taxonomists. Actually, it was the inverted umbrella pattern of the flowers, perched atop slender stems or rays all growing from a single point, that clinched the grouping of so many plants into a single clan. In 1583, well before Linnaeus, Andrea Cesalpino, an Italian botanist, proposed the existence of a family, and Robert Morison’s Umbelliferae treatise of 1672 was the first systematic study of any group of plants.

The history of this venerable family actually goes back much further. One of the first words that Michael Ventris identified, when he deciphered Linear B (the proto-Greek script that dates from 1700–1500 B.C.) was a form of the Greek word for coriander (which, by the way, derives from the Greek word for bedbug, koris, whose odor is supposed to have struck some botanical Hellene as resembling the smell of coriander). Several umbellifers are mentioned in Chinese texts of the Han dynasty. Pre-Columbian peoples also knew the umbellifers. It is no coincidence, then, that coriander in leaf form should still appear most frequently in the cuisines of the Mediterranean, Latin America, and the Far East. In this country, fresh coriander is sold almost exclusively in Chinese and Hispanic markets, and it is customary to identify it in recipes with the three names in local vernacular use: coriander; cilantro, its Spanish name; or Chinese parsley.

If you have never tasted fresh coriander leaves, it is well worth an expedition to an appropriate Latin or Chinese source. The distinct taste will surprise you. Chinese love it so much that they garnish all sorts of food with a sprig or two. Coriander’s essential oil, which is extracted from the seeds of dried, fully ripe fruits by steam distillation, has a pale yellow color and has been in industrial and pharmaceutical use for centuries. Today, it is a common flavoring agent in perfumes, candy, cocoa, chocolate, tobacco, meat products, baked goods, canned soups, and alcoholic beverages, notably gin. Many
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umbellifer oils have very distinct tastes. Anise and caraway seeds may look alike, but they taste as different as Peru-

The toxicity of herbal hemlock is only the most extreme example of the potency of umbellifer extracts. A great many of these plants were once staple items in the premodern pharmacopeia, and it is still possible to find them quaintly described as diaphoretics, for promoting sweat, or emmenagogues, for encouraging menstrual flow.

I have no reliable information on the emmenagogic powers of oil of coriander, but I can attest to the diaphoretic role of coriander seeds ground up in Indian curries. The seeds are also used to enliven stuffings, chutneys, and pickling spice. Elizabeth David mentions the Cypriot technique of spicing crushed green olives with coriander seeds. And they are sometimes found at the center of candies, throwbacks to the old-fashioned, sugar-coated coriander-seed treats known as comfits.

Although coriander is grown quite easily in this country, it is still perceived as an exotic ingredient, especially when used for its leaves. But they can be chopped as easily as ordinary parsley and mixed into all sorts of dishes, usually in small quantities, with remarkable and dramatic results. Chopped coriander leaves, says Paula Wolfert in Mediterranean Cooking are "one of the most important ingredients in Moroccan food, and, to a lesser degree, the food of Algeria, Tunisia, and the Middle East." She goes on to describe Palestinian fava beans dusted with chopped coriander and garlic, as well as saqab braised with saffron, aniseed, scallions, and chopped coriander in the braising water, then sprinkled with more coriander and scallions mixed with lemon juice.

Anyone who wants to prepare


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Moroccan meatballs or one of those delicious Moroccan casseroles called tagines will need coriander leaves to produce the authentic flavor (see recipe). Seeds are, incidentally, not a possible substitute, since their flavor is completely different from that of the leaves. For those who live far from a fresh source of leaves and are unlikely to trek out very often for a supply, the answer is coriander water. Purée three cups of tightly packed leaves in a blender with two cups of cold water. Place the purée in an ice tray and freeze into cubes. The cubes can be popped out and stored in a plastic bag. Each cube is equivalent to two tablespoons of chopped greens and can be used for any recipe except a salad, where fresh leaves are essential.

Thus supplied, you are in a position to try a very cosmopolitan repertory. For instance, you might prepare fresh-killed carp, steamed in the Szechuan manner, with a sauce composed of small amounts of oil, soy sauce, sugar, salt, cooking wine, cayenne, and chopped coriander. Mexicans marinate snapper in lime juice, then bake it in a cup of oil with onion slices, chilies, and two cups of chopped coriander.

Perhaps coriander leaves come into their own most completely in Indian cookery. Indians call them dhania and use them with everything from carrots and peas to sweetbreads. There is even a very rich lamb stew flavored with almonds and sauced at the last minute with cream and coriander leaves.

Finally, there is no need to stick with established recipes for an herb as versatile as coriander. Once you have some, you can follow your own taste and substitute it for parsley as a garnish on almost any main dish. It will make an unusual addition to tabbouleh, the Middle Eastern bulgur (wheat) salad usually flavored with mint. And you can mix chopped leaves with hamburger meat or yogurt or chicken soup. Just go slowly, adding a little at a time, because fresh coriander is like super-parsley and can overpower other flavors if you don’t watch out.

### Stuffed Vegetable Tagine

(Adapted from Paula Wolfert’s recipe)

5-6 medium zucchini (about 2 pounds)
5 large ripe tomatoes, plunged in boiling water and then peeled
Salt
½ lb. ground beef or lamb
Black pepper
½ teaspoon ground ginger
1. Wash and trim zucchini and slice into 2-inch rounds. Cut a thin slice from the top of 4 of the tomatoes and reserve. Scoop out the cores of the zucchini rounds and the tomatoes. The pulp can be reserved for soups. You should leave only about ¼ inch of the zucchini. Sprinkle the hollowed zucchini and tomatoes with salt and let stand for 30 minutes.

2. Meanwhile, prepare the stuffing. Place the meat, ½ teaspoon black pepper, ginger, cinnamon stick, garlic, ¼ of the coriander, mint, rice, onion, butter, and ½ cups water in a saucepan. Bring to a boil, reduce heat, and simmer, uncovered, 25 minutes, or until the rice is fully cooked and the mixture is thick but still juicy. Stir in the lemon juice and correct the seasoning with salt and pepper.

3. Remove the cinnamon stick and let cool. Up to this point the dish can be prepared in advance.

4. Preheat oven to 350 degrees.

5. Rinse, drain, and stuff the tomatoes and zucchini loosely with the meat mixture. Oil a baking dish and arrange the stuffed vegetables in it. Place the remaining stuffing over the tomatoes. Then cover the tomatoes and the stuffing with the tomato tops and slices of the remaining tomato. Sprinkle with salt and pepper. Cover with aluminum foil. Pierce the foil in two places and bake 30 minutes.

6. Remove the foil and transfer the dish to the upper level of the oven. Raise heat to 400 degrees and continue baking for 20 minutes.

7. Meanwhile, beat the eggs with remaining coriander plus salt and pepper to taste. Pour the mixture over the stuffed vegetables and return to the upper shelf of the oven to bake for 10 minutes or until the egg solidifies. Serve hot.

Yield: 4 to 6 servings

Raymond Sokolov is a free-lance writer whose special field of interest is the history and preparation of food.
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Walking the Railroads

Left to nature's ways, abandoned rail lines produce a rich assortment of flora and fauna

Whatever its economic significance, the decrease of American train traffic has left us with hundreds of uncrowded trails throughout the nation. Government-subsidized trains still link large population centers, but miles of tributary tracks now lie abandoned, the passengers and freight they once carried long since shifted to highways.

Some environmental and recreational groups propose purchase and conversion of these lines to formal hiking or biking trails, but other than a few showpiece efforts, little decisive action has resulted. The idea is good, but maybe we should also allow some old spurs to rust away in the second growth. For by the time a railroad track has been converted to a formal trail—with ready access, civic pride, and signs of civil adoration decorating its length—it is back to being not much different than a busy railroad: one technological switch exchanged for another. Completely abandoned track, however, takes on a look of wilderness, sprouting the always incipient possibility of spontaneity.

I like to walk any rusty spur of warped rails and crazily tilted ties, one whose heaviest freight has long since whistled past some boarded-up country station. Such tracks—going nowhere that folks and their luggage still want to go—now head into the woods like old corduroy trails. With their frost-heaved crotsties split and sunken and their vine-snared rails agape, these remnants of noisy commerce demonstrate how steel loosens its grip.

I also like still shiny lines whose freights are just frequent enough to stunt the weeds between rails. Whether corroded or polished, the tracks form a kind of inverted rat, a trail in bas-relief. As human roads go, it seems less imposed, less permanent than most. It does not cap earth so finally; it buries its ground.

Dedicated track walkers know that railroads have always carried traffic other than trains. Fifty years ago botanist B. Shimek identified railroad rights of way in the Midwest as important remnants of original prairie. Railroads have also channeled numerous weeds across the country. On still functioning lines, a track walker comes to realize how conducive the roadsbeds are to the spread of floral associations over continental distances. Mostly alien species, the plants survive constant trimming, flowering early and late in the grease of axle sweepings. Midwestern rails frame alfalfa, chicory, bountiful Bet, green amaranth, white and yellow sweet clovers, peppercorn, mustard, lady's thumb, cinquefoil, and common ragweed. Locomotive bellies scrape the bristles and beards of downy brome, foxtail, and Panicum grasses. Clumped between the ties, their upper stems stiff as caked brushes. Late in the season the only green lies low in the biennial rosettes of spotted knapweed and common mullein.

My favorite railroad hike spans several kinds of environment. Across swampy lowland stretch, the track bed is a dike, sloping down on both sides to
by John Eastman

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build them for cold exposure; hence
they look jellied in the brush, seemingly
materialized from the leaf-ripping
wind. Yet these monuments of a differ-
ent season mark the birth sites of gold-
finch, catbird, cardinal, robin, fly-
catcher, and rose-breasted grosbeak.
The tags mark where I witnessed one,
two, four eggs appear: where the young
birds jostled, feathered, fledged. Now,
in the autumnal chill, I am suddenly
nostalgic for sweat.

Black-capped chickadees, white-
breasted nuthatches, downy wood-
peckers, and dark-eyed juncos are the
common residents now. Cardinals, the
males red as bittersweet berries, fit in
the thickets and utter sharp, quick
notes. Goldfinches still bound in
flight, but yellow feathers are few—the
birds’ dullness, however, is only of
color, not pattern. Tufted titmice rasp
and buzz beside the roadbed. Blue jays
bicker.

Few birds sound melodious now. November’s style is staccato—the ex-
notes exclamatory, mostly monosyl-
babic. One bird with something re-
ssembling a song is the tree sparrow,
down from tundra for the winter. Since this
bird spends most of its time on the
ground or in shrubs, its common name
reflects little more than the grand old
ornithological tradition of dogmatizing
on misnomer.

Among the mammals here, muskrats
depress a path and fox squirrels often walk on a rail for considerable distances; muddy paw-
prints of raccoons, opossums, and ferrets
cats also attest to the rails as a path.

Something about the smooth straight-
ness evidently satisfies some motive of
impulse. I don’t know why, but I, too,
like to walk the rails, and I’ve become
very good at it.

Red foxes deposit signal feces on this,
as on other roads. Last summer, dew
shimmered on steel at five o’clock in the
morning, and robins, perched on the
polished bar, excreted globs of mulberry.
The rails began to clank as the
morning sun warmed them. The
summer railroad is a fast heating unit for
the coldblooded and morning sluggish;
hognose snakes and blue racers
unwind and lie along the ties. For all
these walkers, perchers, baskers, the
inverted rut — linear in the nonlinear
webs of wilderness — is a biotic ingre-
dient, adapted by wildlife in ways
analogous to plank bridges, stone
fences, and telephone wires, and it is
traveled without much surprise.

Best proof of this integration is the
tremedious number of creatures killed by the in-
frequent trains. Only a year’s listing of
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...to make it on my own!

I know I can do it, if I can only get some help.

Trouble is our Indian family is so poor we’re lucky to have food. And I don’t even know if I can stay in school.

Unless you help . . .
Guayule Bounces Back

A desert shrub that supplied the Aztecs with rubber could change our dependence on petroleum-based synthetic rubber.

In 1910, about 10 percent of the world's rubber and half the rubber used in the United States were supplied by guayule, a small shrub native to the Sonoran and Chihuahuan deserts of Mexico and the southwestern United States. A member of the daisy family, guayule was familiar to the Aztecs. They made rubber balls for a basketball-like game by chewing guayule twigs, spitting out the pulp, and saving the remaining elastic mass of rubber. Early commercial rubber production was simply factory adaptation of this Aztec technique. The harvested wild plants, containing rubber in individual stem and root cells, rather than in tappable latex ducts, were first dipped into boiling water to remove the leaves (which contain no rubber), to wash the plant, and to coagulate the rubber. The washed and defoliated plant was then ground and the slurry was deposited in a flotation vat of hot water containing alkali, which facilitates rubber extraction. The rubber floats to the surface in wormlike strands that can be skimmed, while the rest of the plant, the bagasse, becomes waterlogged and sinks. After this process is repeated several times, the rubber produced is reasonably free of gross impurities such as soil, leaves, and wood. About 20 percent of the rubber's weight will be resins, which make the rubber tacky and cause it to age and crack more rapidly. Soluble in warm acetone, these resins are easily extracted from the rubber, which then is indistinguishable from the product of the rubber tree, Hevea brasiliensis.

By about 1980, Hevea rubber production will probably rise to about five million tons per year, constituting about one-third of the world's current rubber needs. The remaining two-thirds will come largely from the petroleum-based synthetic rubber industry. The Soviets still produce some rubber from the Russian dandelion, but the other 2,000 or so species known to contain rubber are not now exploited commercially. But the rise in rubber use, a projected shortage, and the cost or scarcity of petroleum have meant that guayule and other rubber-bearing plants might be pressed back into economic service. This possibility would be especially useful to the United States, which currently uses one-fifth of the world's rubber supply. In 1974, we imported more than 700,000 tons of natural rubber at a cost of half a billion dollars, making rubber our third largest import of inedible crude material.

I first encountered guayule in 1943 when, as a new Ph.D., I went to work on the wartime Emergency Rubber Project at the California Institute of Technology. As a country at war, the United States needed rubber tires for airplanes, trucks, Jeeps, and cars. But because the Japanese had overrun the Malay Peninsula, 90 percent of the world's rubber was out of our reach. To solve this problem, two projects were quickly organized: one was to produce natural rubber from guayule; the second, synthetic rubber from petroleum. Between 1942 and 1946, during the guayule project, about 1,000 researchers planted more than a billion seedlings over 30,000 acres, producing about three million pounds of rubber. Late in 1945 production from two California factories approximated fifteen tons of rubber per day, while in Mexico roughly four factories turned out twice as much. After only three and a half years, the project scientists knew more about guayule than almost any other plant; had the program continued, improvements in guayule genetics, agronomy, pest control, milling, and purification would have increased production much more. But outpaced by the production of synthetic rubber, the guayule project was abandoned in 1946 and its fields plowed under or burned. Recently, after taking a long look at America's needs for the future, a National Academy of Sciences panel has recommended that the production of guayule rubber be resumed.

Guayule's great virtue is that it is completely renewable resource, whose use would free for other purposes petroleum now used to produce synthetic rubber. Guayule can be grown in the United States and Mexico, eliminating our dependence on most foreign sources.

Unlike production of synthetic rubber, producing guayule rubber does not cause pollution. Guayule grows well in semiarid regions and needs only about sixteen inches of rain a year, although optimal rubber production does require irrigation water. And since much of the land on which it could be grown lies on Indian reservations, it could possibly become an economic boon to the generally impoverished segment of the American population.

Early in the twentieth century, a group of financiers, including Rockefeller, Guggenheim, Aldrich, and Burch, invested $30 million in the Continental-Mexican Rubber Company. This American-financed venture produced much revenue for Mexico, and desert land prices in both the United States and Mexico boomed in anticipation of a continued bonanza. But overuse of wild plants and failure to replant (sixteen million pounds of rubber were imported into the United States in 1912 alone) led to a virtual disappearance of the new industry's basis, and mills were forced to close. In Mexico, the revolution gave the industry its coup de grâce as a large operation. Minor operations continued in California. In the late 1920s, Britain's control of Malaya and its resultant rubber monopoly suddenly increased rubber prices threefold (much as the OPEC nations have recently done with petroleum, and Brazil with coffee). In Mexico and California, guayule rubber was profitable again and production resumed. A then Maj. Dwight D. Eisenhower, assigned to study guayule in connection with national security, recommended further development of the industry, but the
world depression of the 1930s postponed the project until its short-
ved resurrection in 1942.

Mexico, however, has never stopped producing guayule, and at present a
plant in Saltillo, in northeast
o's Sonoran desert, can process
ion of shrubs daily. About 2.6 mil-
ons of wild guayule grow in an
rea of approximately 10 million acres
the states of Durango, Coahuila,
tecas, Chihuahua, Nuevo León,
and San Luis Potosí, just south of the
Bend area of Texas. The project's
al is 30,000 tons of rubber per year,
on a harvest of about a third of a
lion tons of plant. Hence, the Mexi-
s have a nine-year supply of gua-
le: the harvest of about one-ninth of
he total number of plants per year
ould allow adequate regrowth of
edings. A harvest of wild shrubs
ously depends on a large supply of
ensive hand labor, available in
ico, but not in the United States.
If guayule growing were revived in
e United States, the main location
uld probably be about five million
res of the arid zones of Texas and
fornia, connected by a narrow band
posed of part of southern Arizona
nd a small portion of southwestern
ew Mexico. But as the National
ademy of Sciences panel points out,
dustry would be economically vi-
able only if it were to benefit from the
me kind of research that has led to a
old increase in Hevea production
er the last thirty years. The
ergency Rubber Project showed
at guayule can be genetically im-
ved through conventional selec-
d breeding techniques. Innovations
 chemical weed control, insect con-
, and rubber technology, as well as
 insights into the biochemistry of
ubber formation in plants, can be
icted to increase yields. Agronomic
ks, such as harvesting only the tops
 leaving the roots to resprout, might
ten the current three- to four-year
le before rubber harvest is optimal.
Along with each ton of purified rub-
er, the guayule plant produces about

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two tons of bagasse (mainly crushed stems), one ton of leaves, and half a ton of extracted resins. Each of these could find commercial use as a byproduct. The bagasse can be used for paper, pressed board, and cardboard manufacture. Guayule leaves are covered by a hard cuticle wax, whose melting point, 169°F, one of the highest ever recorded for a natural wax, makes guayule wax competitive with carnauba wax, most commonly used for polishes. The resins, containing odoriferous terpenes, shellacike components, cinnamic acid, and drying oils, could probably find some use. Minute guayule seeds could be sources of protein and fat, and the leaves might serve as an occasional browse for sheep and goats. But whatever the contribution of its byproducts, guayule must stand or fall on the quality and quantity of its rubber.

Even if petroleum were indefinitely and cheaply available, demand for natural rubber would grow. Rubber is a polymer, a very large molecule made up of repeating units of isoprene—a small molecule made up of four carbon atoms in a row and one branching off the chain and eight hydrogens. When isoprene is polymerized, or linked in a specific way to make rubber, the units join end to end along the unbranched four-carbon chain. The isoprene unit has two double bonds involving four of the five carbon atoms; each of these two double bonds is rigid, whereas the carbons are able to rotate freely around the single bond. This means that there are two possible ways, known to the organic chemist as cis- and trans- configurations, for the carbon atoms to be grouped around the double bond. In natural rubber from Hevea and guayule, the bonds are all cis, that is, the branched carbon atoms all protrude from the same side of the backbone of the polymer. This configuration gives maximum elasticity and bounce to the molecule. Even a small percentage of trans-links can markedly reduce the desirable qualities of the molecule. In synthetic rubber manufacture, both cis- and trans-linkages are produced, so that the resultant molecule is weaker than natural rubber. While perfectly acceptable for many commercial uses, the synthetic product does not stand up well in tire sidewalls; accordingly, all tires must have at least some of the natural polymer, both to give basic strength and durability and to serve as a kind of template around which the synthetic units are deposited in a regular way. Since tires account for about 75 percent of all rubber used in the United States, the reason for continued re-
The amount of natural rubber required depends on the type of tire. Airplane tires, which must withstand tremendous, jarring shocks of landings, are composed almost entirely of natural rubber; truck and bus tires, which operate under great stress for prolonged periods of time, have about 10 percent natural rubber; and ordinary automobile tires generally have about 20 percent. (A post-World War II government-sponsored test of a set of commercial truck tires made of guayule bound that they performed as well as Hevea.) Radial tires have somewhat altered this picture; radials must contain almost double the amount of natural rubber. Since 1972, radial tires have captured more than half the tire market, and this trend will probably continue, underscoring the need for more natural rubber. Since Hevea production, already strained, cannot expand indefinitely, guayule looks like the answer. Even with its modest 1940s production level of about 500 pounds of rubber per acre per year over a three- to five-year period, guayule would be economically viable, but with expected improvements in productivity, it may one to match Hevea, which consistently produces about two and a half times more rubber.

To the plant physiologist, guayule and other rubber-producing species use the additional lure of research. Why does the plant make rubber, since rubber is inert metabolically and cannot be used as a food source? How does the plant manage to achieve 100 percent cis-bonding as it fabricates the long-chain isoprene polymer? Why is rubber made only in stems and roots, not in leaves? How can guayule compete successfully with other plants in the arid desert environment? Part of the answer to the last question involves the secretion from guayule roots of a substance that retards the growth of nearby seedlings. This kind of “chemical warfare” is common in desert plants, and in 1944, working with James Bonner at the Tech, I was able to identify trans-cinnamic acid as the main effective compound. Oddly enough, this same molecule later found use as an antagonist of auxin, one of the major plant growth hormones. As far as I know, guayule is the only plant known to use a natural hormone antagonist in this way. Doubt this is not the last surprise we expect from guayule.
Hall of Reptiles and Amphibians

On November 18 in the Chinese Year of the Snake, 4675, roughly 350 million years after amphibians made their first appearance on earth, the Museum’s new Hall of Reptiles and Amphibians will debut. Reptiles, which came on the scene about 50 million years later, share the billing with their amphibian progenitors.

The evolutionary paths taken by the amphibians and reptiles are remarkable for their breadth and variety. When the first amphibianlike creatures found a suitable niche along some ancient shoreline, new possibilities for life on earth took form. During the Permian period, some 30 million years later, reptiles were the dominant land animals. Dinosaurs came and went, but other reptilian experiments were to be of greater duration: the first shelled eggs were produced by reptiles, and one of their myriad evolutionary lines gave rise to the birds. Another group, the therapsids, produced the precursors of today’s mammals.

Museum halls have also undergone a remarkable evolution. Beginning as curio cabinets housing the odd and exotic leavings of nature, the new generation of exhibition areas pulsates with holistic renderings of ecological systems. Gone are the dusty cases and rows of entombed carcasses. Today, a museum of natural history is a vital

By exposing the vivid, contrasting color of its underside, a ring-necked snake can startle predators. A model depicting this defensive posture is on display in the new hall.

Photographs by Richard G. Zweifel
A featured player in the hall is this South American frog, Physalaemus natteri, below. When disturbed, it presents its hind end on which are two “eye spots.” A predator would presumably take one look at this creature and search elsewhere for a meal. The banded gecko, right, an inhabitant of desert areas in the southwestern United States and Mexico, stores food reserves—in the form of fat—in its tail. This adaptation enables the gecko to survive lean periods.

place: its halls are interlocking stages on which thematic dioramas arrest the eye and inform the beholder.

“Three-dimensional textbook” would be an apt phrase for the new hall, located on the third floor of the Theodore Roosevelt Memorial Building. The Komodo dragons on display are impressive enough to look at. These giant lizards command attention. But there is more to being a huge lizard than weighing two hundred pounds. What adaptations to their environment have the world’s biggest lizards made? What do they eat and how do they reproduce? In their habitat exhibit, a group of “dragons” is scavenging a wild boar. Careful study of the tableau reveals a series of clues to this lizard life style, and a vivid picture emerges.

The new hall is primarily a teaching hall. The specimens are not a taxonomic roll call; they are chapters in the history of evolutionary biology. Amphibian and reptilian feeding and reproductive strategies have their parallels in other orders of animals. Life flows and adapts, and the survivors must meet the challenges of newer worlds. In this age so conspicuously dominated by mammals (Homo sapiens in particular), amphibians and reptiles continue to play an important role in a wide variety of ecosystems. Their interactions with their environments have lessons for man.

Featured players in the hall are poison-dart frogs with brilliant colors so variable that two nearby populations look like completely different species; a twenty-five-foot python coiled around a tree and ready to strike a preening cock jungle fowl; an all-female species of lizard that has eliminated the need for males; a fourteen-foot crocodile and a twelve-foot alligator, both obtained by the Museum many years ago. They would have a slim chance of reaching such lengths today; they would probably be shot by man much earlier in life. Snakes that look like worms and lizards that look like snakes share space with the box, spotted, and painted turtles of the northeastern United States. The
behavioral and physiological adaptations are shown in situ.

The old hall of amphibians and reptiles opened to a wondering public in the 1920s. By 1969, out of date and definitely the worse for wear, it had reached the end of its line. Planning for a successor had gone on for some time. For years, more than a million dollars, all the newest techniques for bringing the drama of nature to life went into the creation of the new hall.

"In the interests of conservation, we used as many specimens from the old hall as possible," reports Richard Zeifel, chairman and curator of the Department of Herpetology. Using ingenious methods of molding and casting plastics and fiberglass, new specimens were created and old ones were given a new lease on life. In some instances, the new lease meant some startling transformations. A leatherback turtle, one of the veterans from the old hall, began life as a male. No longer satisfied to simply show a leatherback as one of the world's largest reptiles, the exhibit on these sea turtles was planned to depict egg laying on a beach. But no female was available and the species is too threatened to allow the collection of one. So, through the magic of plastic surgery, the old male underwent a sex-change operation that was a complete success.

From myths that tell of the snake as earth mother and of turtles as supporters of the universe, we learn of the symbolic importance of these reptiles. From the blowguns of the Choco Indians of Colombia and the role of the green turtle in the colonization of the New World, we learn of the pragmatic uses to which man has put amphibians and reptiles. A bottle of liquor (a Japanese concoction with the look of bourbon) in the new hall also tells us a bit about ourselves. In making the drink, the distillers toss live venomous snakes into the fermenting liquid; the unfortunate snakes become part of the spirits. The label reads: "Old Mam."

Frederick Hartmann
Celestial Events
by Thomas D. Nicholson

Sun and Moon In November, the sun moves to nearly 22° south of the equatorial plane while traveling eastward through the constellation Libra. It enters Ophiuchus about November 23 and Sagittarius after mid-December. Although winter is still three weeks off at the end of November, daylight by then is within sixteen minutes of its shortest duration for the year, and sunset comes only one minute later than on December 7, the date of the earliest sunset.

The moon is in the morning sky in November (and early December). It becomes visible in the evening as a slim waxing crescent on November 13 and remains prominent in the evening till late in the month. Last-quarter is on November 3, new moon on the 11th, first-quarter on the 17th, and full moon on the 25th. In December, the last-quarter moon is on the 3rd and new moon on the 10th.

Stars and Planets Although none of the bright planets (except Mercury, which is poorly placed) is an evening star, Jupiter appears on the Star Map because it rises shortly after sunset and will be above the eastern horizon in the early evening. Above and to the right of the twin stars Pollux and Castor in Gemini, Jupiter will be the brightest starlike object in the sky until Sirius rises later. By midnight, Mars will be visible in the east just below the twins. And Saturn will then be rising to the right and below Mars.

The planets will be best in the morning. Just about dawn, Venus will be low in the east; Saturn will be halfway up the sky in the south, quite close to Regulus in Leo (Saturn is the brighter of the two); Mars will be to Saturn's right; and Jupiter, farther to the right, will be high above the southwestern horizon and above Orion.

November 1–3: The waning gibbous moon moves past Jupiter and Mars, while the other morning planets are in conjunction with nearby stars: Saturn with Regulus and Venus with Spica.
November 4: The Taurid meteors (15 per hour) reach maximum.
November 5: Saturn is near the crescent moon this morning.
November 9: The moon passes very close to Venus, covering it (an occultation) over southern skies.
November 12: The moon is at perigee (nearest earth).
November 16: The Leonid meteor shower reaches maximum. Although sparse (up to 15 per hour), the meteors are swift and often bright.
November 20: Venus is in conjunction with Uranus.
November 27: The moon is at apogee (farthest from earth).
November 27–28: Look for Jupiter near the moon from early evening until dawn.

November 30 – December 1: Mars rises near the moon late at night.
December 2–3: The moon is near Saturn from late evening until morning.
December 3: Although Mercury is at its greatest distance to the sun's left (east), it is poorly placed as an evening star.
December 7: The earliest sunset of the year occurs.
December 10: Perigee occurs six hours after the new moon, enhancing the effects of spring tides. Look for exceptionally high tidal levels tonight and tomorrow.
December 11–13: Mercury, Saturn, and Mars become stationary among the stars, and all three begin to move westward (retrograde): Mercury on the way to conjunction with the sun; Saturn and Mars as they approach opposition from the sun.

★ Hold the Star Map so the compass direction you face is at the bottom; then match the stars in the lower half of the map with those in the sky near the horizon. The map is for 11:20 p.m. on November 1; 10:20 p.m. on November 15; 9:20 p.m. on November 30; and 8:20 p.m. on December 15; but it can also be used for an hour before and after those times.
Ring Galaxies

A recent finding leads to a new explanation of the formation of these peculiar objects

In the past few years, astronomers have recognized a class of rare galaxies that are shaped like giant smoke rings. It appears that these “ring galaxies” may be the short-lived remnants of cosmic collisions in which one galaxy has struck through the heart of another and then passed on into space.

A galaxy is a vast collection of stars, gas, and dust, all held together by mutual gravitational attraction. These assemblages are occasionally referred to as “island universes” in the even vaster expanse of the cosmos. A familiar example is the famous Andromeda Galaxy, pictured in nearly every text on astronomy. The Andromeda object is a fine specimen of a spiral galaxy, resembling a huge, flat pinwheel with a central spheroidal bulge at the galactic nucleus. Spiral galaxies come in a wide range of sizes and shapes, but in each case the arms of the pinwheel are confined to a thin, flat zone known as the “galactic disk.”

Other common types of galaxies, some of which also have disk structures, are ellipsoidal or spheroidal in shape or are so-called irregulars of formless or chaotic appearance. The very small minority of galaxies that do not fit into this classification scheme (spiral, ellipsoid, spheroid, irregular) are known collectively as “peculiar galaxies.” Even among this relatively rare class, it appears that only about one peculiar galaxy in a thousand is a ring. In almost every case, a ring seems to have an adjacent companion galaxy.

The earth has no nearby ring galaxies, hence they are small, faint objects as we observe them. Telescope observations revealed the first of these objects as long ago as the early 1940s, and a few brief papers discussing individual rings appeared in the 1960s. It was not until the present decade, however, that they became recognized as a distinct class of object, one that should be subjected to systematic investigations and comparative studies. By 1973, when the first extensive study of this type was made by John C. Theys and a Ph.D. thesis in physics at Columbia University, only about a dozen rings had been found. Since then, they have attracted much greater attention among astronomers, and many regions of the sky have been carefully searched, so that by now at least six dozen rings have been found.

A negative print made by superimposing three four-meter telescope photographs shows the large off-center nucleus in the ring galaxy II Hz 4. A faint secondary ring can be seen immediately above the main ring. This double-ring galaxy is the first known instance of such an object.
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A typical ring galaxy is perhaps 60,000 light-years in diameter and 100 billion times more massive than our sun, according to rather uncertain estimates. These quantities are somewhat smaller than those characteristic of a typical large spiral galaxy such as the one in Andromeda. John Theys (now an astronomy professor at the State University of New York at Stony Brook) noted that three basic types of ring galaxy can be distinguished: those with a prominent nucleus off center but within the ring; those characterized as “empty rings,” that is, without a nucleus; and those with bright knots, presumably concentrations of stars or other luminous matter, on the ring itself.

The discovery of ring galaxies came as a surprise to astrophysicists because the ring is usually an unstable shape for a large distribution of matter, unless there is a very massive object at its center. (Thus, Saturn’s rings are relatively stable because they are centered on that massive planet.) Without such a central object, theory suggests that any ring is likely to break up, spin apart, or collide, or diffuse into space. Calculations for specific ring galaxies indicate that they cannot persist as rings for much more than a hundred million years. Since most normal galaxies are at least ten billion years old, the observed ring galaxies must have been created long after the normal galaxies came into existence. This, taken together with their unusual shape, might mean that ring galaxies are also produced in a different manner from that of normal galaxies.

At first, theories advanced to explain the rings tended to concentrate on their formation as new objects, somehow generated from a hypothetical gas cloud medium in intergalactic space. Although we know that there is much gas in the interstellar space within spiral and other kinds of galaxies, there is little hard evidence on the properties of any possible gas in the space between galaxies. Theorists tended to concentrate on individual cases since rings in galaxies were not generally recognized as a class of objects with common properties.

One of the pioneering studies was made by E. Margaret Burbidge, an astronomer at the University of California, San Diego, who observed the mysterious Mayall’s Object in May 1961. A photograph obtained with the 120-inch telescope at Lick Observatory in California showed that Mayall’s Object (named for a well-known astronomer) consisted of a ring and a highly elongated

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ted companion galaxy that Burbidge termed the “cigar-shaped main body,” along with a faint luminous streamer, or bridge, apparently connecting the ring and the cigar. Based on a study of the photograph and of spectrograms that were also made with the Lick telescope, Burbidge was led to “propose tentatively that this object is an example of interaction between a galaxy and the intergalactic medium.” By “galaxy” they meant the cigar-shaped body, as the nature of the ring seemed uncertain.

Several years after Burbidge’s idea was published, more detailed theories were advanced that also accounted for normal galaxies as products of encounters with intergalactic matter. According to one theory, a ring formed from a vortex generated in the wake of a normal galaxy as it flies through the intergalactic medium, much as a vortex may occur near a large rock in a shallow, swiftly flowing river. The normal galaxy, of course, would be identified with the observed companion galaxy of the ring.

Another concept, which attracted much more interest, was that ring galaxies “result from encounters of normal spirals with intergalactic clouds.” This theory assumes that intergalactic matter consists of a clumpy distribution of clouds, rather than a simple, smooth medium. Advanced in 1914 by astronomers at the Australian National University and the University of Texas, this proposal was the leading theory for a time. It is interpreted as requiring that intergalactic clouds be composed of neutral hydrogen atoms, with properties that would render the clouds readily detectable in sensitive radio-astronomy surveys. Pertinent observations have now been made with a 30-foot-diameter radio telescope at Green Bank, West Virginia. Although thousands of regions of the sky have been studied with this telescope, analysis of the results reveals no support for the intergalactic cloud theory. Last year, the Green Bank observer wrote to me that radio emission from the clouds “could easily be seen” in his data if it existed, but that “we see nothing.”

In addition to its shape, the most significant characteristic of a ring galaxy may be the presence of the nearby companion. After studying a collection of ring galaxy photographs and taking account of likely effects due to perspective, John Theys concluded that the companion is always located on or near the “axis of symmetry” of the ring. In other words, if some cosmic giant were to take a finger straight through the...
Books in Review

Troubled Waters

Killing the Hidden Waters, by Charles Bowden. University of Texas Press, $9.95; 207 pp., illus.

Moving southwest from New England to Baja California, a distance of some 2,500 miles, one passes from forest through grassland to desert. Rainfall decreases and evaporation increases along this gradient until the extremely arid climate of the desert is reached.

Until recently, population density was roughly proportional to the amount of available moisture. For centuries the sparse native population of the desert survived by strict adjustment to the harsh environment. Water scarce, people few; much water, many people.

In addition to the surface water of lakes, wetlands, and rivers, there are vast stores of water underground. These have been built up during the long geologic past. Where rainfall is abundant, these stores are continually recharged, replacing the water that escapes or is brought to the surface. Where rainfall is light, the rate of underground storage decreases correspondingly, until in the desert it becomes zero. Here the subterranean reservoirs are, like any mineral deposit, nonrenewable. Their content is correctly called "fossil water"; if drawn to the surface by pumps, it cannot be replaced. Rural and urban developments that depend upon it are living on borrowed time.

Such developments were virtually impossible until the advent of cheap fossil fuel and the internal combustion engine, although there were a few remarkable instances of deeply dug wells in ancient times. Once deep drilling and pumping began, early in the present century, change followed fast: irrigated farms; urban centers to serve and be served by them; then large cities to accommodate refugees from harsh winters, wishing to bask in desert sunshine.

Less noticed were the well-meant efforts of the Bureau of Indian Affairs to ease the laborious life of the desert Indians by furnishing them with deep-drilled wells equipped to supply abundant water. Thus, abruptly, the white man's ideal of minimizing physical effort was imposed upon an ancient, highly disciplined pattern of adaptation to the limitations of desert climate.

Essentially, this is the story told by Charles Bowden, project coordinator for the Radio-Television-Film Bureau of the University of Arizona, in his book Killing the Hidden Waters. But unusual, effective, and important is his manner of telling, that a fair amount of background seems justified.

Too little known and almost completely ignored in public policy is quiet revolution in the professional study of human societies. With rare exceptions, such as Marco Polo, observers of alien societies have generally looked upon them as something abnormal, the standard of measurement being the society of the observer. This attitude weakened any scruples about exploitation, enforcement of violation, or even extermination. One reminded of the reply of a rustic chide for shooting a pelican many miles outside of its range. "Shoot it, course shot it. I never seen such a damn thing before."

Gradually, and not too long ago, students of mankind began to adopt a new working assumption. In effect, this amounted to saying, "Suppose that instead of regarding ways of life other than our own as abnormal or even pathological curiosities, we treat them as legitimate entities in their own right each with its own internal logic, making sense to its members, and to be understood, so far as possible, from within."

A century earlier the science of geography became possible when geologists adopted the idea that past changes had been due to the same forces that operate today. In similar fashion, the students of human societies found a powerful tool in their new working assumption. The old idea of folkways (which had emphasized differences) was modified...
by Paul B. Sears

Demonstrate a quality common to all groups, namely the tendency to develop patterns of behavior, and values to reinforce them, that fitted both the resources of each environment and its compelling limitations.

This means that each culture pattern is not a fixed thing, but a process. If it fails in a viable relationship with environment, the group survives. If not, the experiment fails. Meanwhile, the iterations of the group are reinforced by value systems expressed in belief, ritual, and the arts. Thus, what works seems right, and what seems right becomes right.

This idea, of course, is like a red rag to those who insist on an absolute code of right and wrong applying universally to all of mankind. Yet the late Justice Oliver Wendell Holmes, through his study of the common law and the philosophy of law in general, arrived at the essential idea of the culture pattern. The morning as he and Judge Learned Hand were parting on their separate ways to work, Holmes turned half angrily on his friend Hand, who had bade him go and dispense justice, saying, “I don’t dispense justice. All I can do is to go and see that the game is played according to the rules.” Obviously, the rules must vary as do the conditions that have shaped the various cultures.

Not only is each culture pattern a response to environment but to its beliefs and values determine its treatment of environment. Thus, any approach to environmental problems must reckon with the culture patterns involved. The conventional approach insists “there ought to be a law” or divides a society into the righteous and the evil on this issue is too naïve, aimed to fail.

To an extent unique in my experience, and with rare insight, Charles Bowden analyzes the human adventure, past and present, within the great southwestern desert. Introducing the culture of the Papago, he tells of the bird god and the sacred stick that serves as a record. Linking parallel events of the white

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of the traditional culture that made survival possible without exploiting the onereous resources of the southwestern desert, Bowden has furnished the structure upon which to dramatize what follows. For this is an account of the illusory riches suddenly made available by using nonrenewable fuel to exploit nonrenewable water. Instead of operating on the current budget of energy and materials, the farms and cities of the Sunshine Belt are living upon the accumulation of ages, consuming in decades what it took millions of years to form.

Even now this spectacular example of technology is beginning to digest its own tissues in order to keep going. One of the greatest of its urban centers is buying up the water rights of the irrigated farms that spread beyond its borders, thus ending whatever wealth might be created by solar energy acting upon green plants by grace of a limited supply of surface water. Predictably, as this self-cannibalism progresses, there is pressure for relief by an expanded technology, drawing upon increasing amounts of energy and resources from beyond the desert boundaries.

Invoking the inexorable laws of thermodynamics, and pointing out that spent and dispersed resources disadvantage the future, the author concludes: This writing has always been on the wall. It is not a revelation to learn that cheap energy makes societies boom, at groundwater in arid regions has negligible recharge, that humans tend to use as much of anything as they can put their hands on. We can ignore these facts and pump, mine and combust [sic] with abandon, or we can recognize the facts and attempt to construct a sustainable society. There will be no inless answers, nor were there any in the past."

Which suggests something too often overlooked. Cultures establish themselves by learning to use the resources of their environments. They persist by learning to respect the limitations of those environments. Our own has more in met the first of these conditions. our increasing pressure on clean air and water, minerals, building materials, living space, and energy are grim reminders that we have yet to face the need — our limits.

ologist Paul B. Sears is professor emeritus of conservation at Yale University. He is past president of the AAAS and author of several books, including parts on the March.

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Announcements

The new Hall of Reptiles and Amphibians will open on Friday, November 18. Containing ten large exhibits, the hall is one of the most complete presentations on the distribution, behavior, physiology, and evolution of reptiles and amphibians. It is expected to be one of the Museum’s most popular permanent halls and is located on the third floor, Theodore Roosevelt Memorial Building, Central Park West. For further details please see page 98.

In conjunction with the above, the Museum library, fourth floor near the 77th Street elevators, will display some rare illustrated books on reptiles and amphibians. Included in this Rare Book Exhibit will be an important sixteenth-century treatise on natural history written by Conrad Gesner; an early nineteenth-century first printing of an important tracts on Brazilian natural history by Johann Baptiste de Spix; and one of the first and most important books on North American herpetology, written in the mid-nineteenth century by James Holbrook.

On November 10 at 8:00 P.M. in the Museum auditorium there will be a slide lecture on the New Alchemy Institute presented by its cofounder John Todd, an agriculture scientist and marine biologist. The New Alchemy Institute, located near Woods Hole, Massachusetts, was established in 1969 to explore the possibilities of solving the world food shortage problem by creating small, self-contained, ecologically balanced units that would use wind and solar power to recycle water and nutrients. Tickets for associate members and the public are $2.00 and will be available at the auditorium door half an hour before the program begins. Participating and donor members will be admitted free.

The African Elephant, filmed and directed by Simon Trevor, will be shown on December 1 at 8:00 P.M. in the Museum auditorium. Nearly two hours long, the film tells the life story of these intelligent, gentle, and mysterious creatures from birth (after a 22 month gestation period), through dailylife in the highly organized society of the herd, to eventual death. Dr. Richard Van Gelder, curator in the Museum’s Mammalogy Department, will lead discussion following the screening.

Tickets, available at the door one half hour before the program begins, are $2.00 for associate members and the public. Participating and donor members will be admitted free. All persons attending this program should enter through the lower-level driveway entrance on Central Park West.

Peru’s Golden Treasures will remain on view in Gallery 77 on the Museum’s first floor through January 1978. The exhibit includes more than 200 of the relatively few survivors of Peru’s extraordinary gold-working tradition. Gloves, small figures, drinking beakers, a litter backrest, crowns, ceremonial blades, and burial masks, are fashioned out of gold, are on display along with Peruvian ceramics, music instruments, two priceless, 2,000 year-old Paracas textiles embroidered in wool with cactus-thorn needles, and much more.
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Additional Reading

Naked Mollusks (p. 46)


Walruses (p. 52)

*The World of the Walrus*, by Richard Perry (New York: Taplinger Publishing Co., 1968), is enriched by an extensive bibliography. This general history of walruses focuses on their biology, their behavior, and their exploitation by humans. The yearly rhythm of Arctic animals is treated most fully by Peter Freuchen and Finn Salomonsen in *The Arctic Year* (New York: G. P. Putnam Sons, 1958). This popular work, illustrated with line drawings, gives extensive coverage of the walrus. Francis H. Fay and Carleton Ray have reported on their studies in volume 53 (1968), of *Zoológica*, which is published by the New York Zoological Society. The two articles are “Influence of Climate on the Distribution of Walruses, Odobenus rosmarus [Linnaeus]: I. Evidence from Thermoregulatory Behavior” (pp. 1–18 and II. Evidence from Physiological Characteristics” (pp. 19–32). Both sections deal with thermoregulatory causes for walrus huddling behavior. Fay also discusses rogue walruses as disease vectors in “Carnivorous Walruses and Some Arctic Zoones” (Arctic, Jan 1960, pp. 111–22). Gavin Maxwell’s *Seals of the World*, published in 1967 by Houghton Mifflin, Boston, includes detailed descriptions of all seal species as well as information on exploitative and biological subjects.

For other general biological and physiological treatments of the pinniped, please see last month’s “Additional Reading.”

Forest Ecology (p. 62)


do Sheep (p. 72)

A recent Natural History article on wild goats of the west coast is Bruce Elliott’s “Wild Goats of Santa Ana” (June/July 1976, pp. 70-77). Mountain Sheep: A Study in Behavioral Evolution, by Valerius Geist (Chicago: University of Chicago Press, 1974), is based in part on the author’s dissertation field work on American species from 1961 to 1966. His book, available for $7.95 in paperback, includes seventeen pages of photographs and refers the reader to other sources for further study of the behavior of mountain sheep. Black-and-white photographs illustrate specific behaviors and settings. James L. Crockett’s The Great Arc of the Wild Sheep, published in 1964 by the University of Oklahoma Press, Norman, is a less scientific work that describes animal species by species. It is based on the literature and on Clark’s own ringing experiences. Clark was an ardent outdoorsman and the reader’s visual curiosity about each animal is at least partly piqued by illustrations of mounted specimens and by pictures of museum dioramas. The reader might also enjoy reading Richard Lydekker’s Wild Sheep and Goats of All Lands, Living and Extinct (London: R. Ward, 1898). This work is only available in larger research or university libraries, but is beautifully illustrated and the effort involved in locating it is worthwhile. There is a copy in the library of the American Museum of Natural History, and the most complete recent book on the subject of mountain sheep in the New World is edited by James B. Trefethan, and entitled The Wild Sheep in Modern North America. This work, the printed proceedings of a workshop on the management biology of North American wild sheep, was sponsored by the Boone and Crockett Club, the National Audubon Society, and the Wildlife Management Institute. It was published in 1975 by the Boone and Crockett Club with Winchester Press, New York, and is available in paperback for about $10.00.

Street Dwellers (p. 78)

A recent article dealing with New York’s shopping-bag people is Joan Roth’s photographic essay, “If I’m Not on My Milk Crate, You Can Find Me in My Phone Booth,” in the March 1977 issue of Ms. (pp. 74-77). The New York Times of September 30, 1976 (p. 43), published an article by Molly Ivins about one woman’s return to “normal” living. An entire issue of the women’s newspaper Majority Report (October 17, 1974) was devoted to the subject of shopping-bag women with several articles by Beverly Burlett, some based on participatory observation.

Although there is no body of scientific literature to deal with the subject of street dwellers, the following material may be relevant to the subject. First, there is the classic work by Joseph A. Singh and Robert M. Zingg, Wolf Children and Feral Man (Hamden: Shoe String Press, 1966), about cases of so-called wolf children who may have been raised by wild animals without human companionship. In “Feral Man and Extreme Cases of Isolation” (American Journal of Psychology, 1940, pp. 487-517), Zingg suggests that isolation from other humans may cause some of the symptoms shown by these people. Two well-known studies of street people are William Whyte’s Street Corner Society: The Social Structure of an Italian Slum (Chicago: University of Chicago Press, 1955) and Talley’s Corner, written in 1967 by Elliot Liebow (Waltham: Little, Brown & Co.), and available in paperback.

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6 Authors
10 Airs, Waters, and Places Robert S. Desowitz and Louis H. Miller
   Dangerous Nymphs of Nantucket
20 This View of Life Stephen Jay Gould
   Caring Groups and Selfish Genes
26 The Problem With Simple Folk Peter J. Wilson
   Every generalization about the Tsinghity of Madagascar seems false—
   even this one.
36 Eucalyptus Bark Edward S. Ayensu, photographs by Gail Rubin
   These successful and useful trees also bring beauty to 20 million acres of
   the world.
40 The Edge of Europe John F. West, photographs by Michael Spring
   With pride in some self-sufficiency, most Faeroe Island families still
   salt away puffins, fulmars, and barrels of pilot wh hale meat.
48 China’s Ancient Mariners Stan Steiner
   Centuries before European sailors ventured forth, giant Chinese ships
   roamed the oceans.
64 San Salvador’s Urban Orchids Peter Bernhardt
   A modern city wreaks havoc on most tropic flora, but a few modest
   plants manage to make it.
72 Chilean Flamingo Court and Dance Text and photographs by
   Juan Muñoz
   In springtime—early December—the chicks hatch and form crèches of
   hundreds of birds.
80 The Wolf That Lost Its Genes James H. Shaw and Peter A. Jordan
   Extinction can be a slow and subtle matter.
90 The Market
92 Celestial Events Thomas D. Nicholson
94 A Matter of Taste Raymond Sokolov
   A Christmastide Treat
100 Sky Reporter Harold Zirin
   Solar Magnetism
106 Book Review Robert Arbib
   The Elusive Marsh Birds
110 Additional Readings
112 Announcements

Cover: Children on the Faeroe Islands spend the summer hours bicycling
up and down the streets of their isolated villages. Each village has its own
sweater design. Story on page 40. Photograph by Michael Spring.
Dwindling supplies of firewood in developing countries alerted Edward S. Ayensu to the importance of fast-growing eucalyptus trees, which are widely used as a fuel source. His knowledge of the subject led him to head a panel on firewood energy resources held earlier this year by the National Academy of Sciences. A botanist by training, Ayensu is the director of the Smithsonian Institution's Endangered Species Program and secretary-general of the International Union of Biological Sciences. He wrote "Beautiful Gamblers of the Biosphere," for the October 1974 issue of *Natural History*. New York-born Gail Rubin is now living in Israel. Through her work as a free-lance nature photographer, she became aware of the subtle color changes in that country's arid regions and is now studying this phenomenon in the Sinai Desert.

When John F. West first visited the Faeroe Islands in 1956, he immediately felt at home because the villages reminded him of those in his native England. Since then, he has returned to the islands seven times. West, who lectures at Trent Polytechnic in Nottingham, England, has spent many years studying the history and literature of the Faeroes and has written a history of the islands, *Faroe: The Emergence of a Nation*. Photographer Michael Spring went to the islands to find peace and quiet in which to write a play. The beauty of the islands, however, proved a greater distraction than the bustle of New York, where he wears still another hat as editor of *Literary Cavalcade*, a Scholastics Magazines publication.

A professional writer living in New Mexico, Stan Steiner is now in Venezuela, where he is studying the cultural, ecological, and political changes that rural people of developing country undergo when oil is discovered on their lands and they begin working in oil fields and the industry. Steiner's article on the prowess of ancient Chinese miners is taken from the last in a series of four books he has completed on non-European, nonwhite peoples who have contributed to the character of contemporary America. Steiner previously wrote a special supplement for *Natural History*, "The Waning of the West", which appeared in the June/July 1975 issue.
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A consulting geologist for Fondo Nacional Exploración Minera, an agency of the Bolivian Government, Juan Muñoz is exploring the hinterland of that country in search of tin deposits. While on a similar expedition in 1971—in search of fluorite in the Patagonia region of Argentina—he came across the nesting islands of the Chilean flamingo near the village of Colán Conhue. Three years of intermittent observation and filming of the bird’s reproductive activities followed. As a geologist, Muñoz has trekked through many of the less accessible reaches of North and South America, giving him the opportunity to pursue his twin avocations of wildlife study and pre-Columbian archeology.

James H. Shaw conducted one of the first ecological and behavioral studies of the endangered red wolf in the early 1970s. An assistant professor of biology at Oklahoma State University, he is now working on taxonomy, ecology, and socioeconomic status of coyotes. Other search in progress includes a study on elk ecology and fieldwork with the red fox. Coauthor Peter A. Jordan is associate professor in the Department of Entomology, Fisheries, and Wildlife at the University of Minnesota. His recent research has centered on the impact of moose on forest vegetation and aquatic ecosystems. He has also studied wolves on Isle Royale, in Lake Superior, as part of Durward Allen’s long-term program on that island.

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In the wake of major ecological changes, a small arthropod has begun to transmit a serious disease to this island's upper crust.

The rich are not like you and me. They summer on Nantucket and get babesiosis, hardly a household word in the almanac of human ailments. Not readily recognized by the infectious disease pundits or hotly pursued by the parasitologist, this low-class, malarialike parasite of rodents has come to plague the residents of that idyllic Massachusetts island.

*Babesia* parasites have long been known, particularly for infecting domestic stock. In the warm, arid climate of Australia, and at one time in Texas, babesiosis resulted in enormous economic loss to the cattle industry. And before the outbreaks on Nantucket, four well-documented cases had occurred in humans, the first of which was discovered in Yugoslavia in 1957. In each of these cases, however, the infected individuals were immunologically deficient. All of them had previously had their spleens removed, an operation that weakens one's immune defense system. Generally speaking, however, these animal parasites were considered incapable of making the enormous leap to humans. But on Nantucket Island in 1969 they crossed the barrier. The list of epidemiological-ecological ingredients that made this situation possible reads like the contents of a witch's caldron—sheep, deer, mice, ticks, *Babesia* parasites, bayberry, and scrubland.

From this brew emerged the evil genie that was to possess a long-time summer resident of Nantucket Island. The patient had enjoyed remarkably good health for most of her 59 years, but in July 1969, she found herself in a New Brunswick, New Jersey, hospital. Two months earlier, she had closed her home in Santa Barbara, California, to make her annual summer pilgrimage to Nantucket, where she owned a pleasant estate in a scrubland area near the sea. Early in July, she began to suffer from a high fever, abdominal cramps, and a depressed state. Despite a battery of medical tests, the cause of her ailment did not come...
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to light. The fever persisted, the depressed state worsened, and the woman felt the will to live slipping from her.

A New Jersey physician vacationing on Nantucket persuaded the ill woman to enter the hospital where he was affiliated with, where, in addition to her other symptoms, she was found to be suffering from pronounced anemia. Chance now intervened. A technician employed in the hospital laboratory, who had served in the Army Medical Corps in Vietnam, noticed forms in the patient's blood that were remarkably similar to the malaria parasites he had seen in Vietnam. The patient, however, had never traveled in the tropics and Nantucket is hardly an area of endemic malaria. The stained blood smear was then air-mailed to the Center for Disease Control in Atlanta, where parasitologists provisionally identified the parasite as a species of Babesia.

The annals of medical literature are studded with reports of infectious oddities: rare and often bizarre instances of alien pathogens infecting humans. Was this an example of one of these isolated cases or did the woman's infection herald a true zoonosis—a disease of animal parasite origins? The answer began to appear four years later when a second person from Nantucket was diagnosed as having babesiosis. In 1975 seven more cases were reported from the island and during the summer of 1976 another five vacationers were infected. At the time, a zoonotic outbreak of babesiosis seemed to have struck Nantucket; however, no new cases have appeared this year.

There are various species of Babesia, all containing a wisp of cytoplasm and a minute dot of nucleus. Within the red blood cell, they appear deceptively similar to Plasmodium falciparum, the malignant tertian malaria organism. Indeed, considerable parasitological connoisseurship is required to distinguish between the two kinds of parasites. This morphological similarity has led to a diagnosis of malaria in some patients suffering from babesiosis.

Within the red blood cell the Babesia parasite divides asexually once or twice. The cell then disrupts, releasing the parasites, which proceed to invade new host red blood cells. Not all the pathogenic mechanisms associated with babesiosis are fully understood, but anemia, due to continuing red blood cell destruction, is a hallmark of the untreated infection. Another symptom in humans is severe depression. Whether this is caused by a chemical reaction to the parasite is not known.

Unlike the malaria parasite, which is transmitted by mosquitoes, the obligatory vector of Babesia is the tick, that grotesque arthropod that dog owners soundly curse each time their animals return from wandering in the underbrush. The Babesia reproduce within the tick but this phase of their biology is not well known, mainly because their unsex appearance has made scientific spec- tatorship difficult. Researchers do know that the tiny wormlike off-spring first invade the tick's epithelial cells, undergo division, and finally invade the salivary glands. When the tick next feeds, the parasite is capable of infecting a warm-blooded host.

The gaps in our knowledge of Babesia biology illustrate the occasional slow pace of scientific progress. In 1893, T. Smith and F. L. Kilbourne, two Americans studying cattle babesiosis in Texas (where it is commonly called red water fever) determined that the parasite was transmitted by the tick. The discovery that a parasite of warm-blooded animals could, indeed must, jump the biological gulf to develop in the cold blood of invertebrates in order to effect transmission boggled the scientific community.

Those who have suffered tick bites or attempted to dislodge a tick's mouthparts tenaciously buried in their skin would agree with Aristotle's complaint that ticks are "disgusting parasitic animals." They belong to the Arachnida, a class of arthropods that includes the spiders and mites. To survive, grow, and reproduce, ticks must drink the blood of their hosts. Most species partake of this sanguine diet by a kind of movable feast. After hatching from the egg, the small six-legged larva attaches itself to, and feeds on, a host, then molts to an eight-legged, sexually immature nymph (a term coined by an entomologist with a particularly mor-
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animals. Three weeks later *Babesia* parasites appeared in blood of experimentally infected hamsters. A monkey also became infected. The species was identified as *Babesia microti*, a parasite commonly found in certain rodents throughout almost the entire temperate zone of the world. What had happened? Was the Nantucket *B. microti* a mutant dowed with an ability to infect broader host range than its parent strain? Or had a peculiar dosage of conditions brought the tick, parasite, and rodent together in such a way as to facilitate human infection?

An attempt was made to answer these questions by analyzing *B. microti* species. Scientists compared the character of the enzymes from different *B. microti* isolates. The chemical processes that make life possible are catalyzed by proteins called enzymes, with specific enzyme responsible for specific step in the cell's chemistry. Since the basic chemistry of all animals is remarkably similar, the same enzyme (isoenzyme) performs the same task (such as breaking down sugar for energy) in animals ranging from amoebas to zebras. But what they do the same thing, the enzymes of different species have different physical properties. These differences can be visualized by the pattern the enzymes make when migrating in an electric gel. The changes may be subtle but the investigative method is so sensitive it can detect the smallest leading to incipient speciation.

Researchers applied this powerful probe, gel electrophoresis, to compare the enzymes extracted from the infected human's blood, *Nantucket microti* and from strains isolated from wild rodents inhabiting Nantucket and England. No differences were found.

While the parasite species has now been definitely identified as *B. microti*, the question remained of its origins. Which species of rodents acted as reservoir hosts—and how prevalent was the infection among them? Using peanut butter as bait, the researchers trapped mice, voles, and rats. They discovered that only deer mice (*Peromyscus leucopus*) and voles (*Microtus pennsylvanicus*) were infected.

Now the *Babesia* species and reservoir hosts were known,
searchers still had not identified the transmitting tick. The trapped males and deer mice carried both nymphal and nymphal stages of two species. One was Dermacentor variabilis, whose adults feed only on dogs; the other was a species resembling Ixodes scapularis, whose adults prefer deer. The young of these species are not exclusive to rodents and will bite humans who brush by the vegetation on which they rest. While all evidence is not in, the species resembling I. scapularis appears to be the vector.

The development of I. scapularis coincides neatly with the tourist season. In early summer the nymphal ticks, already infected with their charge of Babesia, await their next hosts, primarily rodents, though humans will do. Most of the human babesiosis cases on Nantucket have occurred in late summer and early fall. The infections that occurred in the summer were presumably transmitted by the bites of nymphal Ixodes ticks. During the fall, the ticks feed on the blood of deer and then, as the weather turns colder, drop off to overwinter on the ground.

Finally, the investigators wanted to know the full extent of human babesiosis on Nantucket. Were the diagnosed cases only the tip of the iceberg or did those with clinical manifestations represent the limit of the infections? Analyses of the data disclosed that all those with symptoms severe enough to seek medical help were older people, ranging in age from 52 to 85 years. Most of them were also economically well off. Generally, the more luxurious homes on Nantucket are located some distance from the sand dunes and beaches, in an area that, ecologically, is cheek by jowl with the scrub, the natural habitat of the tick and deer.

Again, the laboratory served epidemiology. Infection, even when clinically inapparent, will elicit antibodies that may persist for some years. The detection of these antibodies can provide a highly useful titlate as to who has or has had the infection. A full-scale "bleed" of Nantucket’s permanent and summer population has not yet been carried out, but the results of the so-called "grab bag" sample suggest a high risk of infection. Approximately 2 percent of the people whose blood was tested showed antibody against B. microti, yet the great majority of these people could not recall having any of the malaria-like symptoms of the clinically afflicted. At the relatively non-pathogenic end of the infection, however, the symptoms may be so ephemeral as to go unnoticed.

While members of all age groups have apparently been infected, clinical babesiosis seems to be a senior citizen’s disease. This agrees with the topsy-turvy immunological pattern that animal babesiosis has shown. Young domestic animals are highly tolerant of Babesia infections, while older animals are particularly susceptible. Ranchers have exploited this age-specific resistance by purposely infecting young stock, which ultimately produces an immunity that protects them in later life. If older animals without antibody were moved into tick-infested range, they would rapidly sicken with babesiosis and the mortality would be high.

We can only speculate upon the historical dynamics that led to the present situation on Nantucket. Retrospective epidemiology is a difficult and sometimes dangerous exercise. And the problem of reconstructing the epidemiological events associated with Nantucket babesiosis is even more thorny because there is no precedent or parallel experience to guide the deductive process.

The visitor to Nantucket gains an impression of unspoiled, unchanged permanence reaching to a distant past. The carefully nurtured and protected island is indeed a delight, but major changes in its landscape have occurred even within living memory.

Prior to colonial settlement, Nantucket was probably forested. Indians hunted deer here with the aid of selective burning, which seemed to cause little permanent ecological disturbance. During the mid-seventeenth century, British commercial enterprise began with the collecting of sassafras, which at the time was selling very nicely on the London market as an aphrodisiac. These early porn brokers were succeeded by a more somber lot of farmers who made the island into a sort of ovine condominium, the land being held in common through a system of shares allotted to individual sheep farmers. The sheep population burgeoned and, according to historical reports, reached an estimated 10,000 to 17,000 by 1875. Sheep are highly efficient grazers and this large population not only deforested the island but also reduced it to close-cropped pastureage. Photographs taken in the early 1900s show an island of grass unrelieved by a single tree.

Sometime during the nineteenth century the combination of dwindling forest cover and increased hunting exterminated the deer and probably the tick I. scapularis. The absence of higher vegetation produces a desiccating environment iminical to survival for many tick species. For many years, the Russians have recommended intensive pasturage by domestic stock as a means of controlling ticks and tick-borne diseases.

In the mid-1850s Nantucket’s ecology again began to change as the island’s economy slumped with the decline of both its whaling and sheep industries. The common land system had already come under attack by wealthy proprietors who in 1812 petitioned the Supreme Court to cede them large acreages. Later, cranberry farmers—and then the wealthy in search of summer retreats—progressively reduced the amount of land grazed by sheep. With their disappearance, the island underwent a botanical transformation. Wes Tiffney, head of the University of Massachusetts field station on Nantucket, believes that the proliferation of indigenous bayberry facilitated the changes that took place in the former sheep pastures. He and his colleagues have shown that, like legumes, bayberry fixes nitrogen and thus enriches the soil. As a result, since 1890 most of inland Nantucket has grown up in heath and scrubland, ideal habitat for ticks. In 1830, settlers introduced pine trees to serve as windbreaks and their spread into discrete forest stands provided the sanctuary necessary for the deer’s comeback.

The first deer to return came by sea. In 1922, a Nantucket fisherman rescued an exhausted buck as it swam from the mainland. Four years later, two does were imported from Michigan, and additional deer were brought in during the 1930s. This meager nucleus has now pro-
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At some point when deer were being imported, the I. scapularis-like tick covertly came with them. It, too, flourished and has now become the dominant tick species on the island. The reason for its proliferation is somewhat of a mystery. During entomological surveys of Nantucket in 1937, 1941, and 1944 no I. scapularis were found. However, I. muris, a tick species exclusive to rodents, was abundant on these animals. This species probably cycled B. microti from rodent to rodent. By 1976 a striking change in the nature of the tick population had taken place. I. muris had virtually disappeared and the I. scapularis-like tick predominated.

At this point, conjecture must embellish the facts. What brought about the change in tick population? Was this change crucial for the transmission of B. microti to humans? The displacement of a native species by an introduced species has occurred many times in many ecosystems. Perhaps this occurred when the I. scapularis-like tick came to Nantucket. After all, there are just so many field mice to go around and I. scapularis may have consistently come to dinner before I. muris. Then, too, the deer host of adult I. scapularis is so much larger than the rodent host of the I. muris adult that it would be reasonable to assume that deer could support a much larger number of ticks. More adult I. scapularis ticks would produce more eggs and, in turn, more larvae, which could outcompete I. muris for hosts.

If we make the broad assumption that human babesiosis did not occur in Nantucket prior to the establishment of a sizable I. scapularis population, then why did only this species and not I. muris transmit the infection to man? Perhaps I. scapularis is more catholic and aggressive in its taste. The sheer density of I. scapularis may have also been an important factor. Another possibility is that this species occupied an ecological niche that brought it into closer contact with humans than did I. muris. Or perhaps I. scapularis is a more efficient biological host of B. microti than is I. muris. Or it may be a combination of some or all of these factors. Perhaps the true story will never be completely known, though the testing of these hypotheses in order to predict, prevent, or control babesiosis outbreaks on Nantucket and elsewhere would be important.

Nantucket should not be pictured as an island embattled to babesiosis. The number of clinical cases have, so far, been non-existent and non-fatal. Nevertheless, the risk is there and those who lack spleen or are otherwise immunologically unresponsive should exercise caution if they visit the island. There is no drug to provide an ease. The antimalaria are ineffective, and the treatment given cattle is too toxic for man except in situations of dire emergency. Nor there a simple solution that would interrupt the chain of transmission other than reducing or eliminating the deer population. We do not even know the limits of the infection. Isolated cases have occurred outside Nantucket, on Martha Vineyard, Shelter Island, and Matouk, Long Island, but all the evidence now suggests that the conditions inherent on a tight little island are responsible for the continuance of the disease in humans.

Human babesiosis on Nantucket represents yet another assault on our sense of complacency. The truly great accomplishment of medical science during the last century has been the discovery of effective methods to combat the infectious diseases caused by bacteria, viruses, and parasites. While vaccines, antibiotics, and the flush toilet have admirably protected us from many pathogens, the last war has not yet been fought. Old diseases such as influenza and malaria are flourishing and new ones such as Lassa fever, legionnaire's disease, and human babesiosis are always a threat. If we accept the necessity of a strong military posture in times of peace, it seems just as reasonable to train and maintain an army of medical experts against these new pathogen invaders.

Robert S. Desowitz teaches tropical medicine at the University of Hawaii and Louis R. Miller directs research at the Laboratory of Parasitic Diseases, National Institutes of Health.
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Caring Groups and Selfish Genes

Recent attacks have failed to downgrade the role of individuals in evolution

The world of objects can be arranged as a hierarchy, box within box. Molecules are made of atoms, crystals are made of molecules, and so on, to minerals, to rocks, the earth, the solar system, the galaxy made of stars, and the universe of galaxies. Different forces work at different levels. Rocks fall by gravity. At the atomic and molecular level, gravity is so weak that standard calculations ignore it.

Life, too, has many levels, and each has its role in the evolutionary process. Consider three major levels: genes, organisms, and species. Genes are blueprints for organisms; organisms are the building blocks of species. Evolution requires variation, for natural selection cannot operate without alternatives to choose among. Mutation is the ultimate source of variation, and genes are the unit of variation. Individual organisms are the units of selection. But individuals do not evolve—they can only grow, reproduce, and die. Evolutionary change occurs in groups of interacting organisms; species are the unit of evolution. In short, as philosopher David Hull writes, genes mutate, individuals are selected, and species evolve. Or so the orthodox, Darwinian view proclaims.

The identification of individuals as the unit of selection is a central theme in Darwin's thought. This idea underlies his most radical claim: that evolution is purposeless and without inherent direction. As I argued in my column for April 1977, Darwin's theory transfers to biology the individualism of Adam Smith's laissez faire economics. Smith had argued that a well-regulated economy, apparently harmonious and stable, would arise as a natural result of untrammeled self-interest, actively pursued by all. Many would lose and fall by the wayside, while winners would check and balance each other. Darwin contended that the exquisite balance of nature had no "higher" cause. Evolution does not recognize the "good of the ecosystem" or even the "good of the species." Any harmony or stability is only an indirect result of individuals relentlessly pursuing their own self-interest—in modern parlance, getting more of their genes into future generations by greater reproductive success. Individuals are the unit of selection; the "struggle for existence" is a matter among individuals.

In the last fifteen years, however, challenges to Darwin's focus on individuals have sparked some lively debates among evolutionists. These challenges have come from above and below. From above, Scottish biologist V.C. Wynne-Edwards raised orthodox hackles fifteen years ago by arguing that groups, not individuals, are units of selection, at least for the evolution of social behavior. From below, English biologist Richard Dawkins has recently raised my hackles with his claim that genes themselves are units of selection, and individuals merely their temporary receptacles.

Wynne-Edwards presented his defense of "group selection" in a long book entitled Animal Dispersion in Relation to Social Behavior (New York: Hafner, 1962). He began with a dilemma: Why, if individuals only struggle to maximize their reproductive success, do many species seem to maintain their populations at a fairly constant level, well matched to their resources available? The traditional Darwinian answer invoked external constraints of food, climate, predation: only so many can be fit. Sometimes the rest starve or freeze to death, and numbers stabilize. Wynne-Edwards, on the other hand, argued that animals regulate their own populations by gauging the restrictions of their environment and regulating their own reproduction accordingly. He recognized right away that such a theory contravened Darwin's insistence on "individual selection" for species, and that many individuals live or forgo their own reproduction for the good of their group.

Wynne-Edwards postulated that a species is divided into many more-or-less discrete groups. Or groups never evolved a way to regulate their reproduction. With these groups, individual selection reigned supreme. In good years populations rose and the group flourished; in bad years, the group could not regulate itself and faced severe crash and even extinction. Other groups developed systems of regulation in which many individuals sacrificed their reproduction for the group's benefit (impossibility if selection can only encourage individuals to seek their own advantage). These groups survived the good and the bad. Evolution is a struggle among groups,
When they remember the gift
they remember the giver.
individuals. And groups survive if they regulate their populations by the altruistic acts of individuals. "It is necessary," Wynne-Edwards wrote, "to postulate that social organizations are capable of progressive evolution and perfection as entities in their own right."

Wynne-Edwards reinterpreted most animal behavior in this light. The environment, if you will, prints only so many tickets for reproduction. Animals then compete for tickets through elaborate systems of conventionalized rivalry. In territorial species, each parcel of land has a ticket and animals (usually males) posture for the parcels. Losers accept gracefully and retreat to peripheral celibacy for the good of all. (Wynne-Edwards, of course, does not impute conscious intent to winners and losers. He imagines that some unconscious hormonal mechanism underlies the good grace of losers.)

In species with dominance hierarchies, tickets are allotted to the appropriate number of places, and animals compete for rank. Competition is by bluff and posture, for animals must not destroy each other by fighting like gladiators. They are, after all, only competing for tickets to benefit the group. The contest is more of a lottery than a test of skills; an allotment of the right number of tickets is far more important than who wins. "The conventionalization of rivalry and the foundation of society are one and the same thing," Wynne-Edwards proclaimed.

But how do animals know the number of tickets? Clearly, they cannot, unless they can census their own populations. In his most striking hypothesis, Wynne-Edwards suggested that flocking, swarming, communal singing, and chorusing evolved through group selection as an effective device for censusing. He included "the singing of birds, the trilling of katydids, crickets and frogs, the underwater sounds of fish, and the flashing of fireflies."

Darwinians came down hard on Wynne-Edwards in the decade following his book. They pursued two strategies. First, they accepted most of Wynne-Edwards's observations, but reinterpreted them as examples of individual selection. They argued, for example, that who wins is what dominance hierarchies and territoriality are all about. If the sex ratio between males and females is near 50:50 and if successful males monopolize several females, then not all males can breed. Everyone competes for the Darwinian prize of passing more genes along. The losers don't walk away with grace, content that their sacrifices increase the common good. They have simply been beaten; with luck, they will win on their next try. The result may be a well-regulated population, but the mechanism is individual struggle. Adam Smith's invisible hand operates again—order and harmony from the pursuit of personal gain alone.

Virtually all Wynne-Edwards's examples of apparent altruism can be rephrased just as well as tales of individual selfishness. In many flocks of birds, for example, the first individual that spots a predator utters a warning cry. The flock scatters but, according to group selectionists, the crier has saved his flockmates by calling attention to himself—self-destruction (or at least danger) for the good of the flock. Groups with altruist criers prevailed in evolution over all-selfish, silent groups, despite the danger to individual altruists. But the debates have brought forth at least a dozen alternatives that interpret crying as beneficial for the crier. The cry may put the flock in random motion, thus befuddling the predator and making it less likely that he will catch anyone, including the crier. Or the crier may wish to retreat to safety but dares not break rank to do it alone, lest the predator detect an individual out of step. So he cries to bring the flock along with him. As the crier, he may be disadvantaged relative to flockmates (or he may not, as the first to safety), but he may still be better off than if he had kept silent and allowed the predator to take someone (perhaps himself) at random.

The second strategy against Wynne-Edwards reinterprets apparent acts of disinterested altruism as selfish devices to propagate genes through surviving kin—the theory of kin selection (discussed twice in this column, May and November 1976). Siblings, on average, share half their genes. If you die to save three sibs, you pass on 150 percent of yourself through their reproduction. Again, you have acted for your own evolutionary benefit, if not for your corporate continuity. Kin selection is a form of Darwinian individual selection. These alternatives do not prove group selection, for they merely retell its stories in the more conventional Darwinian mode: individual selection. The dust yet to settle on this contentious issue but a consensus (perhaps correct) seems to be emerging. Most evolutionists would now admit that group selection occurs in certain special situations (species made of many very concrete, socially cohesive groups direct competition with each other). But they regard such situations as uncommon if only because discrete groups are often small and leading to a preference for kin selection as an explanation of altruism within the group.

Yet, just as individual selection emerged relatively unscathed at its battle from above with group selection, some other evolutions launched an attack from below. Genes, they argue, not individuals are the units of selection. To begin with, recasting Butler's famous metaphor that a hen is merely an egg's way of making another egg is a bit of an anachronism. An animal, they argue, is only DNA's way of making more DNA. Richard Dawkins has put the most forcefully in his recent book, The Selfish Gene (New York: Oxford University Press, 1976). "We are all our own bodies," he writes, "is the genetic way of preserving the genes altered."

For Dawkins, evolution is a battle among genes, each seeking to make more copies of itself. Bodies are merely the places where genes aggregate for a time. Bodies are temporary receptacles, survival machines manipulated by genes and tossed away on the geologic scrapheap once genes have replicated and slaked their insatiable thirst for more copies of themselves in bodies of the next generation. He writes: "We are survival machines—robot vehicles blindly programmed to preserve the selfish molecule known as genes. . . . "They swarm in huge colonies safe inside gigantic lumbering robots . . . they are in you and they created us, body and mind and their preservation is the ultimate rationale for our existence. Dawkins explicitly abandons
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Darwinian concept of individuals as units of selection: “I shall argue that the fundamental unit of selection, and therefore of self-interest, is not the species, nor the group, nor even, strictly, the individual. It is the gene, the unit of heredity.” Thus, we should not talk about kin selection and apparent altruism. Bodies are not the appropriate units. Genes merely try to recognize copies of themselves wherever they occur. They act only to preserve copies and make more of them. They couldn’t care less which body happens to be their temporary home.

I begin my criticism by stating that I am not bothered by what strikes most people as the most outrageous component of these statements—the imputation of conscious action to genes. Dawkins knows as well as you and I do that genes do not plan and scheme; they do not act as witting agents of their own preservation. He is only perpetuating, albeit more colorfully than most, a metaphorical shorthand used (perhaps unwisely) by all popular writers on evolution, including myself (although sparingly, I hope). When he says that genes strive to make more copies of themselves, he means that “selection has operated to favor genes that, by chance, varied in such a way that more copies survived in subsequent generations.” The second is quite a mouthful; the first is direct and acceptable as metaphor although literally inaccurate.

Still, I find a fatal flaw in Dawkins’s attack from below. No matter how much power Dawkins wishes to assign to genes, there is one thing that he cannot give them—direct visibility to natural selection. Selection simply cannot see genes and pick among them directly. It must use bodies as an intermediary. A gene is a bit of DNA hidden within a cell. Selection views bodies. It favors some bodies because they are stronger, better insulated, earlier in their sexual maturation, fitter in combat, or more beautiful to behold.

If, in favoring a stronger body selection acted directly upon a gene for strength, then Dawkins might be vindicated. If bodies were unambiguous maps of their genes, then battling bits of DNA would display their colors externally and selection might act upon them directly. But bodies are no such thing.

There is no gene “for” such unambiguous bits of morphology as your left kneecap or your fingernail. Bodies cannot be atomized into parts, each constructed by an individual gene. Hundreds of genes contribute to the building of most body parts and their action is channeled through a kaleidoscopic series of environmental influences: embryonic and postnatal, internal and external. So parts are not translated genes, and selection doesn’t even work directly on parts. It accepts or rejects entire organisms because suites of parts, interacting in complex ways, confer advantages. The image of individual genes, plotting the course of their own survival, bears little relationship to developmental genetics as we understand it. Dawkins will need another metaphor: genes causing, forming alliances, showing deference for a chance to join a pact, gauging probable environments. But when you amalgamate so many genes and tie them together in hierarchical chains of action mediated by environments, we call the resultant object a body.

Moreover, Dawkins’s vision requires that genes have an influence upon bodies. Selection cannot see them unless they translate to bits of morphology, physiology, or behavior that make a difference to the success of an organism. Not only do we need a one-to-one mapping between gene and body (criticized in the last paragraph), we also need a one-to-one adaptive mapping. Ironically, Dawkins’s theory comes just at a time when more and more evolutionists are rejecting the panselectionist claim that all bits of the body are fashioned in the crucible of natural selection. It may be that many, if not most, genes work equally well (or at least well enough) in all their variants and that selection does not choose among them (see my column of December 1975 on the theory of neutrality). If most genes do not present themselves for review, then they cannot be the unit of selection.

I think, in short, that the fascination generated by Dawkins’s theory arises from some bad habits of Western scientific thought—from attitudes (pardon the jargon) that we call atomism, reductionism, and determinism. The idea that wholes should be understood by decomposition into “basic” units; that properties of microscopic units can generate and explain the behavior of macroscopic results; that events and objects have definite, predictable, determined causes. These ideas have been successful in our study of simple objects, many of few components, and uninflected by prior history. I’m pretty sure that my stove will light when I turn it on (it did). The gas law builds up from molecules to predictable properties of larger volumes. But organisms are much more than amalgamations of genes. They have a history that matters, their parts interact in complex ways. Organisms are built by gene acting in concert, influenced environments, translated into parts that selection sees and parts visible to selection. Atoms determine the properties of water, but poor analogues for genes as bodies. I may not be the master of my fate, but my intuition of who ness probably reflects a biological truth.


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The Problem With Simple Folk
by Peter J. Wilson

Some peoples, like the Tsimihety of Madagascar, prove difficult to describe because they don’t take structure as seriously as anthropologists do.

In the Indian Ocean, 250 miles off the southeast coast of Africa, lies Madagascar, called the Great Red Island because it is a thousand miles long and composed of red laterite soil. It contrasts steamy, tropical rain forest on its east coast with cool, temperate highlands in its center and arid deserts in the south and west. Its five million people came across the Indian Ocean from the islands of Indonesia. But they have African blood, particularly those who live on the west coast where Arab traders landed with African slaves.

Runaway slaves from East Africa settled in Madagascar, and the political structure of many Malagasy is clearly African. People look more European on Madagascar’s northeast coast, where in the seventeenth and eighteenth centuries Malagasy mated with European pirates. The Malagasy language bears out the people’s Indonesian origins, for it is distinctly Malayo-Polynesian and seems most closely related to Maanjan, a language of Borneo.

Some years ago I spent a year among the Tsimihety people of Madagascar, who live in the north-central interior’s hilly savanna, which is separated from the highland plateau by a belt of forest. The Tsimihety live in villages of 20 to 500 inhabitants; their huts are made of mud and cattle dung. Herding cattle and growing rice are the principal Tsimihety occupations and my objective was to find out how these occupations might determine other aspects of Tsimihety life. My research should have resulted in the customary scholarly articles, climaxed by a monograph that would have entered the Tsimihety into the ethnographic annals. So far, I have written a few articles, but the awaited monograph is still stuck somewhere between my field notes and my intentions. Since my stay with the Tsimihety, several English-speaking anthropologists—for whom Madagascar is virtually terra incognita—have studied Malagasy tribes, and one, Maurice Bloch, has actually published a monograph. Whether the others suffer from my own block I cannot say, but they have not been prolific. Fortunately, French anthropologists have published a large number of studies, many of them excellent. Is it perhaps a coincidence that Bloch is a native-born Frenchman, even though he grew up and was educated in England? Do English anthropologists, who can cope very well with the anthropology of the British Empire, or Americans, who can handle the Spanish Empire, find the combination of the erratic French and the indigenous tribes who have come under their aegis in Madagascar just too much for Anglo-Saxon susceptibilities?

I think there may be something in this, but as for me, I think my difficulty originates with the Tsimihety themselves. In any case, after seventy years of French colonial rule, they remain impervious to French culture. As I have tried, time and time again, to report on the Tsimihety to the anthropological fraternity, I have begun to wonder whether my specific problem is not far more general than is at present realized or admitted. Perhaps many more of the world’s tribes than we suspect do not lend themselves to being described systematically by anthropologists.

Since Sir James Frazer, in The Golden Bough, more or less defined anthropology for the layman, civilization’s interest in non-European cultures has been guided by curiosity about the strange and exotic aspects of our own beginnings. Contemporary anthropologists, like their nineteenth-century colleagues, see the exotic as challenging them to make some sense of it by ferreting out the logic and rationality that presumably lies behind alien behavior. And so the library is stocked with descriptive and analytical tribes who, in the way, are shown to be as intellectual as the anthropologists who study them—tribes whose lives evolve around dominant themes, rationalized, highly structured institutions; metaphysical morphs; and central ideas.

But what of those tribes, such as the Tsimihety of Madagascar, who do not appear to be of a more physical bent; who show little concern about conforming to a unified, coherent philosophy or social system; who live opportunistic, unspectacularly, with as little fear and bother as possible; who appeal to an outsider to be pragmatic, utilitarian, mundane, and within the constraints or esthetics of a systemic, ordering structure?

The Tsimihety cannot be interpreted in the light of environmental determinism for they are a people who choose where and how they will live, selecting their own environmental conditions. Tsimihety move in search of new cattle pastures, but they lack the competitive pride in cattle ownership that would transform it into an economic institution. Similarly, Malagasy Tsimihety villages grow rice, production and exchange vary considerably from village to village.

These are hardly the sort of tribes who can provide the anthropologist with a new model to be slotted into the anthropological repertoire or help him dazzle his colleagues with a virtuoso analysis of a new logic. The people of such tribes don’t do things, don’t think, new thoughts, don’t create symbols; they can, in a sense,
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Cultivating—which is simply the turning or loosening of the soil by mechanical means in order to control weeds and aerate the soil—might seem to some to be the most prosaic of all vineyard operations.

Yet, the Tsimihety do not live in aos or anarchy and their lives and tribe are not disintegrating. The first census of the Tsimihety, taken about 1900, placed the population at 60,000, a figure that cannot be taken too seriously, given the tribe’s lack of sympathy for an enterprise. But the most recent census numbers the Tsimihety at more than 400,000, firmly establishing that they have multiplied enormously.

Once I had explained my purpose in being among them, the Tsimihety were more than friendly and went out of their way to keep us informed. In fact, most Tsimihety were natural ethnographers, asserting that they lived the best of possible lives in the best of all possible ways. They never tired of pointing out how different—and inferior—were the customs of neighboring peoples. Actually, the differences were only minor. Madagascar’s twenty tribes share many cultural elements, based on a common language and a common ancestor and funerary cult, which is in Christianity, the recognized religion of the Malagasy Republic.

Themes of Tsimihety culture are present throughout Madagascar, where other tribes orchestrate the same themes in different styles, Tsimihety simplify them down to the bare essentials.

Soon after my arrival in the trict town of Mandritsara, the mahety heartland, the “mayor” led together as many elders as he could contact, and for three days we sat in his office and ticked out a list of Tsimihety cultivations—than normal simply because we prefer not to use herbicides when we can avoid them.

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clans—their genealogies, histories, and domains. The townspeople not only thought that this was an obvious thing to do, but expressed astonishment at their not having done it before. As for kinship and descent, the social anthropologist’s bread and butter, there was no reticence about explaining how they worked and what their role was. But no orderly kinship system provided the Tsimihety mind with a blueprint for actions and social relations. Tsimihety kinship terminology is a fairly common variant of the Iroquois system. Descent through males is commonly practiced, but in no case as an orthodox principle. Sometimes it is not recognized at all. One of my most memorable evenings was spent in a hut trying to convince the resident family and its neighbors that matrilineal descent existed and that many African tribes lived by its rules. My listeners were fascinated but incredulous, pointing out immediately the inherent problems of this system, and firmly avowing that people who followed it must be simple or stupid or both. Yet the Tsimihety are by no means averse to recounting genealogies in which descent is regularly traced through the mother’s brother or where residence after marriage might be in the bride’s village. For them this is no contradiction. Expediency and freedom from structural purity come first.

Therein lay the catch for me: there did not seem to be a Tsimihety way of going about things, at least not a way so well defined that it could constitute a sort of ethnographic trademark. What these people did and thought was simple and straightforward, devoid of flourish and subtlety, and suited to personal situations. Some villagers irrigated their rice fields while others relied upon rain. Some organized cooperatives that exchanged labor; others worked on their own. Some men performed a certain ritual using a prayer; others omitted the prayer or used a different one. I see the Tsimihety as a people wholeheartedly dedicated to the possibilities of freedom, probably more so than any other people I have read about. While sharing with all Malagasy a common culture, they have, within its limits, refused to be imprisoned by the demands of system and symbol.

For all Malagasy, ancestors are the most important aspect of life. Every person looks forward to becoming an ancestor, a status insured by the birth of children and then grandchildren. The ancestors keep a constant watch on all that goes on and are quick to react when they are not given their due—sacrificial offerings, observance of taboos, and the building and upkeep of tombs.

In return, the Tsimihety expect protection against illness, misfortune, bad crops, and supernatural forces. Sacrifices to ancestors are not particularly inconvenient; they usually consist of small offerings of honey placed in a raffia tube hung in the house, a libation of rice water, coffee, or fermented cane juice poured on the floor, or a mention in a prayer prefatory to an undertaking. But the Tsimihety make these offerings only if and when they think of doing so—and then in a thoroughly offhand manner. Only when something goes drastically wrong—when crops fail, when cattle are missing, or when people fall ill—do the Tsimihety seem to take spirits and ancestors seriously. Then individuals will consult a medicine man-diviner (ombiasa) to pinpoint the cause of the trouble, meanwhile urging the ombiasa to prescribe the cheapest possible sacrifice. If only an ox will do, they will make sure that the oldest, feeblest beast in the herd is sacrificed.

Observance of taboos, usually by promising to avoid acts or objects favored by particular ancestors, is equally lackadaisical. In return, the Tsimihety request similar abstinence from the ancestors. In very few cases can these taboos be considered onerous. Common taboos are small birds or insects that no one would eat anyway or oxen without horns. Taboo days, when work is forbidden, are more significant because of the frustration they used to cause the French colonial administration and now cause the present government. Although these taboos play a large and important part in the regulation of Tsimihety life, a broken taboo, even the rare instance of incestuous marriage, is no great calamity. Taboos are certainly not allowed to interfere with practical matters. One village had inherited taboos on eating or using sugar cane and on traveling at a certain time. Since these were inconvenient, the villagers arranged that the oldest woman among them would observe the taboos on everyone’s behalf.

Tsimihety tombs are perhaps the best illustration of the people’s matter-of-fact approach to life. While other tribes of the island build elaborate tombs, highly decorated and very visible, the Tsimihety place their dead in natural caves hidden high in the hills. In fact, they indulge in no artistic pursuits whatsoever. The raffia cloths they weave has no design and leaves its natural color; their tools are plain and finished only enough to make them usable. Their music rarely performed, is crude and elementary compared to the skillful instrumentation and singing of other tribes. A Merina valihana zitherlike instrument easily found in the marketplace, is highly decorated, but a Tsimihety valihana, a rare object, is a plain raffia tube with wooden strings. (The Merina are the largest ethnic group on Madagascar.) The Tsimihety drum, once made of wood and cowhide, is now usually an earthen bowl covered with cloth. Tsimihety cuisine consists of boiled rice accompanied by a boiled vegetable or, if a special visitor arrives, boiled chicken. Meat is eaten only when an ox must be sacrificed. The standard drink is rice water made by allowing rice to form a burned crust around a pot’s edge; the crust imparts a flavor to the water.

One possible explanation for unabandoned nature is that it is decline. Has exposure to European culture brought such a change that I observed only remnants of a more sumptuous authentic past? Yes, there are instances, such as that of the drum where modern items have replaced some indigenous ones. Generally speaking, the Tsimihety are dyed-in-the-wool cultural conservatives. In the mid-1820s, when the Merina king conquered most of Madagascar and vaded Tsimihety, the people’s action was to retreat to caves in the hills, offering no resistance, leaving villages either abandoned or one or two elderly people living in the fort. In order to main...
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his rule, Radama brought Merina to settle in Tsimihety territory. The Tsimihety countered by placing total taboo on all interaction with the Merina. (Because the Merina were Christians, this taboo included Christianity. European missionaries have since had a most unrewarding time trying to convert the Tsimihety.) When the French took over Madagascar in the 1890s, the Tsimihety again resisted passively. In reports to the governor, French-appointed district officers uniformly complained of the impossibility of getting cooperation from, or taxes out of the Tsimihety. Neither threats nor persuasion ever worked. The French distributed plows to each village, hoping that Tsimihety rice farming would become more efficient and productive. Today the French plows stand half-buried in front of village houses, and the Tsimihety as they have always done, prepare rice fields by allowing cattle to trample them.

The colonial government considered education a necessary instrument of development, and in most of Madagascar, particularly in the highlands, literacy is highly valued and almost universal. The Tsimihety, however, have generally refused to allow schools to be built in their villages. If the government offered a grant, the village would accept the money with profound gratitude and promises—but usually would somehow never find the labor to build a school. If the Catholic Church, the London Missionary Society, or another private organization built a school, the Tsimihety rarely sent their children to it. Such schools were attended by Europeans or by children of the migrant tribes.

Yet I cannot get away entirely with this generalization, for some Tsimihety are individualists. Some villages and some individuals have gone out of their way to acquire modern education and to gain entry into a new world. From a tribe that has deliberately chosen to preserve its preliteracy and its own ways, came one of the principal movers for Madagascar’s independence, the first French colonel to achieve this status after World War II. Philibert Tsiranana, Tsimihety village schoolmaster, became the first president of Malagasy Republic and his...
was dominated by Tsimihety. That the first president of the Republic should have been a Tsimihety was another irony. Although other Malagasy tribes have various forms of political and social hierarchies, the fiercely egalitarian Tsimihety recognize no office to which they assign responsibility or obedience. Every village is a unitary confederacy of households; each has an equal say in village affairs, exercised through the village assembly of 
\textit{fokon'olona} (village assembly), which is presided over by the village elders. No two villages are in political alliance, although some have a cultivation and living space in a pasture. Apart from the right to be buried in family plots, no person or household is allegiance to, or has any claim on, the village. All are free to go or come at any time. Equally, individuals who disturb the village are asked to leave. Especially in the dry season, numerous families, their belongings piled on ox carts, off for other villages or to assist in their activities. They give little reason for moving, and most common is a desire for a change of scenery, but some families have new cattle pastures or better fields or new neighbors. Such movement is hardly conducive to hierarchy.

Of course, the French and the Malagasy government after them tried to govern the Tsimihety. Districts are supervised by a district officer; within the district are quarters, with appointed and paid officials, and villages, each headed by a chef de village. The Tsimihety have little choice but to accept these formalities. At the same time they have found ways to avoid the French structure for all practical purposes and thereby preserve their autonomy. An instruction from the district officer goes down thearchy to the chef de village, who conveys the order to the people. Once, the chef de village where I lived called together the people and asked, "Who are you?" ... that you fill with Kahlua. Sip the drink, nibble the cup and start all over again. Because you deserve something nice. Cups, complete with foil servers, twelve to the box, 3 boxes for $7.00; minimum order, 3 boxes. Shipped postpaid. Sorry, no COD.

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stood up and, imitating President Tsirihany, directed the chief to report back that since the administration had done little for the villagers in the past year, they saw no reason to pay for services no rendered.

Generally, the Tsirihany refuses to acknowledge hierarchy and authority vested in individuals. Yet I visited two villages ruled by chiefs whose office was hereditary, and sanctified by ritual. However, the anthropologist tries to build a model describing the Tsirihany, he finds the joinings insecure. Whenever he generalizes about common cultural norms, he has to insert a caveat.

Perhaps the constraint of having to provide a coherent and systematic account of some aspect of an alien form of life has imposed upon anthropologists the structure that they attribute to other people. Perhaps the esthetic necessity of basing a monograph upon a central theme or problem has led anthropologists to overlay one another of the possible models the think they can discern for another culture or even to give us a model for its own sake, irrespective of what they have, in fact, observed and recorded. Undeniably, man of the world's peoples have indeed developed intricate, beautiful, and intellectual philosophies and cosmologies by means of which the live out their lives in structure symmetry.

My own feeling, however, is that the Tsirihany, like many other peoples, have—for one reason or another—developed an unsperracular, elastic, pragmatic, utilitarian solution to social life. They choose to retain their freedom, giving up the possibility of producing a thoroughgoing metaphysic by which they might organize their lives systematically. For them the world—often incommensurable and always piecemeal—exists as a fact and not as a closed bounded system to be known through central metaphors. Piecemeal world is a free world and that contention is surely the Tsirihany philosophy.

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Besides the Grand Prize, the 1978 competition offers cash prizes totaling more than $3,000. The winning entries will be published in a special double issue of Natural History in August and will be exhibited at the American Museum of Natural History.

The four categories for entries are broad enough to fit the interests of any photographer. They are: (1) The Natural World; (2) A Sequence of an Event in Nature; (3) Photomicroscopy, including pictures with a scanning electron microscope; and (4) The Human Environment. First Prize in each category is $500. In addition, all entries are eligible for the following awards: Humor in Nature, $200; Urban Wildlife, $200; and ten Honorable Mentions at $100 each.

The deadline is April 15, 1978. Please put your name and address on every entry and include a stamped, self-addressed envelope—since we do want to return your pictures to you.

To all, the best of luck!

THE RULES

1. The competition is open to everyone except employees of the American Museum of Natural History and their kin.

2. Competitors may submit up to three previously unpublished entries in each of the four categories. Decision of the judges is final.

3. The Museum acquires the right to publish and exhibit the winning photographs and to use them for promotional purposes. The Museum assumes no responsibility for other entries.

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No one is certain how many species of eucalyptus trees exist, but there are between 400 and 500, making the *Eucalyptus* genus one of the largest in the plant kingdom. Some species are probably best known for the sweet-smelling oil their leaves produce, while the leaves of other species provide the sole forage for koalas, both the tree and the animal being indigenous to Australia. Eucalyptus species are also indigenous to Tasmania and New Zealand.

For more than one hundred years, thirty to forty species of eucalyptus have been grown on different continents, introduced when it was discovered that the wood of the fast-growing and versatile trees could be put to any number of uses. Wherever one travels in the world’s warmer and more arid regions, eucalyptus trees now thrive—their great height and drooping, leathery leaves often contrasting sharply with their stark surroundings. The trees are common in southern Asia, Africa, the Middle East, and in the western United States. On a global scale, more than twenty million acres of the trees are growing.

In the late nineteenth century, eucalyptus seedlings were introduced into what is now Israel (where the accompanying photos were taken), in order to aid the draining of malaria-infested coastal swamps. Today, twenty species of eucalyptus, growing on some 25,000 acres of land, serve numerous purposes: as sand dune stabilizers and windbreaks along roads, in soil conservation projects, and as a source of lumber and fuel.

Most eucalyptus plantations were begun because of the need for firewood. Now, some species are used for hardwood lumber, while the wood of others is used for transmission poles, pilings, railroad ties, pulp, plywood; as charcoal; and in the manufacture of fiberboard and chipboard. The tannin of some species is extracted for leather processing and the abundant supplies of oil in the leaves are used in medicines, perfumes, and solvents.

Eucalyptus trees make up three-quarters of the entire tree population of Australia. Prior to commercialization on a massive scale, Australian aborigines used eucalyptus bark for canoes, roofing, ropes, shoes, stools, and sacks.

In most places throughout the world, the varieties of eucalyptus still retain the common names they were given in Australia long ago. Many of these refer to the unique and sometimes flamboyant characteristics of the bark, the trees’ most identifiable trait. Stringybarks, for example, have thick, long-fibered bark that peels off in strips. Ironbarks produce rough and deeply furrowed hard bark whose extremely short fibers break up into small polyhedrons with a texture like that of hard cork. Other species are called "boxes" because of their thin, scaly, square-shaped bark pattern.

Whether the bark is hard, scaly, long- or short-fibered, it takes on marvelous patterns and hues that rival the imagination of the most skillful modern artist. The art form unfolds when the trunk’s diameter grows to such an extent that the bark tissues stretch and subsequently crack to form various patterns.

The composition of bark is more complex than meets the eye. Tree contain two thin, but distinct layers of tissue—the vascular (wood) cambium and the cork cambium—which encircle the trunk beneath the bark. The vascular cambium produces the inner portion of the bark, or phellem. The prominent outer bark is derived from the cork cambium, or phellogen, which forms as the tree grows in diameter. The phellogen produces to its outside a corky tissue known as phellem, or ordinary cork, and to its inside a minor layer of tissue known as phelloderm. These two types of tissue—cork cambium and ordinary cork—are collectively known as periderm. Exterior to the periderm in young trees is another layer of cells that make up a tree epidermis. As a tree expands in girth, the cells of the epidermis divide, stretch to their limit, and burst, and the epidermis sloughs off. The periderm layer of tissue then multiplies, replacing the epidermis and forming the protective coating of bark. At the point, the various bark characteristics of each tree species develop.

The intricate color patterns of eucalyptus bark result from the abundant amount of anthocyanin and, to a minor degree, tannin which the trees produce. Anthocyanin, formed by sugar and other compounds, produces red, blue, and purple pigments in various hues. The anthocyanin pigmentation manifested in eucalyptus bark is a result of a rather complicated phenomenon. Simply put, the co
Combination of colors and their intensity derive from the concentration of the different pigments, the modifying effects of color rendition due to the presence of tannin, the physical state of the anthocyanins—whether they are in solution or absorbed—and the acidity of the cell sap. In acidic solution, anthocyanins are usually red, but as the acidity decreases, the color changes to blue and violet.

Color variations may also result from the reaction of tannin to metallic elements in a tree's sap. For example, the combination of ferric iron and tannin in such eucalyptus species as mountain ash, messmate, stringybark, and alpine ash causes bark patterns ranging from blue to mauve to dark red.

Although a considerable amount of research has been conducted on anthocyanin, very little is known of its actual formation other than that the process differs from one kind of plant to another. Researchers have discovered, however, that the characteristics of the pigments are closely associated with the accumulation of sugars in the plant. Any environmentally induced factor—drought, poor nitrogen supply, low temperature, or high light intensity—that favors an increase in a plant's sugar content, often results in the increase of anthocyanins.

Given the virtually infinite variations in the genetic makeup of eucalyptus trees and the different environments in which they grow, the combinations of shapes and colors of bark are also infinite. Even from day to day, the delicate designs and hues of these trees are constantly changing as the bark peels in different successions and shapes, the removal of each piece subtly altering the appearance of the trunk.
The Edge of Europe
by John F. West
photographs by Michael Spring

As an ancient way of life in the Faeroe Islands dies, peace-seeking vacationers are reclaiming isolated villages.

The Faeroe Islands are a world of mist and drizzle hurled against gray-green mountains; of stony, treeless valleys, wet moorland, and black basalt cliffs rising a sheer 500 feet above the wild, but patterned, swirl of the tides. Even in summer, storms can throw one on the hospitality of strangers for days on end; in the winter, it could go for weeks.

Much of the 550 square miles of this Danish dependency, located about midway between Norway and Iceland, looks as it did when Norsemen first settled it 1,100 years ago. Even the Faeroese language, like Icelandic, has changed little from the Old Norse of the Vikings.

Isolation from world population centers, pronounced until the present century, has bred an independent, hardy people, who live in a hundred or so villages and small towns that look out across the straits or nestle in the fjords of the islands. Some of the houses are still grass roofed, and until a decade or two ago, the acrid but comforting smell of peat smoke hung over the more remote villages. Some of the older men, carrying on traditional sheep raising and cod fishing, wore handmade lamb-skin shoes fastened around their ankles with multicolored woolen bands.

Sheep raising used to be the islanders’ most important activity (faeroe means sheep islands). The sheep are now rounded up twice each year—in June for shearing and in October for slaughtering. After the animals have been butchered and skinned, the carcasses are hung in curious little wood-slat out-houses to dry in the winter winds, creating a tough but tasty meat that the Faeroese eat raw in thin slices. For centuries, wool played an important part in the economy and until a hundred years ago was the principal export.

The Faeroese distant-water fishery began to develop about a century ago; the first vessels used were wooden smacks that sailed to Iceland and Greenland every summer. Then, the fishermen used ordinary handlines. Just before World War II, the Faeroese bought their trawlers. During the war, smack fishermen performed heroic service running cargoes of Icelandic fish to a beleaguered Great Britain. Wartime earnings, together with some Marshall Plan financial aid, led to the establishment of a modern Faeroese fishing fleet.

Today, fishermen work aboard well-equipped trawlers, seiners, or
factory ships. Many fishermen own a share in one of the sturdy wooden vessels that work in the inshore waters. The Faeroese now export quick-frozen cod fillets, Greenland shrimp, and herring meal to a score of countries, the principal importers being Denmark, Britain, Spain, Portugal, Italy, and the United States.

One result of this economic boom has been the modernization of Tórshavn, the Faeroese capital. With a population of only 11,500, it possesses the facilities of a city ten times its size—three hotels, three banks, two libraries, two museums, a number of bookstores, and a small university. Five newspapers are published and a radio station broadcasts during part of each day.

Village life is also changing. Those with good harbor facilities or those linked by the new road network, with its bridges, ferries, and tunnels, are doing well, but the more remote villages are in decline. In both, however, the inhabitants tend to be pulled one way by their cultural heritage, the other by their prosperity and the allure of modernization.

The village of Nólsoy, three miles from Tórshavn by sea, is prospering. When I first visited the islands in 1956, I fell in love with this little settlement of 340 people, made it my home for the summer, and lived among its shepherds, fishermen, and smallholders. Some of the old tarred houses around the tiny harbor still had grass roofs. There was no electricity in the village and at night, one often had to rely for guidance on the phosphorescence produced by the oxidation of split fish and pilot whale meat strips hanging to dry near almost every back door.

In two decades, Nólsoy has changed greatly. An underwater cable now brings power from a hydroelectric plant twenty miles away. A new school stands on a hill just outside the village. Brightly painted houses have sprung up everywhere, and one is hard put to find any of the cunning wooden racks and locks that were once used everywhere. A new graveyard is partially hidden behind ugly concrete walls. Two sturdy wooden smacks lie moored in the enlarged harbor.

In the fields, small tractors with mowers have replaced scythes. Yet much remains of the old way of life in such villages as Nólsoy. Old World courtesy is still
mony among the people, and their speech is pithy and concise,
volatile with allusions to Faeroese
ends and ballads. Some ballads
have been handed down orally for
more than five centuries, and dur-
times of celebration, the village
sing them lustily, linking arms
and dancing time-hallowed steps.
Nólsoy will undoubtedly con-
tinue to develop, retaining some of
ancient customs, but also
outing modern buildings and
veniences.
Mykines, a far more isolated vil-
lage, and one that lacks a harbor,
does not have a future. Like a num-
ber of outlying villages and is-
lands, it has only a past. The
island of Mykines lies thirty miles
to the west of Tórshavn, on the
very edge of the archipelago. Here,
the ancient Faeroese way of life
continues little altered from Viking
times, but now there are few left
to carry it on. At the end of the
last century, the population was
150. Today, there are only 50 peo-
ple and most of the young have
gone to Tórshavn and modern
times. Last year, the village school
closed as there were only three
small children left on the island.
Many of the neat dwellings along
the single village lane stand empty,
and visitors in search of peace can
rent them for a pittance.
Mykines is probably the most
inaccessible spot in Europe. The
only way of getting there is on the
mail boat, which sails four times a
week from the village of Sörvágur,
ten miles away. It is supposed to
leave at 10:00 A.M., but whether it
does depends upon the landing con-
ditions on Mykines. Winds often exceed fifty miles an hour for days on end, but even more crucial is the wind direction. Even a light breeze from the south can make it impossible for a boat as small as a dinghy to land. The final decision as to whether the mail boat leaves Sör-
vágur rests with its eighty-year-old captain.

The first four miles of the journey are through a sheltered fjord, but once in the open Atlantic, the little wood boat begins to pitch and roll in the swells. The passengers have to clamber over crates, card-
board boxes, milk churns, and heaps of lumber, for literally ever-
thing that reaches Mykines is car-
ried in this twelve-ton vessel. After three more miles, the boat com-
under the lee of the towering cliff on the south of Mykines. The rise up, stratum after stratum
The only landing place lies at the southwest extremity of the island. Here, a valley slopes toward the sea, terminating in a cliff a mere twenty or thirty feet high. The landing lies in a shallow basin; with an onshore wind, it alternately fills and empties with great violence. A concrete jetty juts into the basin and a stairway leads up to the tiny village. Whenever the mail boat arrives, a little crowd gathers on the jetty; invariably, it turns out to be the entire population of the island.

Nobody knows when the island was first settled. There is some evidence that by 1200, herdsmen were bringing cattle to the island to graze on its abundant summer grass. By late medieval times there was a settled population, and a tiny church had been built, as well as an even smaller chapel that was demolished during the Reforma-

Because wood is virtually nonexistent on the wind-swept islands, most buildings are constructed of concrete or corrugated metal. Settlements, such as Sørvágur, at left, are nestled deep within protective fjords. On Mykines, puffins used to form an important part of the islanders' diet. Now, the birds are netted as a form of recreation.

tion. A Faeroese archeologist recently excavated the site and found a broken basalt candlestick and some fragments of a bronze candle snuffer. The first documentary records of Mykines date from 1584. One blessing that Mykines offered was security from enemies. The population of the Faeroe Islands has never been large enough to defend itself from marauders, and in former times there were many. During the fifteenth and sixteenth centuries, English fishing boats were not above stopping at the Faeroe Islands on their way to the Iceland banks and helping themselves to sheep or seizing islanders for unpaid service on board. In the seventeenth century, pirates—even Barbary corsairs from Algeria—became a menace. Many Faeroese villagers cunningly concealed refuge huts in the mountains and hid there while their homes were pillaged.

Mykines, however, was safe from such terrors. On the north and south, the island is protected by sheer cliffs that rise 1,300 feet or more out of the sea. There is no beach, and it is difficult to imagine how any landings could have been made here before the jetty was constructed.

For the traditional subsistence economy, Mykines was well en-
dowed. Every visitor to the island is impressed by the greenness of its fields. The unusual fertility is produced by the droppings of hundreds of thousands of birds—guillemots, puffins, kittiwakes, razor-billed auks, gannets, petrels, and arctic terns. Through subsistence methods of farming, the lush grass could carry 40 cows and 800 sheep through the winter.

In summer, the fields around the village are a patchwork quilt of tiny grass plots—some freshly mown, others grown up in rich hay. This is the result of an incredible subdivision of ownership. On Nólsoy, ownership was rationalized a few years ago by means of the Faeroese enclosure laws. On Mykines, enclosure has not been worthwhile, and the cultivated land remains a complex of tiny strips, many owned by nonresidents.

A five-foot-high dry wall protects crops from being consumed by the moorland sheep. The gates in the wall are thrown open every October 25, after harvest, and the sheep surge in to graze over the fields. They are rounded up each May 14 and driven back to their summer pastures and the gates are once again closed.

Cattle graze just outside the wall during the summer, but they are brought inside the village and kept in small outbuildings for the winter. Nowadays, on Mykines as elsewhere in the Faeroe Islands, beef cattle are preferred to dairy stock. The task of searching out the cows for milking every morning and evening seems unnecessary when sterilized milk imported from Denmark is so cheap.

Sea birds used to be an important factor in the Mykines economy in former centuries. Even today, the hunt is carried on with enthusiasm. Traditionally, the most frequently hunted birds were puffins, guillemots, and gannets. Recently, fulmars have also become popular.

Gannet catching is peculiar to Mykines, as the only Faeroese gannetry is situated on the westernmost cliffs of the island. The breeding stock is said to vary between one and two thousand pairs. Gannet is tasty—like a fat goose.

Puffins are hunted with nets, an extraordinary method requiring speed and timing. Using a V-shaped net at the end of a twelve-foot pole, the hunter conceals his

Knowledge of traditional occupations is handed down from generation to generation. Each spring, children are encouraged to lend a helping hand when sheep are herded into corrals for shearing, but instruction is usually informal. After shearing on Mykines, the sheep are let out of the gates of the village and left to graze for the summer on the island's lush expanses.
behind one of the low, dry walls built for this purpose near the large breeding ground just east of Mykines village. When the puffins fly past, the hunter swings the net up so as to take them from behind.

Most Faeroese families take pride in being at least partially self-sufficient, and their basements will always have some puffins or illmars salted away, in addition to barrels of pilot whale meat and sacks of home-grown potatoes.

At least some of the cultural heritage of the Faeroese village will live on into the modern age. But the very existence of the Mykines community hangs in the balance. Two tiny hamlets on the nearby island of Vágar have already disappeared, as have several small villages on islands in the northeast. A dozen other outlying Faeroese villages are likewise threatened. With the ever declining population of Mykines, the day may come when there are not enough able-bodied men for the spring and autumn sheep roundups.

The values and skills cherished over the centuries in villages such as Mykines may, to some degree, continue to influence the modern, urbanized Faeroese, but given the present trend, within a generation a way of life rooted in the Viking culture of a thousand years ago may be a thing of the past.
Collection of Hing-tsang Lee, photograph by Wan-go Weng
BY STAN STEINER

CHINA'S ANCIENT MARINERS

The sea comes to an end somewhere in China . . . .
Anonymous Roman author, A.D. 100

Long ago in China, there lived a father who had two sons. He was a merchant. So were they. Whenever he sailed across the seas to trade in far-off countries, he would ask his sons to accompany him. On one of these voyages, a terrible storm engulfed their ship; the waves tossed the ship so violently that the father and his sons feared they soon would be drowned. But the youngest daughter of the family rescued them.

She was a mere seven years old, but she already possessed supernatural powers. Although she was at home, the little girl sensed her father’s and brothers’ danger. And so her soul left her body and flew like a bird over the turbulent waves to the sinking ship. Sweeping down from the sky, she grasped one brother in each fist and her father in her mouth and flew away to safety.

When the little girl’s soul had left her body in her father’s house, her physical being became empty and limp. On seeing this, her mother began to comfort the child and fondle her old limbs.

“Are you all right?” her mother asked.

When the little girl opened her mouth to answer her mother, her father fell out of her mouth, his body dropped into the stormy seas, and he drowned.

“You,” the little girl angrily told her mother, “are to blame for the death of my father!”

Then sorrowfully, she told her mother how her soul had flown out to sea to rescue her father and her brothers on the sinking ship. And how she had saved their lives. But because her mother had been so worried about her physical being, she had opened her mouth to comfort her, and in doing so, her father had fallen from her lips into the seas and died.

In 1592, the Ming dynasty’s long reign (1368–1644) was marred by the Japanese invasion of Korea. Facing page, a Ming ship under full sail (at right) successfully repels Japanese vessels.
In 1788, rebel forces from south and central Vietnam occupied Hanoi, and the emperor appealed to China. Below, a Chinese fleet sent by the Manchu emperor lands cavalry to quell the rebels.

"Is it really true?" her mother asked.

"Look, my hair is still moist from the sea," the little girl said. And seeing this, the mother wept.

Compassion now filled the heart of the child. Her anger let her, and she grieved for the sorrow of her widowed mother. She took an oath never to marry. And until her mother died, the youngest daughter cared for her. She was as selfless as a daughter should be.

She became an immortal known to all as T'ien-hou, goddess of the sea, protector of ships and seamen on all the oceans of the earth and all the rivers of China.

And it was said she even became an empress of Heaven. That is why all along the Fukien coast of China, one of the most sacred and popular of deities has been T'ien-hou. Her cult spread throughout southern China. Her worshipers carried her legend across the Pacific to the shores of America.
And they built temples for T'ien-hou in many of the Chinatownsof California.

Some of the writings celebrating the powers of the goddess of the sea are known to date from the tenth century A.D. and there are some writers who trace her origin to the third century B.C., to the river goddess of Wushan. Sung Yu in *Fu of the Goddess* tells of the dreams of the emperor Hsiang (298–264 B.C.) in which the goddess is described as the source of the rain and mist. But her deification and worship may be much older, as old as the earliest fishermen and seamen of tribal China, who sailed the rivers and seas before the beginning of written history. And, if so, who was T'ien-hou? Where did she come from? Why was she so powerful?

A sacred tablet in the temple of T'ien-hou, in the village of Foshan, puts the seamen's pragmatic faith in the divine goddess this way: "As the ancients said, 'In the age of perfect..."
government, the spirits become unnecessary.' " But at sea, "when the Way of Man fails to do right, the spirits and the gods come into the light."

Was she a mythic sister of the great goddess of the seafaring Pelasgians of pre-Grecian tribalism? Or was she the daughter of the mother goddess worshiped by the ancestors of Phoenician seamen and described by the second-century Roman writer Lucius Apuleius, in The Golden Ass, as having "risen from the midst of the sea" to guide "the seas' winds," and whose "true name" was Isis? The worship of these goddesses may be as ageless as the fears of the first tribal seamen—and seawomen—who needed guidance on the unknown seas.

Even older, her lineage may be in the darker beginnings of the sea, going back to the earliest worship of water. In the Shang dynasty (mid-sixteenth to early thirteenth century B.C.) a god of Ho (the Yellow River) lived like a drowned man beneath the water. In times of flood and storm, he was calmed by the gift of a young girl who, upon a raft for a bridal bed, was given to him in marriage. In his palace of fish scales and cowrie shells, she became goddess of the river, while on the shore the people sang her wedding song, 3,500 years ago:

Oh, you mount a white turtle!  
your robe is a striped fish!  
Oh, I wander at your side!  
in the corridors of Ho!  
Oh, we combine our hands!  
as we travel to the East!  
Oh, waves in steady surges!  
come to welcome us!

The symbol of the dragon as a giver of life is not solely Chinese, but it is particularly so. And what is a dragon but a great fish with feet; a serpent with wings. In China, this awesome and powerful creature was not a bringer of knowledge and evil, as it was in the Garden of Eden in the West; rather it brought fertility and abundance, which was knowledge and wealth. It was a magical fish that created human progeny; the legendary father of Heaven of the legendary emperors.

And in the oldest of the older legends, the heavenly dragon was often a woman, a young woman. She was at times an innocent girl or the forsaken virgin or the bride abandoned at the altar, who went forth as a dragon to bring her lover back from the seas. T'ien-hou, the goddess of the sea, might be the daughter of that dragon.

The origin of Chinese civilization may owe more to the importance of fishing on its rivers and its seas than has ever
been recognized. Fish were an essential food of the "nuclear" civilization of northern China, writes Kwang-Chih Chang in *The Archaeology of Ancient China* (1971). Chang says that some authorities on early Chinese history have come to believe that "the birthplace of farmers and herders" in ancient China was in that cradle of land at the confluence of the northern rivers, the "habitat for the sedentary water-side fishermen" of Neolithic times. Here was the origin of the "distinctive pattern" of the Chinese civilization's "independence and originality."

Fishing may well have provided ancient peoples with an easier and more accessible source of food than hunting. The long coasts and longer rivers of China offered a natural reservoir of fish. Both in the folklore of the ancient fishermen and in the scientific lore of modern archeologists, there is evidence of the importance of fishing not only for the survival of the people but also in the creation of their character.

In Honan Province, caves of the Yang-shao civilization have been found filled with towering heaps of fish bones. These ceremonial and culinary mounds date to 3000 B.C., and before. And on the banks of the Yellow River and its many

An eighteenth-century cloisonné box cover shows a seascape and dragon boats in the earlier Tang style (618–907). The scaly dragon, giver of life, is really a giant fish with feet. The Chinese sea goddess is thought to be the dragon's daughter.
tributaries, fishing, a source of myth and food, was a highly skilled Neolithic industry. The symbolic significance of fish in early Chinese history is extraordinary.

"In subsequent centuries, down to the modern period, stories of the miracles of T'ien-hou continued to be told by sailors returning from dangerous voyages up and down the China coast," C. K. Yang writes in Religion In Chinese Society (1961). The Chinese seamen were "among the most adventurous and self-confident" of explorers but their belief in the "magical practices" of their goddess of the sea was so old that it began long before the "dawn of history."

No one knows how long ago the tribal fishermen and seamen of China set sail. There is no written history of their journeys or much archeological evidence of their way of living, as there is of hunting tribes. On the seacoasts, the boats and tools of seafaring peoples were vulnerable to wave and weather; they were not as well preserved as the fires and tools of hunters, deep within caves where even the pollen of flowers has been preserved after a hundred thousand years.

An early twelfth-century scroll painting of a festival in the Sung capital depicts bustling river traffic. Under the Sung (960–1279), China's navy first became important.

The Palace Museum, Peking; photograph by Wan-go Weng
The rafts of logs and boats of reeds, the dugout canoes and primitive sails have vanished.

The sea has never been gentle with the memory of its dead, buries its conquerors and victims indiscriminately and with equal grace.

Still, upon those glacial blue waters of the Ice Age, blown by stormy trade winds, there is evidence of Stone Age seamen in Asia who sailed forth on incredible voyages. They saw the turbulent waves as courageously as their tribal contemporaries who walked across entire continents. They crossed the oceans, leaving the details of their voyages in legends and on stones that we have just begun to decipher, or we could hardly imagine the skill, or measure the daring, of our ancestors.

On the islands of the Pacific there are still sailors who remember the nearly forgotten science of the ancient mariners. Seeking to record their dying science, the Australian anthropologist David Lewis has explored the ways that islanders aided by modern navigational equipment traveled great distances on the open sea.” His journal, *We the Navigators: The Ancient Art of Landfilling in the Pacific* (1975), as been described by a fellow Australian, anthropologist Stephen Harris, as listing the navigational guides of ancient seafarers from “the more obvious ones of sun and moon positions, positions of the zenith stars, land loom, cloud lore, homing birds, sea marks and wind direction, but also the less obvious features of swell orientation, wave refraction pat-
One of China's most popular deities was the sea goddess. This twelfth-century Sung painting on silk depicts a local water deity, the nymph of the Lo River. Her impressive entourage includes a multidecked ship like those dispatched by the Sung to trade with Korea, Japan, and the Arab world.

terns, wave shapes, deep phosphorescence and current speeds and direction.”

The islanders, even today, can sail for great distances using their sea and sky technology. One of these contemporary “ancient” seaman is said to know a world of navigation that spans an area 2,600 miles wide.

The ancient Chinese and Japanese mariners were surely noble, and perhaps more, skilled. The earliest known voyages of the seamen of the Asian continent seem remarkable in length and duration. But they were not. In the most distant times, seamen sailed the seas as far and as freely as those whose later voyages happened to be remembered on paper. And we are beginning to decipher their legends and stones, to recognize and appreciate their accomplishments.

In recent years, archeologists have been startled by the discovery on the shores of the Americas of pottery resembling the Jōmon ware of Neolithic Japan. The thought that Chinese or Japanese ships may have reached the coasts of Ecuador nearly 5,000 years ago was baffling. The pottery could have been traded from island to island across the Pacific, but this would indicate the existence of Neolithic trade routes, thousands of miles long, across the world's largest ocean.

In ancient Mexico, signs of oceanic contact between the Stone Age tribes of Asia and America have also been unearthed. The evidence of a possible Chinese influence on the art and ritual of the Olmec culture has long been a source of
wonder for Mexican archeologists. As Miguel Covarrubias demonstrated in *Mexico South* (1946), even the spiritual use of jade was similar in both cultures.

China itself may have been subject to "disturbing influences from as far afield as the arctic coasts of North America, central and southern America, and the South Pacific, in late prehistoric times," declared William Willetts, in *Chinese Art*. The effects of such influences on Chinese culture have long been debated, but to Willetts the findings of archeology supported a belief in Stone Age crossings of the Pacific Ocean. In any event, "the implications are evidently highly rewarding." These surprising discoveries confirmed possible transpacific contact as long ago as 3000 B.C., or before. In the nineteenth century, such historians of the West as Hubert H. Bancroft and Charles W. Brooks were less cautious. They boldly believed that early explorers had crossed the Pacific Ocean in both directions.

Speaking before the California Academy of Sciences, in May 1876, Brooks said: "Great maritime empires existed in very remote times. And both Atlantic and Pacific Oceans were crossed, and races and civilization widely extended in ages still called prehistoric. A knowledge of the western shores of the American continent has long existence in both China and Japan. That a restricted communication has existed by sea across the Pacific does not admit to question."

To cross such vast and uncharted seas, in small boats of
primitive design, required a knowledge of geography and astronomy that could only be acquired by years of experience. Perhaps by generations and centuries spent upon the sea. But these were rough and robust men, skillful and knowing in mastering the discontents of winds and waves.

More than that, these earliest seamen had to learn the character of the sea. They had to be both daring and bold, stoic and cautious, as people of the sea have been throughout history. The character of the sea had to become their own.

And what of their shipbuilding skills? They sailed forth on seagoing canoes dug out of huge Neolithic trees and on great rafts of reeds and on flat-bottomed boats made of tied logs. Many similar boats of contemporary tribal people are larger than those of European explorers who “discovered” America and Africa and Asia. Most likely the ancient boat of the Chinese were as large as, or larger than, the more famous ships of the Renaissance.

In classical times the Chinese were already building massiv junk that could cross oceans. These heavy, ornate seagoing vessels were known to have reached South Asia before the birth of Christ. “For upwards of twenty centuries the Chinese junks have been known to be large, fast and strong, the people skilled mariners, excellent carpenters, and marine architects. They early possessed mechanical skill to build junks of comparatively great tonnage, capable of conveying large amounts of cargo and great numbers of passengers, wrote Brooks.

These early junks rivaled the ships of Arab caliphs. In the fourth century A.D., sea voyages lasting months were recorded, during which the crews survived thousands of miles at sea before reaching port. The mastery of the sea by these men, “may account for [ancestral China’s] skilled boatmen who have lived upon the water from time immemorial, and for the enormous fleets of junks, generally of large dimensions,” thought Brooks. “A taste [for the sea] early cultivated may have come down through many centuries.”

One of the earliest emperors of the Ch’in dynasty, 221-206 B.C., sent a fleet of seagoing junks to the Isles of the Immortals in the Eastern Sea. We now believe that these may have been the islands of Japan, but there is no one who can say they were not the Solomon, or the Hawaiian, or the Aleutian islands.

No one knows the islands of the Pacific by the names that the early Chinese seafarers knew them. So all we can say for certain is that while the scholars argue about their geography,
location, the sailors and traders of the Ch’in empire simply sailed to them, and in celebration of their daring gave these islands names so poetic that we shall never discover them upon our prosaic, precise scientific maps.

Just as the seas flow many ways, so do the ships that sail upon them. When the Roman emperor Marcus Aurelius sought the silks of China he sent a fleet of traders to buy them. It is said that these Roman merchants reached Asia in A.D. 66, “going around Arabia and across the Indian Ocean.” It was evidence, wrote one historian, “that the sea route from the West to China was already in operation” at the time of the Caesars. Recent discoveries of Roman lamps and trading goods in the seacoast cities of Thailand confirm the extent of the trade between Europe and Asia in the earliest years of the Christian era. The sea route was a well-traveled thoroughfare.

No Latin or Greek equivalents exist for the names the Chinese gave the envoys of the Roman emperor; but they were recorded by the historians of the Han dynasty. The Chinese were suspicious of the Roman merchants and doubted their credentials. So the Roman emperor sent a second fleet of traders with convincing credentials, and the Han emperor diplomatically sent an envoy to Rome; unfortunately, he died during the long voyage to Europe.

It was not an expedition for the weak—in mind or body. One Chinese traveler, Fa Hsien, who journeyed to India in A.D. 399, described how he sailed back to China by way of Java, and how the sea captain lost his way in the China Sea, so that this ship sailed for seventy days before land was sighted—a longer voyage than that of the Mayflower more than a thousand years later.

Even so, for centuries the sea trade to China was dominated by foreigners. By the sixth century, Roman, Egyptian, Persian, Indian, Arabian, and Jewish merchants and seamen crowded the harbor of Canton, making it one of the world’s largest and most cosmopolitan ports. But in A.D. 727 a T’ang historian reported that the “Posse [Persians] sacked and burned the city of Kwang-chou [Canton],” as the Arabs had done, and would do again. Infuriated, the T’ang emperor banned foreigners from the city. But, on second thought, he launched a vast shipbuilding program that was to create China’s greatest merchant and naval fleets.

By the Sung dynasty, the Chinese navy had grown to hundreds of ships: an impressive armada larger than the Renaissance navies of Spain and England. The fleet was manned by
This illustration of a Chinese trader appeared in a book that the British ambassador commissioned and presented to the Chinese emperor in 1792. The hold of a vessel of this type was divided into several partitions so that, in the event of a leak, most of the cargo was protected.

52,000 sailors. The seagoing junks of the emperors of Sun were built at this time—huge vessels that could hold six hundred people and "a year's supply of grain." Chou Ch'u-fe described these junks as being "like houses," with sails "like great clouds in the sky." The cargoes of these junks, as listed in the Annals of the Sung in the year 999, included export and imports of all sorts, from rhinoceros horns to steel-plate armor. The geographers of the emperors had learned enough
ven by then, to describe faraway lands such as Somaliland, Arabia, and Sicily, and the dragon-shaped ships were becoming known far into the Western seas.

These enormous junks must have seemed an apparition to Westerners, who first saw them when the Great Khan, Kublai, sent an entire fleet to bring a Mongol princess to her royal wedding in Persia. In some disbelief, the Chinese junks were described as having four to six masts, fifty to sixty cabins separated into watertight compartments for safety, as any as ten lifeboats on board, and two or three supply boats tow, with room on their decks for vegetable gardens for hundreds and hundreds of passengers and crew.

To Europeans the Golden Horde is remembered as the seamen of the Khans who swept across the steppes of Asia to the very banks of the Volga and the Danube. They were of the most brilliant and victorious land armies in all of history. Less known were the maritime exploits of the Khans, or these were less triumphant.

Soon after the Mongol conquest of the Sung empire, Kublai Khan commanded the Chinese fleets to invade Japan. A naval force of 900 ships and 25,000 men tried in 1274, and died again in 1281, with 600 newer ships and 140,000 men. At the Kamakura shogunate of Japan and the god of weather, who unleashed a typhoon, combined to all but destroy the fleets of the Great Khan. Nor were the fleets sent to conquer that is now Vietnam and Java any more successful or any less spectacular. On the sea, as on the land, the Great Khan wished to be second to none. Even his defeats were legendary.

By the time that Marco Polo arrived at the court of the great Khan, the Mongol-commanded Chinese fleets on the Yangtze River alone were so numerous that the traveler from Venice wrote in amazement: “The amount of shipping it [the sea] carries, and the total volume and value of its traffic, exceeds all the rivers of the Christians put together, and their seas into the bargain.” On coming to the port of Sinju (I-hing), Polo saw 5,000 ships “in the harbor at once.” The reports of China were “a marvel to behold” he wrote, most of Zaiton (Ch’uan-chou), which another European traveler, Odoric of Pordenone, described as twice as big as Rome. An Arabian chronicler, who visited Ch’uan-chou not long after proclaimed: “The harbor is one of the greatest in the world. No! I am wrong! It is the greatest!”

Of all the feats of Chinese seamanship none surpassed the voyages of the eunuch admiral of the Ming dynasty: these
“seven voyages of Cheng Ho” equaled the adventures of Sinbad.

Emperor Hung-wu, founder of the Ming dynasty, had decided to extend Chinese mastery of the sea as far west as his fleets could sail. His successor, Emperor Yung-lo, chose Cheng Ho, the “three-jeweled eunuch” of the court, as the commander of the imperial fleets, to go into the western seas. And though Cheng Ho had come from the inland province of Yunnan, his seamanship was so exemplary, so skilled, that he will be remembered, along with Odysseus, Leif Ericsson, and Magellan, as one of the great captains of the sea.

In 1405, Cheng Ho sailed from Foochow at the head of a fleet of sixty-three junks and 27,870 seamen. His flagship measured 444 by 180 feet, as large as a modern ocean liner. The fleet explored Java, Ceylon, Malacca, and the coast of India, sweeping the sea of enemies throughout the Indian Ocean, before returning in triumph to China. From 1405 to 1433 seven of these royal fleets, actually armadas, sailed into the western seas. One of the greatest was the third fleet of 30,000 men and forty-eight junks: the largest one carried a crew of about 1,000; the average held 600 men. These fleets reached not only the Persian Gulf and the Red Sea (in Aden, they captured a giraffe for the emperor’s gardens), but the sixth fleet also explored the coast of East Africa, perhaps as far as Kenya.

Of his voyages Cheng Ho wrote, with no immodesty: “The Imperial Ming dynasty, in unifying the seas and continents, surpassing the three dynasties even goes beyond the Han and T’ang. The countries beyond the horizon and at the ends of the earth have all become our subjects.” The ships sailed 100,000 li (a li is about one-third of a mile), more than the now known circumference of the earth. “Our sails, loftily unfurled like the clouds, day and night continued on their course, rapid as a star, traversing the savage waves as if we were treading public thoroughfare,” Cheng Ho reported to the emperor.

The last of the fleets had barely returned when the mandarins of the court began to decry the extravagance of sailing so far away, as is so often the opinion of those who stay home. No sooner had the emperor begun to doubt the wisdom of the sea voyages than Japanese piracy swept across the sea like a scourge; it had been provoked by the invasions of Kublai Khan and the civil war raging between the warlords of feudal Japan. One after another the ports of China were sacked by Japanese pirates who attacked, not singly, but in roving packs, year after year.
And so the Ming emperors enacted a decree prohibiting sea journeys. The explorations of the vast fleets ended ingloriously; an era of Chinese seamanship died stillborn. Within the century, European ships commanded the seas.

Since that time historians have wondered what might have happened to the course of history if the emperors of the Ming dynasty had not withdrawn their fleets from the seas and had sailed down the coasts of East Africa and around the Cape of Good Hope? And if, in doing so, they had met the smaller and lighter ships of the Dutch and the Portuguese head on? And if they had gone farther into the Atlantic, north to the shores of Europe?

One thing is certain: the seamanship of these ancient Chinese mariners refutes the myth that China was a withdrawn, backward nation, living in self-imposed isolation. The mystery of the mysterious Orient, inscrutable and secretive, as little foundation in the robust and raucous history of the seas. If anything, the seamen of China seem to have opened any of the trade routes to the West, which Westerners then used to reach China.

"No race [on earth] can compare with the Chinese in their capacity as traders, colonists, and pioneers," wrote Sir John Chatt in his history of the China trade.

"As far back as we can discern, the sea-borne trade [of China] between the countries bordering on the Indian Ocean and the China Seas exceeded many times in volume the petty traffic of the Mediterranean world. . . . If their vessels never sailed the Atlantic or the Mediterranean it was because, as H'ien-lung pointed out, China had no [need to] import manufactures of outside [namely, European] barbarians.

"The Chinese, like the British, are a seafaring race," Pratt said; and no Englishman could say any more than that.  

This 165-foot wooden ship, dating from the Sung dynasty, was recently salvaged from Ch'uan-chou Bay in Fukien Province, on the southeast coast of China. These remains barely suggest the magnificence of Sung ships, which often had as many as five or ten masts, were as wide as a modern ocean liner, and were frequently 400 to 500 feet long.
San Salvador’s Urban Orchids
by Peter Bernhardt

In the trees of El Salvador’s capital, orchids thrive, largely because the city’s population ignores them.

The Central American country of El Salvador is the smallest mainland American republic, roughly the size of Massachusetts. Nevertheless, like other political boundaries carved out of the Neotropics, El Salvador possesses an abundant native flora to delight and fascinate a systematic botanist. One Sunday, for example, I found two orchid species in blossom. These sightings were not made under especially romantic circumstances. I was not slashing my way through rain forest llanias or climbing a cow path on one of El Salvador’s numerous volcanoes. I was walking down some of the busiest streets in the capital city of San Salvador.

The first plant was Cattleya aurantiaca, which produces small, star-shaped, red-orange blossoms. The plant was clinging to a telephone pole that overlooks five daily bus routes.

The second plant, Oncidium cebolleta, was brightening the fork of a tree growing in a school playground and bore a spray of flowers, each the size of a child’s fingernail. The sepals and petals of Oncidium have a yellow finish marked with red-brown spots that undoubtedly gave this orchid its common Salvadoran name of chorizo con huevo, “sausage and egg.”

As far as San Salvadorans are concerned, the ten orchid species that adorn their streets are as useless as the wild, weedy plants North Americans associate with their own cities. No one takes care of dandelions, crab grass, ragweed, or ailanthus, “the tree that grows in Brooklyn.” Yet they flourish under minimal conditions, regardless of whether city dwellers root them out or ignore them.

These plants are colonizers that benefit from the exposed soil of a disrupted or destroyed ecosystem, be it a fire-ruined forest or an abandoned lot. Their seeds germinate rapidly, and their growth pattern is typical of weeds: long, spreading stems; no woody tissue; dense, durable root systems; and anatomical and physiological adaptations that permit them to withstand environmental pressures from climate, animals, and insects. Most important of all, the energy that they glean from their habitat is almost completely directed toward their reproductive systems. Weeds’ individual life spans are short—they flower and die—but several generations a year insure many offspring during the limited growing season. There is a penalty to be paid here, in the form of limited exchange of genes.

But the orchid may only comfortably survive in association with the environment in which the original seed was deposited. The family Orchidaceae belongs principally to climax ecosystems and old stable environments. The sunlight, water, and minerals orchids convert into life processes indicate slow maturation and feature complete adaptation to the subtle ties of their habitat. While a single orchid plant may contain thousands, if not millions, of viable seeds, the plant may not be ready to flower for several years. Individual species rarely flower more than once a year. In the tropics, the blooming season of a single plant may last up to two months.

San Salvador is hardly Walden Pond. The population exceeded 350,000 in 1970 and increases annually by 3.8 percent. The city suffers from all the ills that plague other Latin American capitals—a large transient population; over-expansion, which threatens the water table; and environmental and hygienic abuses, ranging from the discharge of raw sewage into local rivers to the absence of air pollution filters and noise control units on automobiles and public transportation. Yet in the face of these obstacles, ten orchid species appear to maintain standing populations here.

At 2,238 feet above sea level San Salvador is in the climatic range that local topographers and meteorologists call el clima templado, the climate of the high central valleys. Sixty-six to seventy-eight inches of rain falls during the rainy season months of June through October, and the average annual temperature is 75 degrees Fahrenheit. Where natural vegetation has been permitted to remain, plant geographers note that a low altitude hot zone flora and a high altitude cool zone flora coexist in this area. The orchids of San Salvador represent both floras. Species such as Oncidium cebolleta and Catasetum integerrimum beg their range in the dry forests of the Pacific coast. Epidendrum chocoense, Brassavola cucullata, Epidendrum adenocarpon, and Laelia rubescens become common in the low valleys. All the other species are essentially cooler zone plants, but they descend to the lower altitudes and meet the former orchids on equal terms in the parks and side streets of San Salvador.

All urban orchids are epiphytic and exploit microhabitats that human beings have no intention of claiming for their own. They spend their lives clinging to the bark of trees, all of which are native in this part of the world, not introduced from abroad.
trees, but unlike strangler figs and mistletoe, orchids never parasitize their hosts. The long, tangled root systems of epiphytic orchids encircle a tree's limbs to form a living net that traps rushing rainwater and holds dust and leaf debris used as a mineral supplement after being broken down by epiphytic bacteria and fungi. In this way, parks and tree-lined streets form islands of life in a sea of asphalt.

This principle also holds in the countryside. Roughly 30 to 40 percent of El Salvador's forests have fallen to cultivation. When forests are cleared for coffee (the country's most important export and greatest source of wealth), the orchids of the herb layer, such as the many species of Spiranthus, Habenaria, and Sobralia, vanish for good. But since the tallest trees are left standing to shade coffee bushes, many epiphytic orchids are given a reprieve. Local populations survive, if on a somewhat limited scale. One reason they last is that at the onset of the rainy season, Salvadoran farmers cut boughs of local tree and shrub species, strip the branches, and use them as stakes for barbed wire. Many stakes take root and put out new branches. Within a few years these living fences and windbreaks become hosts to orchids and other epiphytic plants.

Only a few centimeters of rain falls during El Salvador's dry season, November to May, but since dryness is a cyclical aspect of the climate, the native flora generally has evolved to deal with both the excess and absence of water. The leaves and shoots of all orchids are covered with a thick, waxy cuticle that retards evaporation. The leaf stem is normally swollen and globose, forming succulent, fibrous structures that botanists and orchid fanciers call pseudobulbs. During the height of the European orchid craze in the latter half of the nineteenth century, pseudobulbs, like the tuber of the potato, were believed to be the plant's true regenerative part. Deprived of their roots, leaf blades, and the shoot meristem, pseudobulbs prepared in this manner for export did not survive to produce flowers or more pseudobulbs. As its name implies, the resemblance between a pseudobulb and a true bulb is superficial. Like most species of cactus or South African euphorbias, orchids growing in dry places draw in water through their roots during the rainy season and store moisture in their pseudobulbs against long months of deprivation; however, orchids growing on trees in areas of high moisture may also have pseudobulbs because even if rainfall is plentiful, drainage on a tree limb is rapid.

Not only are El Salvador's orchids able to tolerate changes in climate; they are also able to thrive on a remarkable variety of cultivated and introduced tree species. I have seen the tiny-flowered Barkeria chinensis and the handsome Epidendrum ciliare and Brassavola cucullata forming massed colonies on Australian pines that line the road to the National Fairgrounds. The dense branches of the monkey puzzle tree support the heavily pseudobulbed Catasetum integerrimum. And on the grounds of the National University, sweetly scented bottlebrush plays host to naturally dispersed colonies of Epidendrum adenocarpum.

Orchids grow in parks, in playgrounds, along streets—in virtually any spot with trees. But along the banks of the Rio Lempa, where the homeless have cleared trees and vegetation out of ravines and put up cardboard, sheet metal, and adobe huts, no orchids grow.

While the situation has not been studied thoroughly, there do not seem to be many barriers blocking the fertilization of a city blossom, Catasetum integerrimum, for example, belongs to one of the few orchid genera with unisexual flowers. The plants are dioecious. Each plant produces either male

Cattleya aurantiaca is a cousin of the large hybrids commonly used for corsages. Shaped like small stars, its reddish-orange blossoms grow in thick clusters on tree limbs over San Salvador's streets.
flowers (the anthers are fertile; the ovaries small and useless) or female flowers (small infertile anthers, functioning ovaries) and self-pollination is impossible. Instead, both male and female flowers exude a chemically complex, clovlike scent during the morning hours that attracts the large, furry Eulaena bee. *Epipedium adenocarpum*’s fragrance smells like a mixture of orange blossoms and burned rubber. It draws small, solitary bees that transport the sticky pollen wads, known as pollinia, from flower to flower. *Brassavola cucullata* only exudes fragrance after dusk; its sweet perfume fills the night air and is believed to attract night-flying sphinx moths that carry the pollinia on their heads.

Moth-pollinated species of *Brassavola* and some bee-loving species such as *Epipedium adenocarpum* offer insects the usual caloric reward, nectar, for their vector services. Nectar, a fluid consisting of well-diluted simple sugars, is a form of easily metabolized liquid energy. However, about half of all orchid species have no nectar. *Catasetum* and probably some of the urban *Epipediums* fall into this category. Bees have been observed assiduously scraping the scent glands located on the flowers’ epidermis and storing the perfumes in the pollen baskets on their legs. Pollination biologists used to think that these lazy male bees were “floral junkies,” using orchids as easy fixes. But recent research suggests that bees use orchid scent to produce a pheromone essential to the completion of their life cycle.

The floral biology of one orchid, *Cattleya aurantiaca*, appears to have changed under urban conditions. In neighboring Guatemala, this orchid’s red-orange color and half-open flower is typical of bird-pollinated species, and orchidologists suspect that *C. aurantiaca* is pollinated chiefly by hummingbirds. In Guatemala, probably thanks to a bee vector, *C. aurantiaca* also crosses naturally with the large, purple-flowered *C. skinneri*, resulting in a medium-sized, delicately scented, pink-flowered hybrid known as *C. x guatemalen-sis*. But even though both *C. aurantiaca* and *C. skinneri* are found south of Mexico, I have not found in El Salvador the natural hybrid to which the two are supposed to give rise when they share a pollinator. The form of *C. aurantiaca* found in San Salvador fails to open completely: the irregularly shaped petal known as the labellum remains partially folded over the column composed of a single stamen fused to the pistil. The labellum also lacks the characteristic red dots believed to attract pollinators drawn to nectaries by visual cues. Yet every flower on the urban *C. aurantiaca* sets fruit. Presumably, although its pollinators are absent in the city, the orchid flourishes by self-pollination.

El Salvador’s orchids, even those urban species that lack floral nectaries, have established a sophisticated relationship with the local ants. Below the flower bud of most species, on the flowering branch, but not on or in the flower, is an extrafloral nectary. Before the buds blossom, these nectaries excrete large, luminous drops of nectar, which are gathered by tree ants. The orchid’s flowering branches remain free of sucking pests such as aphids. Further experimental work will reveal whether the ants studiously keep the branches clean on their own or whether the nectar is a bribe to keep the ants from tending their “cows” on the orchid’s delicate flowers.

Seeding presents little problem for urban orchids. Parasites, such as mistletoe, and many epiphytes, including aroids such as philodendron and night-blooming cacti, produce fleshy fruits or seeds bearing oil glands or sweet, pulpy seed husks. These are eaten by birds, as well as by bats and other mammals. Some seeds are eventually defecated or regurgitated in fertile places, such as lichen-encrusted branches. This method of seed dispersal is alien to all orchids. Urban orchids, like their country cousins, have hard capsules, or pods. Orchid seeds are incredibly numerous and practically microscopic. They are so small, in fact, that one seed consists solely of a tiny embryo.
and a transparent testa only one cell thick. In the city or the wild, orchids do not need animal agents to spread seeds. Ripe capsules split open and the wind carries the seeds away.

I have found orchid plantlets citywide—on both rough-barked and lichen-covered trees. Seeds fortunate enough to reach the latter havens germinate in the presence of a species of fungus. Presumably, until the plantlets produce their first leaves and roots, the fungus nurtures the orchid, while the orchid's tissues offer a comfortable environment for the fungus.

Another factor contributing to the survival of orchids in the city is the apparent apathy of the general populace. More than 290 species of orchids have been described in El Salvador, and taxonomists believe that there are more than 300. Oddly enough, both urban and rural Salvadorans continue to think of orchids as the ornamental imports and florists' novelties that they are in North America. Orchids are not generally worn in El Salvador, and the middle class is only just beginning to discover their possibilities as house ornaments. Some species, such as the vanilla orchid, are thought to have medicinal properties, but these have remained mainly uninvestigated and unexploited.

The Salvadoran attitude toward orchids is reflected linguistically. The word *orquidea* is a technical term used by plant fanciers and botanists here. All tree-dwelling plants, including orchids, bromeliads, peperomias, ferns, certain cacti, mistletoe, and strangler figs, are known by the collective name of *parásita* or "parasite." Few Salvadoran orchids have common names, and those that do frequently share them with members

*The green-and-white flowers of Epidendrum ciliare, abundant in Mexico and common throughout Central America as far south as Colombia, appear in El Salvador from April to June.*
of the same genus. For instance, *chorizo con huevo* is applied not only to *Oncidium cebolleta* but also to all yellow- and brown-flowered members of the genus *Oncidium*, of which there are fourteen. *Epidendrum pentotis* and *E. fragrans*, flowers of the city and of forests and coffee plantations, are known collectively as *conchitas*, or “little shells.” *Catasetum integerim* and *C. russelianum* share the surprising name of *zapatellas suecas*, “little Swedish shoes.” The shoe part of the name must refer to the slipper-shaped labellum, which is also found in the North American *Cypripediums*, but I have found no good explanation as to why they suggest Swedish clogs.

Since the flowers of the urban species are rarely larger than two or three centimeters and the plants are usually hidden by the dense foliage of their host trees, they are comparatively safe from dilettante collectors and gardeners. *Oncidium cebolleta* frequently grows on mango trees planted in the city to shade passersby. Green mangoes are popular sliced and served with salt and chili sauce, and the poor are adept at knocking the fruits down with sticks and stones. I have never seen anyone apply the same technique to orchids that grow out of reach.

The case of one urban species indicates that, for orchids, popularity is risky. As late as fifteen years ago, *Cattleya skinneri* (*flor de San Sebastián*) was a familiar sight in San Salvador, and books on the local flora note how common the flower was in the city. A comparatively recent burst of interest in what is now the national flower of Costa Rica has caused these extremely showy plants to vanish from their old haunts in public parks and in the city estates of the wealthy. The plants may still be found in San Salvador but their distribution can hardly be called natural. Now they brighten the enclosed private courtyards of middle-class homes, where they are stuffed into window boxes or wired to branches and logs.

Many questions about urban orchids remain unanswered. Why are some species seen on the outskirts of San Salvador but never seen downtown? Large and ancient fig trees mark important bus stops just outside the city limits. Here I found *Epidendrum stamfordianum*, *Isochilus*, and dense, matlike colonies of *Hexadesmias*. Are these merely remnant populations of a time when the area was a forest or are there subtle environmental factors that keep them around the periphery and deny them a niche in the city?

And as for the terrestrial orchids, will they be forever denied their old territory in the city? I have found one or two terrestrial species surviving in San Salvador. Last year I came across a mature *Cyrtopodium punctatum* growing in a bed of snake plants (*Sansevieria*) at the university. This orchid is the largest species in the country, bearing thick, rigid pseudobulbs more than three feet long. Because it was growing in an area that was originally a center for tropical research, this orchid may be the lone survivor of an earlier landscape. But there is no such explanation for the tight little colony of green-flowered *Habenaria alata* I found two months ago, growing in the center of a well-tended lawn. “Oh those,” the owner said, “Aren’t they cute? Just sprang up one day.”

I suspect that orchids will continue to colonize San Salvador for as long as appropriate microhabitats remain and the interest of the residents remains tepid. Just recently I proudly dragged a girlfriend across town to see what I considered an especially fine stand of *Cattleya aurantiaca* growing on an African tulip tree off a side street. “How ugly!” my friend sneered, “so small and only one color. Not at all like the ones I got for proms.”

A close view of an *Epidendrum ciliare* blossom, seen from above, shows the lip pointing downward, as it does in most orchids. The ciliated side lobes probably entice hummingbirds and other pollinators.
Chilean Flamingo Court and Dance

Text and photographs by Juan Muñoz

**Pair of Chilean flamingos form a mating dance. The long legs pivot around their touching backs. After the dance, either partner may still reject the other.**

These long-legged birds nest in muddy lakes where predators would need an airboat to reach them.

The Tehuelche Indians of Argentina's Patagonia region tell a legend about how the child-god Elal Mothered all the animals to give them their places on earth. The flamingo, such at that time was white, arched late. It was assigned to a lake it had already been given to the sun, so the flamingo had to go to warren, salty lagoon to live. Elal it sorry for the bird and decreed it henceforth its feathers should be the color of the dawn sky.

A more recent explanation of the flamingo's coloring is that it comes from carotenoids in the bird's food. In any case, a brilliant pink mass of Chilean flamingos contrasts vividly against the stark landscape of the South American altiplano. The Chilean flamingo, readily identified by its bright red knees and legs, has the widest range and greatest numbers of the American flamingos. Its population, estimated at about half a million birds, ranges south from Peru to Tierra del Fuego, throughout Chile, Bolivia, Argentina, Uruguay, Paraguay, and southern Brazil. In Patagonia, these flamingos usually nest in shallow, brackish lagoons, more than 11,000 feet above sea level, which often dry up completely during periods of low rainfall. Temperatures range from 68°F in summer to -5°F or lower in winter. In the higher Andean lagoons, nighttime temperatures, even in summer, can suddenly drop below freezing, creating problems for feeding flamingos.

During the nesting seasons of 1971, 1972, and 1973, my wife and I observed and photographed an isolated breeding colony of Chilean flamingos near the village of Colán Conhué in western Chubut Province, Argentina.

The area is one of moderate relief, with elevations of from 2,400 to about 5,000 feet, and the nesting lagoon is about three-fifths of a mile wide and almost two miles long. The lagoon's usually exposed bottom is of a treacherous, quicksand type of mud that is highly caustic and encrusted with a layer of salt. Standing water is most often present only in the center of the basin. Amidst the mud, eight small, grass-covered islands serve as the actual nesting sites. These grassy knolls, situated above freshwater springs, form a long line 600 to 900 feet from the western shore. They average 90 to 240 feet in length and 33 to 50 feet in width. The flamingos feed at a number of shallow lakes three and a half miles from the lagoon.

Probably no other flamingo nesting site in South America is as accessible to man and so close to his activities. A well-traveled highway passes within two and a half miles of the lagoon, and the ranch house of the Urretiviscaya family is only several hundred feet from the shore. José Urretiviscaya harvests salt from the lagoon during the nesting season but does not seem to disturb the birds. His livestock water at the same spring at which the flamingos feed and bathe.

Flamingos are noted for the irregularity of their breeding habits, often not returning to a site for several years. But here they breed each of the three years we observed them, and Urretiviscaya told us that during his forty years on the ranch he could not remember a year when the flamingos had not raised a cèche of young.

During the first few days of October, adult flamingos begin to arrive in the Colán Conhué area from their wintering grounds at lower elevations on the pampas and along both coasts of southern South America. This is early spring, when the temperature is above freezing for only a few hours each day. The flamingos scatter around their feeding lakes and appear to have very little interest in one another.

In 1973, the first flamingos arrived at the nesting lagoon on October 6, but spent their time feeding and sleeping in the central part of the lagoon. On the 7th, we counted twenty birds, and by the 13th, more than one hundred birds were sighted in the lagoon. There was some minor courtship displaying, one short-lived "march," or group dance, and for two hours they seemed to be doing an imitation of incubating eggs. Fifty or more birds sat on one island as if incubating, while a small group displayed beside them.

The flock increased daily by ten to twenty birds, and soon displaying continued for two or three hours at a time. Larger numbers were now arriving each day, and by November 2, we estimated that between 2,000 and 2,500 birds had arrived, and all of the eight nesting islands were occupied. On November 9, the colony numbered more than 4,000. Virtually all of the birds participated in courtship displays during these early days of Novem-
At the onset of a breeding season, displaying birds engage in a premating "group dance." The birds rush headlong for about fifty feet, do an about-face, then dash back to the starting point.

ber, and more than half started to build nests.

Displays of the Chilean flamingo take various forms but usually follow a distinct pattern. Typically, we observed a group of five or ten (usually led by a male) holding their heads in an "alert" posture with the neck stretched to its full length. They would then begin a "head-flagging" display, call to one another, and move their heads from side to side in a horizontal arc. This would increase in tempo during a period of several minutes. Others would soon join the head-flagging group, until there were twenty-five to fifty birds displaying together. At times the head flagging would stop as suddenly as it began, but more often it would be followed by "wing salutes" or a marching display.

In a march, the displaying flock rushes in a tightly packed mass for fifty feet or more in one direction while continually calling and head flagging. They then pivot in unison and dash back to their starting point. These marches are often repeated five or six times in quick succession. They stop abruptly, but the head flagging continues and then gradually decreases, as if the birds are winding down.

During periods of intense displaying, we observed many birds pairing. Two birds stand with their necks fully stretched, beaks touching. They then circle slowly, pivoting around the touching beaks.

Both male and female take turns sitting on the egg during the thirty-day incubation period. A change of shift often takes place at dawn, and the relieved partner flies off to feed at nearby lakes and streams.
hen the chicks are more than a
t week old, they form a crèche,
which is patrolled by a few
adults, or "aunties," that
serve as herders and lookouts
the absence of the parents.

Gradually intertwining their necks,
it takes them some ritual peck-
ing and sparring. This may continue
for three or four minutes, after
which they walk off together if the
parentship is successful. During the
early period of copulation, the birds
often mount each other, especially
while bathing. Often a third will
mount the second, and once we saw
our stack on top of each other.

Frequent bathing and preening
are important parts of the daily rou-
tine during courtship. At the Colán
hut site, bathing is important
during the entire period the birds
occupy the nesting islands because
cut mud dries to cement
ardness and must be removed
hile it is damp. A nesting pair rou-
tinely swim each other for this
purpose.

Both sexes share in nest building.
hey build cone-shaped, foot-high
mounds by picking up mud in their
ills and piling it up. Some of the
and is so soft that the birds drool it
over the mound; the mud runs
own the sides and hardens. The
mound is deposited in a concave de-
ession on the top of the mound, it
some eggs are deposited on
assy, level areas of the island.
both birds add to the nest until the
by the egg hatches.

Late arrivals to the colony were
ill displaying and mating through
ovember 25, but the great major-
ity of birds were incubating eggs.
y December 8, almost the start of

summer, the first eggs were begin-
ing to hatch. On that day we
counted 200 newly hatched chicks.
Within a week, all but the infertile
eggs had hatched on the island
where nesting first took place. This
synchronous pattern of egg hatch-
ing occurred, at intervals, on the
other nesting islands in the lagoon.

The thirty-day incubation period
is the only time when the colony is
relatively quiet. The birds sleep
during the day, heads tucked under
wings; occasionally they stand to
turn the egg with their bills. At first
light in the morning and just after
sunrise there is a change of shift.
Birds that have fed in nearby lakes,
ponds, and streams return to the
nest, and a pair will usually spend a
short time together. The new
arrival stands over its incubating
mate for a few moments before tak-
ing its turn on the nest. The other
promptly leaves for the feeding
grounds where, with the coarse fil-
ter in its bill, it strains the water for
annelid worms, small mollusks,
crustaceans, and such zooplankton
as amphipods, copepods, and in-
sert larvae.

A newly hatched chick has white
down, red legs, and a red beak.
After a few days, the down becomes
grey; the legs and beak black.
Feedings are several hours apart—
a task shared, as is brooding, by
both parents. The chick's head pro-
trudes from under the brooding
adult's wing, and with beaks touch-
ing, the feeding parent drools a red
liquid into the open bill of the
chick. This liquid is rich in fat and
contains a good amount of glucose.
Carotenoids, erythrocytes (blood
cells), and about one percent whole
blood are also parts of the mixture.
The liquid is thought to be a secre-
tion from the lining of the upper
digestive tract.

The chicks leave the nest when
they are three or four days old
and able to walk. Searching for food,
they mill around, scavenging egg-
shells, feathers, and mud from
other nests. Crèches begin to form
when there are from 100 to 200
week-old chicks. The assemblage
quickly builds to hundreds of
chicks, and they leave the nest-
ing area en masse to wander all over
the nesting lagoon. Frequently, the

crèche will move to a freshwater
spring where the chicks drink and
bathe.

The crèches are supervised by
only a few adults who serve as
"aunties." These aunties may be
parent birds who are staying with
the crèche at a given time or, pos-
sibly, they are birds that have lost
their egg or young. Another possi-
ibility is that they are unpaired indi-
viduals or subadults that have a
"parental urge" but no offspring.
The ratio is approximately one
supervising adult per one hundred
chicks. The aunties function chiefly
as herders and lookouts rather than
actual protectors. They keep the
creche together by constantly pa-
trolling the periphery, while a few
maintain order among the inner
ranks. As long as the crèche stays
in the areas surrounded by sticky
mud, there is little danger from
foxes, dogs, or other mammalian
predators. The chicks are seldom
molested by predatory birds; they
seem to have an instinct to draw
tightly together when alarmed, do-
ing so even if no supervising adults
are nearby.

All of the eight nesting islands
are completely abandoned by the
time the youngest chicks from the
last colony to hatch eggs have
reached two weeks of age. By mid-
January the mud around the islands
dries up and no longer provides
sanctuary for the birds. The entire
creche, now composed of chicks
from all the nesting islands, moves
to the middle of the lagoon where
a few scattered springs and residual
water keep the mud damp and im-
penetrable to predators.

The creche, which in 1973 we
estimated to be about 1,500 chicks,
gathers around two constantly
flowing springs on the eastern side
of the lagoon to bathe, fight, and
sleep under the watchful eyes of the
aunties. From time to time a group
of adults fly in, find their young
(possibly by vocalization) and feed
them. By the time the chicks are
about fifty days old, their bills have
developed enough so that they can
begin feeding on their own. Some
of the incoming adults relieve the
aunties, giving them a chance to
feed in the nearby lakes.

By late summer, the chicks are
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ready to practice flying, and group of young separates from the main crèche. Strong winds are a most constant in Chubut. Opening their wings, the chicks run into the wind to gain airspeed. Usually, this is enough to lift them two or three feet above the ground. Those advanced enough to flap their wings sometimes manage a fifty-foot flight. Others come back down, most immediately, hitting the ground on the run. When several hundred birds are practicing, the confusion is great, resulting in many collisions between the clumsy chicks. But they learn quickly, and by the end of March those with full plumage are beginning to fly to the nearest lake around the nesting lagoons to feed.

As their chicks become independent, the adults begin to leave for lower elevations in the north. This is a critical time for the young birds by mid-April there are practical no adults remaining. Those chicks unable to fly to the wintering area are abandoned. Although they are able to feed around the nesting lagoon, very few can survive the freezing rain and snow flurries the hard fall and winter.

In our three years of observing the colony, we estimated that the population varied from 4,000 to 6,000 nesting birds, and the crèche averaged about 1,500 young. Urrutivisca said he had never seen any major changes in the population during the years he has lived on the ranch. Unlike many other flamingo colonies, seasonal variations in rainfall, which greatly affect the shallow lagoons where the birds feed and nest, apparently do not affect their breeding at this site.

The greatest danger to this colony is the accelerated development of Patagonia, bringing with it tourism, industry, and an expanding human population. There have been numerous incidents of wanton shooting of flamingos in the area and with only nominal protection afforded the birds, this can only increase. The local ranchers respect the flamingos and do their best to protect them, but they cannot coexist with the flood of settlers coming into the area. Our hope is that the government will take the necessary measures to create a proper preserve that will secure the nests and feeding grounds of these beautiful birds.
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Coyotes are "genetically swamping" this little-known carnivore, bringing it to the brink of extinction

Remnant populations of one of North America’s most critically endangered mammals live within an hour’s drive of Houston, Texas. Most travelers passing through the prairies and marshes along the upper Texas gulf coast would probably not suspect that a large carnivore, averaging some 55 pounds, still inhabits this farm and ranch country that has been settled for more than a century. Although the howl of the red wolf can still be heard from Galveston Bay to the southwest corner of Louisiana, perhaps fewer than one hundred animals, the last of their kind, still survive in the wild.

The red wolf (Canis rufus) once occurred throughout the southeastern United States from southern Florida to central Texas and possibly as far north as the Carolinas and Kentucky. Along with other large carnivores, red wolves were persecuted by generations of farmers and ranchers who feared for their livestock. State and local governments subsidized the destruction of the animals by offering bounties, and personnel of the Bureau of Biological Survey (fore-runner of today’s U.S. Fish and Wildlife Service) trapped and poisoned the animals under a mandate from Congress. These efforts, together with habitat alterations as the land was logged, grazed, and farmed, resulted in the animal’s disappearance from most of its geographic range.

Just short of annihilation, the red wolf was officially recognized as an endangered species in 1965, and lethal control measures by federal agents were halted. Today, when
rancher claims that wolves are 

fleeting his stock, a federal trapper 

dispatched to capture the sus-

tect. Should the animal turn out to 

a red wolf, it is relegated to a 

vive breeding program.

Most endangered species can 

live given adequate legal pro-

tection and sufficiently large re-

erves of critical habitat. The red 

wolf is now protected by federal 

law and there seems to 

be enough suitable habitat to sus-

tain several populations. But a 

more subtle form of extinction 

eats the species—genetic dilu-

tion through hybridization with 

other, far more numerous and 

aptible species, the coyote 

(Canis latrans). Although the natu-

ral occurrence of interspecies 

hybridization is rare among free-

ing mammals, human distur-

bance of animal populations and 

their habitat increases the chances 

of this happening. The result can be 

alteration of the genetic charac-

teristics of one or both species.

As red wolf numbers declined, 

coyote (a species more resistant 

to trapping and poisoning and 

ster suited to disturbed habitats) 

can extend its range eastward, 

hinging the two into increasingly 

iler contact. Most members of 

the genus Canis are interfertile; 

ere being no physiological bars 

against hybridization. Fur-

more, the hybrid offspring may 

to be fertile, either breeding 

ong themselves or backcrossing 

h either parent species.

Under normal conditions, differ-

ent species of wild canids maintain 

etic distinctiveness through 

atural selection or by mul-

ple interference in the form of ter-

ity and species-specific court-

ship patterns. Evolutionists predict 

that hybridization is most likely to 

er when a rapidly expanding 

species comes into contact with a 

less numerous close relative. Fluc-

tuating populations and altered 

habitats also enhance the prospects 

for hybridization. Since all these 

conditions were present as coyotes 

invaded areas where red wolves 

were being drastically reduced, the 

behavioral safeguards failed and 

hybridization began.

The coyote-hybridization threat, 

gether with very low red wolf num-

bers, requires that management be 

approached in terms of saving the 

red wolf's "gene pool." This term 

refers to the sum of genetic infor-

mation carried by all members of a 

"deme," or interbreeding group. 

On a larger scale, it is all the genetic 

information possessed by a series 

of related demes that may make up 

the entire species.

Traditionally, wildlife manage-

ment has largely been a numbers 

game, the objective being to either 

crease, decrease, or maintain 

population sizes with little or no 

regard for genetic changes. Man-

agement of a gene pool is broader 

because it considers not only num-

bers of individuals but also the 

amount of genetic variability pre-

erved. When working with rem-

ant populations, wildlife managers 

must try to save all remaining 

etic variability in order to as-

ure the species' adaptability to 

uture environments. The smaller 

the remnant population's gene 

pool, the more vulnerable it is to 

dilution through interspecies hy-

bridization. To preserve a gene 

pool, the species' genetic limits 

must be identified. For most mam-

alian and avian species this is no 

problem—the black bear, the 

whooping crane, and the white-

tailed deer are so clearly distinct 

from their nearest relatives that 

there is no debate as to where one 

species ends and another begins.

Defining the red wolf's gene pool 

is difficult for several reasons. 

First, individual specimens range 

in size from that of large coyotes to 

that of small gray wolves (Canis 

lupus). Second, because so little is 

known of the red wolf's behavior, 

taxonomic comparisons by beha-

vioral criteria have not been possible. And finally, the extent of the 

terographic overlap that once 

existed between the red wolf and 

the gray wolf in the eastern United 

States will never be known because 

both were long ago extirpated from 

that region and not enough skulls 

were preserved from either type to 

permit reconstruction of the origi-

nal picture. So we will never know 

whether the red wolves of the south 

maintained themselves as a clearly 

distinct entity from the larger gray 

wolves to the north or whether the 

two merged into a continuum char-

acteristic of single, widely dis-

tributed species. Most taxonomists 

describe the red wolf as a distinct 

species; some claim it is merely a 

small subspecies of gray wolf; still 

others suggest that it represents a 

stable hybrid complex between 

the coyote and the gray wolf.

Accurate recognition of a species 

and the limits of its gene pool have 

important conservation impli-

cations. The U.S. Fish and Wildlife 

Service, and other conservation 

agencies, recognize that an entire 

species on the brink of extinction 

presents a more critical situation 

than does an endangered subspe-

cies in the same condition. pro-

vided that other subspecies exist 

safely elsewhere. Unless zoologists 

maintain a reasonable consensus 

on the question of separate-species 

status, agency administrators may 

face difficulty justifying significant 

portions of their limited budgets 

toward saving such animals as the 

red wolf. Most likely the issue will
never be completely resolved because of so much missing evidence, but we believe that the bulk of the evidence supports the separate-species view. Furthermore, for management purposes the animal should be given the benefit of any lingering doubts and recognized as a distinct species.

When we first became involved with the red wolf in 1970 its endangered status had been clearly established. The animal's ecology and behavior remained largely unknown, however, and the taxonomic uncertainty persisted. We began a detailed field study of the animal, concentrating on collecting ecological and behavioral data to aid management efforts and facilitate understanding of gene pool management. By comparing our results with those of similar studies on the gray wolf and the coyote, we also hoped to provide new insights on the taxonomic relationships between North American canid species.

We needed a study area that had a relatively high red wolf population density and that did not contain coyotes or hyruids. Because more than 90 percent of the remaining red wolf range is on private land, we also required landowner cooperation. A 1970 red wolf survey by the Texas Parks and Wildlife Department indicated that Chambers County, Texas, along the eastern shore of Galveston Bay, offered the best potential. Ranchers there proved cooperative, freely allowing us to trap, release, and track wolves on their land and sometimes recording useful observations. At the center of this area lies the Anahuac National Wildlife Refuge, which had already become a sort of center for red wolf research. Anahuac had kennels for holding wolves, and refuge manager Russel Clapper and his staff generously provided vital logistic support.

Elusive species can best be studied in the free-living state by the use of radio-location telemetry. The U.S. Fish and Wildlife Service loaned us radio telemetry equipment and supplied the services of Glynn Riley, a skilled trapper and self-taught biologist experienced in safe and effective live trapping of red wolves.

In the summer of 1971, Riley found unusually small canid tracks...
in the vicinity of the Anahuac refuge, indicating that at least one coyote or possible hybrid was living among the last red wolves. It was probably the same animal we captured the following November—a 36-pound adult female with a narrow, coyelike head. We held her for five days while we searched the surrounding area for additional small tracks made in her absence. Fortunately, none appeared, so we concluded that she was probably the only abnormally small Canis in the study area. She was then immobilized, measured, photographed, and fitted with a radio transmitter collar. We released her at her capture point, hoping to learn whether or not such an atypical animal would be accepted socially by local red wolves.

The additional nine canids captured in the study area were markedly larger than coyotes and typical of red wolves before the coyote hybridization began. Four adults weighed from 52 to 76 pounds; five immatures, from 45 to 50 pounds, roughly 20 percent smaller than eastern gray wolves and nearly 100 percent larger than Texas coyotes. One young male became the only fatality when hunters found and shot the trapped animal.

Red wolf facial threat expressions proved to be unusually interesting. While all North American canids can threaten with a snarl, only the coyote is known to threaten with a wide gape of the mouth. Those animals that, on the basis of size, appearance, and capture location, were judged to be pure red wolves threatened only with a snarl and could not be induced to gape. Wild canids captured outside the study area and judged to be hybrids threatened with a gape. We believe the ability to gape is inherited rather than learned—a conclusion strongly supported by Benson Ginsburg's behavioral genetics studies on canids at the University of Connecticut. The threat expression may well be one of the more valuable criteria for distinguishing trapped red wolves from coyotes and hybrids.

To make genetic comparisons between species, subspecies, or local populations, population geneticists are relying increasingly upon comparisons of the molecular structure of enzymes. These struc-
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tural differences are simple and are
direct reflections of genetic varia-
tions. Enzymes related to funda-
mental cellular processes, such as
ergy metabolism or respiration,
tend to be less altered by environ-
mental changes and are therefore
conservative compared with many
external characteristics, such as
body size or color. Any observed
differences in enzyme structure
indicate that animals carrying them
are members of demes that have
been separated for quite some time.

We collected blood samples from
our trapped animals and sent them
to Robert Storez of Yale University
who was studying enzyme relation-
ships within canids. Storez isolated
some thirty enzymes from the
blood and examined differences in
the molecular structure of each
enzyme. He then compared our
samples with others collected from
known coyotes and gray wolves.

Only one of the thirty enzymes
had more than a single molecular
structure. Of its two forms, one
was typical for the gray wolf and
the other typical for the coyote, but
neither form was 100 percent con-
sistent within either species. This
enzyme alone, therefore, could not
invariably determine the species of
an animal, but the frequency with
which the two forms occur within
given populations could be a useful
measure of genetic changes through
time and space. By this criteria, the
animals in our study area ranked
about midway between gray wolf
and coyote populations. Outside
the study area, populations sus-
ppected by other criteria of being
hybrids proved virtually identical
to coyote populations. This enzyme
comparison could prove useful for
monitoring populations that are
suspected of undergoing hybridiza-
tion.

Our main research effort was
devoted to the ecology and be-
behavior of free-living red wolves.
Food habits, determined from the
contents of scats, showed that
these red wolves invariably killed
animals smaller than themselves.
Leading prey were nutria (a large
aquatic rodent introduced from
South America), swamp and cot-
tontail rabbits, and cotton rats. De-
spite the numerous cattler and occa-
sional deer in the study area, we
found no remains of these larger
animals in red wolf scats through-
out the study's fifteen-month dura-

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Sheep ranching is not practiced to any extent along the upper Texas gulf coast and this is fortunate because these animals might make easy and tempting prey for the red wolf.

Home ranges averaged only seventeen square miles for our radio-equipped red wolves, far smaller than gray wolf home ranges but similar to those of most coyotes. Red wolves proved to be primarily nocturnal, even in winter, an activity pattern more typical of coyotes than of gray wolves.

Within its remaining range, the red wolf forms small, unstable social groups, an arrangement well suited for hunting small prey. Gray wolves, in contrast, usually form packs that permit them to prey upon larger animals. Sightings of up to six or seven red wolves have been reported, but the vast majority of year-round observations are of one or two.

Parasites of serious consequence flourish in the warm, damp climate of the Texas gulf coast. Serious infestations of heartworms, hookworms, tapeworms, and sarcotic mange have been found in cap-
tured red wolves. A heavy heartworm infestation can kill adult red wolves just as it can kill domestic dogs. Hookworms constitute an even greater threat because they can be transmitted to pups, killing entire litters. Mange and tapeworm, although common, pose less of a threat in terms of direct mortality.

Since heartworms are mosquito-borne and hookworms are transmitted through contact with wet soil, we suspected that a positive correlation exists between rainfall and red wolf mortality. Residents of the study area recalled a sharp increase in red wolf numbers from 1961 to 1964. Local weather records showed that these were exceptionally dry years, particularly during the spring whelping periods. Although this is only circumstantial evidence, it suggests a causal relationship between rainfall, parasitism, and red wolf mortality. It also supports the view that the gulf coast region, while providing abundant natural foods for red wolves, is ecologically marginal because of the heavy parasite burden. These parasite loads were compensated for by some favorable conditions, such as the sparse human population and an abundant food supply from the highly productive prairies and marshes.

Overall we found that the ecology and social behavior of the red wolf within its remaining range were similar to those of the coyote and generally different from those of the gray wolf. These similarities between the red wolf and the coyote may explain why the behavioral barriers against hybridization between these species were breached. The gray wolf’s strong social affiliations cause that animal to form packs that maintain distinct territories and repel intruders, thereby minimizing opportunities for breeding with outsiders. Since neither the coyote nor the red wolf has such strong group bonds, hybridization is more likely to occur.

About five years ago the U.S. Fish and Wildlife Service began developing a recovery plan for the red wolf. Curtis Carley was assigned as biologist in charge of field operations and Russel Clapper was appointed leader of the Red Wolf Recovery Team. The recovery plan consists of three interrelated strategies: maintenance of a captive breeding colony, reintroduction into areas where red wolves occurred, and curbing hybridization within the animal’s ranges.

A captive breeding colony had been established at the Point Defiance Zoo in Tacoma, Washington, and field personnel of the Fish and Wildlife Service have sent animals considered to be pure red wolves to Tacoma. Norm Winnick of the Tacoma zoo reports that in 1971 captive red wolves produced five litters totaling fourteen pups. The breeding colony could provide long-term survival insurance if else fails.

The captive breeding strategy, while a necessary last resort, has several drawbacks. High costs and limited space make it difficult to preserve a large enough gene pool. A long-term captive population may only lose many learned survival traits but also may undergo natural selection, losing critical genetic information unrelated to survival in captivity, but essential for survival in the wild. Saving
species only in a zoo is something of a tie game with extinction. Only ensuring that the red wolf can exist in the natural, free-living state can the species genuinely be preserved.

Reestablishing red wolves somewhere within their original geographic range presents a difficult critical challenge requiring cooperation between federal and state wildlife agencies, private conservators, and area residents, as well as careful selection of suitable transplant sites. Another problem involves the source of red wolves to be transplanted. Captive-reared individuals may not have the hunting skills and wariness of humans necessary to survive in a new environment. Removing wild red wolves from the gulf coast might hasten the demise of the last wild population. The hybridization threat will persist if coyotes are in the area, so sites selected for release cannot contain a competitor, which has invaded most of the southeast in recent years. Southern Florida and some islands along the Atlantic and gulf coasts are essentially coyote-free, but there may be other areas yet undiscovered. The first transplant attempt did not provide a very encouraging start.

Bull Island lies about three miles off the South Carolina coast. As part of the Cape Romain National Wildlife Refuge, it seemed a readily good site for an experimental red wolf release. After several years of planning, the Fish and Wildlife Service transported a pair of wild-caught red wolves to a holding facility at Bull Island. There they stayed for six weeks to acclimate before being radio-collared and released in December 1976. About a week the pair explored the island; then the female sud- denly swam to the mainland and was recaptured. (Later the male was also recaptured.) The Fish and Wildlife Service now believes that something frightened the male and caused her to flee the island. They are planning another introduction on Bull Island with different pair of red wolves. But small size of the island, and its proximity to the mainland, may make it difficult to hold such far-ranging animals.

Southern Florida and perhaps a coastal islands may offer suitable release sites. Everglades National Park has been suggested because protection would be automatic and no coyotes are known to occur there.

The third aspect of the red wolf recovery plan is the effort to maintain existing wild populations along the Texas and Louisiana coasts. During our 1970/1972 investigations, the wild red wolves seemed to be relatively homogeneous and robust, but even then we accounted for one apparent hybrid within the study area. Our radio tracking, incidentally, showed that this suspected hybrid regularly associated with a large male red wolf. After her death we examined her reproductive tract and found that she had been bred, presumably by her frequent companion. The Fish and Wildlife Service has since sampled wild canid populations more extensively, eastward into southwestern Louisiana. While some large, wolf-like animals are being found, the ratio of apparent hybrids to red wolves seems to be increasing rapidly.

Curtis Carley now believes that there is little hope for preserving pure red wolves within the animal's remaining range. Accordingly, the Fish and Wildlife Service is now attempting to capture the last apparently pure red wolves for inclusion in the captive breeding colony. If the tide of the coyote invasion is overwhelming and the remaining red wolves are unable to maintain their genetic integrity, then this is the only course left open. It will, however, invariably hasten the rate at which the remaining wild red wolf population is genetically swamped by the coyote.

Whenever an animal population is drastically reduced, there is danger of irretrievable loss of genetic information. The possibility that some genes will be completely lost from the population by chance alone increases as the population shrinks. If only one corner of the species' original range is left, often the case with endangered species, losses from the gene pool through genetic drift will be permanent and will occur independently of natural selection. As more genes are lost, the population's chances of adapting to future environments diminish and the threat of extinction increases.
When an entire population is lost, a large part of that species’ gene pool vanishes. When the California grizzly became extinct in 1924, the differences between that bear and other grizzlies were lost forever. If grizzlies from the northern Rocky Mountains were introduced into California and allowed to thrive, they would not assume the particular set of traits that made the original California subspecies unique.

Transplanting members of one subspecies into the geographic range of another subspecies can result in genetic mixing that permanently blurs local distinctiveness. The bison that originally inhabited Yellowstone National Park were wood or mountain bison, a subspecies morphologically and behaviorally distinct from the more numerous plains bison. A few native mountain bison survived in Yellowstone into the twentieth century. In 1902 plains bison were introduced from herds in Montana and Texas to increase the Yellowstone population. The two subspecies interbred and, although bison thrive in Yellowstone today, they are a hybrid population, genetically different from their wild ancestors.

Some population geneticists, such as Michael Smith of the Savannah River Ecology Laboratory in South Carolina, have presented evidence suggesting that the ebbs and flows in a population’s gene variability (heterozygosity) directly influence that population’s growth rates and productivity. Not all authorities agree on this interpretation, but if heterozygosity proves to play a significant role, it may someday provide important estimates of survival and recovery potentials for endangered species.

Techniques for measuring genetic variability in wild populations are indirect and somewhat crude, but they are undergoing rapid refinement. Future wildlife managers can take advantage of new technology to manage species more terms of their gene pools rather than in terms of numbers alone.

The only realistic hope for the survival of red wolves in the wild would seem to be transplanting into suitable sites outside of the current shrinking range. We hope that the U.S. Fish and Wildlife Service and various cooperative agencies are successful in finding coyote-free and otherwise suitable sites within the generally recognized former range of the red wolves, and that the animals adapt to these moves. If this does not happen, this unique North American wolf will be known to future generations as a mere vestige of a former self, surviving only in zoos dedicated to preserving vestiges of its genetic distinctiveness.
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Celestial Events

Thomas D. Nicholson

**Sun and Moon:** As December begins, the sun is moving east and drifting slowly south (relative to the equatorial plane) through the constellation Ophiuchus. On about the 18th, it crosses into Sagittarius, where, on the 21st, it arrives at the winter solstice, its most southerly position in the sky. This event marks a change in the seasons, from autumn to winter in the Northern Hemisphere.

The evening crescent moon should first appear in December on the 12th or 13th. As it waxes, it will brighten and stay in the sky later, until the night of Christmas Eve and Christmas morning, when it will be full. It will also be in conjunction with Jupiter that night, and the planet (the only bright object visible near the moon) will accompany the brilliant full moon on its high, long winter course through the skies, to give us an exceptionally beautiful Christmas Eve sky (weather permitting). Phases of the moon in December are first-quarter on the 3rd, new on the 10th, first-quarter on the 17th, full on the 25th. In early January, last-quarter is on the 2nd, new moon on the 8th, and first-quarter on the 15th.

**Stars and Planets:** With the coming of the winter constellations into our evening sky, we will find the brighter planets returning as evening stars.

Jupiter is the most prominent evening planet, brighter than any starlike object in our sky this month. It rises at about sundown in Gemini, and moves across the sky, about midway between Pollux and Castor (the twin stars of Gemini) and Aldebaran (the bright red star of Taurus), until it sets at sunrise. Mars rises some four hours after sunset, but earlier at month’s end, as it rapidly approaches opposition in January. It will also brighten rapidly and should stand out prominently among the dim stars of Cancer, as it rises high into the south in the hours past midnight. Saturn rises late in the evening near Regulus, the bright star of Leo, and will be high in the south at dawn.

December 1-2: The waning gibbous moon passes near Mars and Saturn, visible from shortly before midnight on.
December 8: Latest sunset of the year occurs.
December 10: Perigee moon occurs. Its effects will enhance the normally strong spring tides tonight and tomorrow.
December 11-13: Mercury, Saturn, and Mars become stationary with respect to the stars and begin retrograde (westerly) movement. On the 13th, the Geminid meteor shower reaches maximum. Observers may see up to 50 meteors per hour early on the 14th, perhaps half as many on the 13th and 15th.
December 21: Winter begins at 6:24 p.m., EST. Mercury is at inferior conjunction and enters the morning sky.
December 22: The weak and unreliable Ursid meteors reach maximum. Jupiter is at opposition from the sun.
December 24: The moon is at apogee. Jupiter and the moon move across the sky together.
December 28-30: The moon passes near Mars and Saturn.
January 1: The earth is at perihelion, nearest the sun.
January 5: Latest sunrise of the year occurs.
January 8: The moon is at perigee.

*Hold the Star Map so the compass direction you face is at the bottom; then match the stars in the lower half of the map with those in the sky near the horizon. The map is for 11:20 p.m. on December 1; 10:20 p.m. on December 15; 9:15 p.m. on December 31; and 8:15 p.m. on January 15; but it can also be used for an hour before and after those times.*
This is the season to be merry and to eat the now plentiful chestnuts

In America, most of the time, nuts are not a problem. We can buy almonds and walnuts, filberts and cashews—shelled, even slivered and toasted and salted if we prefer. Macadamias are available for a price year-round and ready to munch, which is a boon, for their spherical shells resist most nut-crackers (I once had to resort to a claw hammer and a flat rock). But chestnuts are not normally plentiful in this country, except now, at Christmas time.

In New York City, chestnut vendors are out on street corners with their braziers. Gourmet shops have dusted off their chestnut-roasting pans hoping to sell some to those folks with wood-burning fireplaces at home. Food editors, meanwhile, dust off their favorite recipes for chestnut dishes. And so, with all this seasonal flurry of interest in the fruit of the genus Castanea, a nutnaive person might conclude that chestnuts are a winter crop, shipped in for the holidays from California or Florida, like most other produce.

That, at any rate, was my working theory, until one spring I asked a petulant home economist (known behind her back as the Witch of Blender) why the American chestnut industry couldn’t stock the stores after Epiphany. With scorn, the W. of B. retorted: “There are no local chestnuts. They’re all imported.”

How could this be? Chestnuts (C. dentata) grow wild on this continent. That’s what the textbooks say. And as any schoolboy knows, Thomas Jefferson named chestnuts of the larger, Old World chestnut (C. sativa) onto local host trees at Monticello in 1773. By 1803, Irénée Du Pont took time out from building the industrial empire that bears his name to start commercial production of European chestnuts in Wilmington, Delaware. All appears to have gone well for Du Pont’s trees and their descendents. It was not for nothing that Henry Wadsworth Longfellow wrote, “Under the spreading chestnut tree/The village smithy stands,” when he wanted to depict a typical scene of American small-town life. Chestnuts, like their cousins in the Fagaceae family, the oaks, were typical American shade trees. The tallest rose to a magnificent eminence of 100 feet. And when their nuts fell ripe to the ground, the spiny outer covering, the involucre, or bur, would open and release the delicious, starchy nut to anyone, man or foraging pig, who could deal with the thin shell.

Around the globe, the story was similar. Corsican peasants led a life so bountiful in chestnuts that they used chestnut meats for flour in bread and porridge, in polenta, in fritters called castagnacci, in an anise-flavored cake known as pistacine, and as fodder for their pigs. So too, in the Aveyron and neighboring districts of south-central France, chestnuts were a staple. Koreans to this day consume chestnuts as we would eat potatoes. In the United States, however, the loss of chestnut abundance came too tragic close.

A tree grew in the Bronx. At the Botanical Garden. Or possibly in the Bronx Zoo. And it had become infected with a fungus brought probably, from the Orient on nursery stock. Within twenty years after the blight was discovered in 1904, this fungus, Endothia parasitica, spread throughout the entire American commercial chestnut industry, established itself in the cambium of virtually every producing tree in the land, and girdled each one—and that was the end. Spraying did not help.

Today, there is once again hope for a viable American chestnut. The chestnut blight seems to have finally been licked. A spontaneously nonpathogenic strain of E. parasitica was isolated not long ago in Italy. And recent work by Richard A. Jaynes, geneticist at the Connecticut Agricultural Experiment Station in New Haven, confirms that the new strain will convert the old, pathogenic strain out of its normally virulent state. By putting the good fungus in proximity with the old, Jaynes and his team of researchers have, in effect, cured sick trees. They discovered that a virus moves from the Italian variety to the old Oriental fungus type that neutralizes the malignant tendencies. Jaynes doesn’t know precisely how
France and IMC. are Bill State of through Zip into LLUND bother Bill -hestnut (cined ttcup eiois ji' euetic, "ole aound I 4 iail (lerican read siduous dned though ying dlad lady rcial icacy. The most luxurious commercial preparation is glazing. My lady in France once went through the arduous process of preserving and glazing whole chestnuts in syrup to make marrons glacés, but she was a sturdy sort—woman who singlehandedly declared her own daughter during the aerial bombardment of Caen in 14—and even she vowed never to bother with marrons glacés in the French—and Hungarian chestnut industries also preserve whole chestnuts as well as chestnut puree. If you push the puree, which already sweetened and ready to be, through a potato ricer and top with a mound of whipped cream, you have that elegant and very rich desert known as Mont Blanc, or the snowcapped Alp. Seekers at the ultimate revel in this line melt six ounces of semisweet chocolate and blend it into the chestnut puree, along with a quarter cup of dark rum, before icing. For many reasons—economic, aesthetic, and possibly political chestnut puree is expensive, leaves aeway for the cook with definite bias about sweetness levels, and
cedes culinary craft and the option to add artificial ingredients to a foreign factory—some people will want to start from scratch with chestnuts in the shell. This is not a simple matter. Expert opinion divides. The Larousse Gastronomique advises either (1) slotting the curved surfaces of the shells, placing them in a baking tin with a small amount of water, roasting in the oven for eight minutes, and peeling while still hot; or (2) slotting, deep-frying the chestnuts, a few at a time, for two minutes, and then peeling them as soon as possible after draining.

For her part, Marcella Hazan, author of The Classic Italian Cookbook, recommends slotting the shells all the way around the curved side, simmering in abundant water for twenty-five minutes (put the nuts into cold water and bring the water to the boil), then peeling one by one, leaving the other nuts in the hot water until you are ready to peel them. Finally, there is the utterly simple method of Lily Joss Reich (in The Viennese Pastry Cookbook), who does not slot the chestnuts at all. She simmers them in water for fifteen to twenty minutes, then extracts them one at a time and peels.

All these methods involve peeling the chestnuts while they are still quite hot. Slotted or not, the nuts become impossible to peel handily once they have cooled. The paperlike inner membrane loosens during heating but reattaches itself to the wrinkles of the nutmeat as it returns to room temperature. Slotting the nut is probably essential to prevent explosions in the oven or in hot fat. Slotting also eliminates many a burned finger since it speeds the peeling of very hot nuts no matter how they are heated. On the other hand, Mrs. Reich’s procedure works perfectly well and does not require asbestos palms (the knack of partially cooling a handful of nuts to a manageable, but not too cool, temperature for successful peeling is quickly learned). Furthermore, unslotted nuts remain ideally dry and ready for riding into flour for tortes.

Whatever method of peeling one chooses, prying loose two pounds of chestnuts from their fibrous husks is a paradigm of tedium. But it is the only way to acquire the fresh chestnuts for a corrupting and delectable array of chestnut dishes that run the gamut—quite literally—from soup to nuts. Perhaps the richest selection of non-sweet chestnut dishes in any ethnic menu comes from the Caucasus. In The Best Foods of Russia, Sonia Uvezian gives recipes for lamb soup with chestnuts, quince, and prunes (see below); quince stuffed with meat and chestnuts; and rice pilaf with lamb, dried fruits, and chestnuts.

Among less exotic cuisines, similar dishes also exist. Our own and other Western cookbooks all list some kind of fowl stuffing with chopped chestnuts as an ingredient. Hungary contributes a vegetable soup thickened with chestnut purée, heavy cream, and egg yolk. Braised chestnuts and unsweetened chestnut purée are traditional accompaniments for game nearly everywhere.

Most chestnut dishes, however, are desserts. Austria-Hungary carried chestnut baking to its highest level. Tortes, creams, sweet pâtés, and a sweet spectrum of other familiar chestnut goodies need no special introduction. France contributes an ice cream, a sort of chestnut rice pudding, cold and hot soufflés, dessert croquettes, and most elaborate of all, pastry barquettes filled with a purée of marrons glaciés, flavored with kirsch, and iced with a kirsch fondant.

Marrons, incidentally, are a special variety of large chestnut that grow one to each bur. Typical Old World chestnuts (châtaignes, in French) come three to a bur. One way or the other, they are all chestnuts and, fancy or plain sized, don’t need elaborate preparation. Scored and roasted over hot coals in a special pan or a wire basket and tossed frequently until tender, any chestnut will provide the perfect, convivial, and folkloric note to a holiday celebration. People without wood-burning fireplaces can use outdoor barbecues or even stove-top burners.

Aside from the obvious gustatory and spiritual benefits they bring, chestnuts will, according to German tradition, ward off backache if carried in one’s pocket. An American variant of this nostrum promises relief from rheumatism. The English also have endorsed the preventive powers of chestnuts, but only those chestnuts that are begged or borrowed. And it is important to remember that overindulgence in chestnuts will, by legend, thicken the blood and cause headaches. Keep this in mind when you are next pulling your chestnuts out of the fire. Don’t try to pass too many old chestnuts on your friends, either real ones or those hackneyed stories colloquially known as “old chestnuts” in American expression of unknowledge dating from about 1880. Most important of all: stay away from horse chestnuts (Aesculus hippocastanum), those lovely shade trees that bear nothing but real edibility and are, you might say, chestnuts of a different color.

Lamb Soup with Chestnuts, Quince, and Prunes

1 pound boneless lean lamb, cut into 1-inch cubes
Salt and freshly ground black pepper to taste
3 tablespoons butter
1 medium onion, finely chopped
4 cups beef stock
1 medium potato, peeled and cubed
1 small quince, peeled and cubed
½ cup dried, pitted prunes or cup fresh sour prunes
¼ pound chestnuts, shelled and peeled
⅔ cup canned chick peas, drained and rinsed
2 tablespoons clarified butter
1. Season the lamb with the salt and pepper.
2. In a heavy pot, melt the 3 tablespoons butter over moderate heat. Add the lamb and onions and sauté until browned, stirring frequently.
3. Add the stock and season to taste with salt.
4. Cover and simmer 30 minutes. Add the potato, quince, prunes and chestnuts. Cover and simmer 20 minutes. Add the chick peas and simmer, covered, about 15 minutes.
5. Taste the soup and make sure it is done. Before serving, swirl the clarified butter into the soup.

Yield: 4 servings

Raymond Sokolov is a free-lance writer whose special field of interest is the history and preparation of food.
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![The Rocky Mountain States contain 12.3% of commercial forestland.]

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That’s the bad news. The good news is this: What Operation Double Tree is doing in the rest of the country has already begun in the Rockies, on a large scale.

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In Libby, Montana, St. Regis Paper company helps make nature more prove by working within the natural system. As the young forests grow, they are thinned out to give the best room to grow. And after the next generation—a new forest—the land is carefully prepared for the next generation—new forests that will grow stronger, faster.

St. Regis raises these seedlings in its own greenhouses and nursery beds. A similar program has taken at Bonner and Plains, where Champion International has established its own nursery. Operation Double Tree is not just about growing more trees, faster, but getting more use out of every harvested tree. In Wyoming, Edward Lumber Company is using computers to analyze every log that comes into its mill to determine its best use.

Other companies like Champion, Potlatch, Kiabab, St. Regis and Southwest Forest Industries use virtually all of the wood in each and every tree they harvest. Residues from lumber and plywood manufacture, formerly considered waste, today are ground into wood chips for the paper mills.

**A Long Way To Go.**

So there is some progress with Operation Double Tree in the Rockies. And even more progress in forests all across the country. But we still have a long way to go.

On the average, industry lands grow 50 percent more wood than the lands owned by government and private individuals. Yet, even here, there's room for improvement.

Overall, the American forest is only half as productive as it could be. And this is a waste of one of our most valuable natural resources. But working together, all timber growers—private owners, industry and government—can learn to make the most productive use of our remaining commercial forests.

Industry has invested millions to make the concept a reality. But money isn’t enough.

Leaders and landowners alike must both understand the problem. And, more important, the solution.

For more information, write for our free booklet, “Managing the Great American Forest,” American Forest Institute, P.O. Box 873, Springfield, VA 22150.

*Commercial forest is that portion of the total forest which is capable of, and available for, growing trees for harvest. Parks, wilderness and primitive areas are not included.*

**Trees. The Renewable Resource.**
**Solar Magnetism**

The sun’s magnetic fields not only cause such solar phenomena as sunspots and coronal holes; they also affect the earth’s atmosphere.

The sun is quiet at present—it has been virtually without sunspots for the last few years of the sunspot minimum. I write these pages after looking through a telescope at an uninteresting sun that shows only two mealy spots. Yet there is a feeling of expectancy—the existing sunspots already have the magnetic polarity of a new eleven-year cycle. Any day now the first great outbreak of the new sunspot cycle will occur, as it did in February 1956 and July 1966. The poles of the sun still show their coronal holes, which means that the general solar magnetic field of the last sunspot cycle will dominate until enough new-cycle spots erupt to change it in their mysterious way. So we watch the grand pattern of solar magnetism continue.

There are two kinds of solar magnetic fields: a relatively weak general field, which covers the entire sun, and local sunspot magnetic fields that are much smaller—about 50,000 kilometers (30,000 miles) across—but also much more intense. The general field, like that of the earth, has a positive (or north) magnetic polarity at one solar pole and a negative (or south) polarity at the other. Sunspot fields also have dual polarity. At great distances from the sun, the effects of sunspot fields of opposite polarity cancel, leaving the general field dominant. Locally, on the solar surface, the sunspot fields are far more intense than the general field. In fact, in the long run the sunspots are the source of the general field (see “The Turbulent Sun,” November 1976 issue of *Natural History*).

Sunspot magnetic fields seem to form below the sun’s surface in an unknown way and then rise to the surface where they live for a few weeks. Spots appear in pairs or groups of plus and minus polarity. The groups often measure 50,000 km (about 30,000 miles) or more across. At heights of about 10,000 km (6,000 miles) their magnetic fields are still almost as strong as they are at the sun’s surface. If the density of the gas falls off very sharply above the surface, with the result that solar matter at the heights is dominated by the sunspot magnetic fields and is aligned along them. Conversely, lower in the atmosphere, in the photosphere (the visible surface), gas density is much higher; and when the sun has more energy than the field pushes the magnetic field around. The alignment of gas clouds is above the surface, easily visible in hydrogen-alpha pictures, indicating the direction of the local magnetic field lines of force—imaginary lines showing which way a compass would point.

As practically everyone knows, the number of sunspots varies with an eleven-year period. Although magnetic fields appear in pairs, they are not always symmetrical. Sometimes one of the magnetic poles is broken up into a weak field and shows no spots. There is only a bright region called a plage that marks the medium-strength field. Sometimes there are many spots each polarity, but there is always balance of opposite fields. In the cycle the spots first show up at higher latitudes, about 30° (never above 40°), but during the course of the cycle, spots appear in latitude belts gradually closer to the equator.

Emerging sunspot fields have
The characteristic appearance. The first thing we see when a magnetic arch rises from below is a bright arch in the chromosphere (seen in the red light of the hydrogen-$\alpha$ spectrum line). Next come dark, arched loops that trace the lines of force pushing up from below. When the loops are particularly long, little sunspots appear at their ends. The material at the top of loops is shifted toward the blue end of the spectrum, indicating upward motion. Wherever such loops intersect the sun's surface, we get a sunspot. It is thought that sunspots are dark because the strong magnetic fields inhibit the outward flow of energy and leave sunspots cooler and darker in their surroundings. The sunspots spread rapidly as the feet of arched loops rise through the atmosphere, forming extensive regions of opposite magnetic polarity about 900 km apart. In time the sunspots break up and disappear, leaving behind these magnetic fields in weaker form. These fields migrate toward the poles of rotation and eventually form the weak general field of the solar magnetic field.

Somewhere, instead of dissipating energy by mixing and canceling with the magnetic fields of other sunspot groups, these fields segregate into very large loops of one polarity known as polar regions. If the general magnetic field of the sun has plus polarity in the northern hemisphere, then almost all the spot fields in that hemisphere have plus polarity leading each other group as the sun rotates from east to west and a minus polarity following. In the southern hemisphere, the situation is reversed. As the unipolar regions fade, the minus polarity spreads to

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102

the north pole of rotation, and the time of sunspot maximum, a new field cancels out the old general solar field. Gradually the new magnetic polarity builds up at the north pole until, a few years before the sunspot minimum, a new general magnetic field is in place at the pole of rotation, with minus magnetic field in the north, plus in the south, and the leading star having the same magnetic sign as the new polar field.

After eleven years, the sunspots have come and gone, and left behind a reversed solar magnetic field. The process then begins anew, but with minus magnetic polarity at the north pole of rotation and the leading sunspots in the northern hemisphere now having minus polarity. After twenty-two years we are back where started, with plus field at the north pole and minus field at the south pole.

The solar magnetic cycle is thus a twenty-two-year cycle. Interestingly enough, that is also the period of droughts in the Great Plains, which have occurred at alternate sunspot minima of 19, 1954, and 1976, as well as earlier. Something in the earth’s atmosphere is apparently connected with the polarity of the overall solar magnetic field, rather than with number of sunspots (although other much weaker effects in weather, such as abrupt changes in large-scale storm patterns, may be connected with sunspot activity.

The leading sunspot of a pain group always has the same magnetic polarity as that of the general field in that hemisphere. An inexorable force seems to propel the spots to the proper polar region. Sometimes when a sunspot group of the wrong magnetic polarity rises to the sun’s surface, the “unplaced” sunspots muscle their way into their proper place through surrounding magnetic fields, twisting and straining the fields producing many solar flares. The greatest solar flares, such as that of August 1972, have been produced in such reversed polarity regions.

We do not understand how a twenty-two-year solar magnetic cycle is produced, but some good ideas have been set forth. In one model the lines of magnetic force running through the inside of the
In from pole to pole are wound up like the differential rotation of the sun. (The sun, being a sphere of gas, is not a solid body, is thought to rotate faster at the equator than the poles: once every 26 days at the former; once every 29 days or more at the latter, for an average rotation period of 27 days.) As the magnetic field is wound up, dotted lines of force appear, which float to the surface as sunspots. The winding up would take first at higher latitudes, so the first spots appear there.

Another model carried this picture further and showed that old magnetic fields would diffuse outward from the old sunspot groups. Because of a tiny tilt of the arches, their lines of force away from the east and west, the magnetic field of the leading spot group moves equatorward, where it cancels the fields from the other hemisphere, while the field of the following spot drifts to the pole, where it produces the new polar field.

These models make some sense because they have big problems. First, differential solar rotation winds the magnetic fields, the rotation itself slows down. Actually, the presence of differential rotation is somewhat doubtful. Sunspots and measurements of the photosphere show differential rotation, but large-scale surface magnetic patterns do not. Nor is the magnetic field seen to diffuse outward from the active solar regions. In fact, our magnetic observations of the surface are too crude to show the long-term poleward diffusion of magnetic fields or the cancellation of the polar field, so it can't be sure that this model is valid.

One of the most interesting sets of solar magnetism is the existence of coronal holes. A long time ago it was noticed that, although the outer atmosphere, or corona, could be seen during total eclipses as a pearly halo around the sun, it sometimes had missing patches. At sunspot minimum the corona was absent at the poles, while at sunspot maximum it was visible all around the edge of the sun. When X-ray pictures of the corona became available, we could see the corona against the solar disk without an eclipse. Although the disk is far brighter in ordinary light than the corona, it is about 10 times brighter at X-rays.

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glad adj 1 characterized by or expressing the mood of happiness; joyful
syn happy, joyful, lighthearted
rel delighted, gratified, pleased, rejoiced, tickled;
blithe, exhilarated, jovial, jolly, merry, gleeful;
hilarious, mirthful
idiom filled with (or full of) delight
con blue, dejected, depressed, downcast, melancholy;
despondent, dispirited, heavyhearted, sadhearted, unhappy;
forlorn, joyless, sorrowful, woeful
ant sad
2 full of brightness and cheerfulness <a glad spring morning>
syn bright, cheerful, cheery, radiant
rel beaming, sparkling; beautiful, genial, pleasant
con dark, dim, dull, gloomy, somber

 gladen vb syn PLEASE 2, arride, embellish
light, the corona’s million degree temperature makes it a potent source of X-rays. Long-term X-ray observations of coronal holes have enabled us to watch their evolution.

It has been found that coronal holes occur wherever magnetic field lines stretch far outward from the solar surface and are swept away by the solar wind, so that they do not return directly to another point on the sun. These “open” field lines permit hot coronal material to escape into space as high-speed streams in the solar wind. Because the general field, which dominates at sunspot minimum, is simple and open at the poles, we get polar coronal holes.

Besides the polar holes, several extensive equatorial coronal holes were observed in X-rays by Skylab. In each case the hole followed a large-scale magnetic pattern—sometimes extending north-south nearly from pole to pole—in which the magnetic field flowed out into interplanetary space. Studies of the solar wind and geomagnetism showed that a series of high-speed interplanetary streams accompanied by geomagnetic disturbances was associated with these coronal holes. These disturbances showed up every twenty-seven days, each time the hole rotated with the sun to face the earth.

Geomagnetic storms always occur during the last few years of the sunspot-cycle maximum and into the minimum, as though, with the sunspots gone, the solar magnetic field is getting itself reorganized and simplified for the next cycle and forming extensive coronal holes in the process. Unfortunately our instruments are not good enough to pick out all these large-scale magnetic patterns, but the coronal holes trace their locations for us. The patterns are so extensive and long lasting that they are enabling us to test whether the sun does in fact rotate faster at the equator than at the poles.

The largest coronal hole observed by Skylab lasted seven rotations, or 189 days, and stretched from the north pole to forty degrees south latitude. If the sun really rotates 10 percent faster at the equator than at the poles, as indicated by some measurements, we would expect to have seen the coronal hole wrap nearly once around the sun in this period—instead, the equatorial part gained only two degrees. This indicates either that there is no differential rotation that the large-scale magnetic field are unaffected by it and flow around the solar surface like continental plates.

The equatorial coronal holes are usually low-latitude extensions of the polar holes. It has been suggested that the sun’s magnetic field is like the two stitched halves of a baseball, at least for part of the cycle, with the north field distributed around the surface in the longitude sectors and the south field protruding upward in between. It is further suggested these field patterns are blown outward the earth by the solar wind so that as the sun rotates, the east passes from one solar polarity to the other within a few hours.

It has been found that when the interplanetary magnetic field blowing from the sun has a component that is parallel to the earth’s magnetic field and then reverses its polarity (which may happen as the “baseball stitch” sweep across the earth), great changes are brought about in the outer reaches of the earth’s field. Geomagnetic substorms take place at such times, accompanied by auroras, other atmospheric effects and even power outages. This may be a clue to the way in which the earth’s polarity, and not just the magnitude, of the solar magnetic field can play a role in geomagnetic disturbances. The sun’s magnetic field returns to the same sign every twenty-two years even though the magnitude of the field peaks every eleven years.

For a long time we have been puzzled by the fact that only cyclic of twenty-two years can be found in the terrestrial climate in such phenomena as the twenty-two-year Great Plains droughts and in temperature-sensitive isotope ratios in tree rings. The key to the puzzle of some of the earth’s changing climatic rhythms may thus lie in the solar magnetic cycle.

Harold Zirin teaches astrophysics at the California Institute of Technology in Pasadena and is the Big Bear Solar Observatory, one of the Hale Observatories.
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The Elusive Marsh Birds

Rails of the World, by S. Dillon Ripley, with 41 paintings by J. Fenwick Lansdowne. David R. Godine, Publisher, $75.00; 406 pp.

The tradition of the lavish and costly treatise dealing with a single family of birds is more than a century old. It first flourished during the latter half of the nineteenth century, when—for the edification and delight of wealthy ‘subscribers’—ornithologists, artists, and publishers vied in producing large and handsome volumes, with hand-colored plates, in strictly limited editions. Many of these monographs have soared in value in recent years, thanks to the general affluence that brings more and more collectors into the market, and to the less savory demands of the ‘breakers,’ those art dealers who bid against the bibliophiles with the intent of retailing the color plates, page by page. In recent catalogs we have seen D.G. Elliott’s monograph on the hornbills quoted at $2,450; Wyatt and Sharpe’s swallows at $3,150; and Gould’s toucans at $3,750. And some run much higher.

Because of recent tremendous strides in color reproduction, the days of the hand-colored plates are over, but today there is no shortage of serious ornithologists devoting themselves to single avian families, with fine artists to supply the portraiture. Such a book is Ripley’s Rails of the World.

There are, of course, a few basic requirements for the creation of a successful monograph. First, there is the family itself. It must be interesting and varied, and the rails are that. Secretive and elusive, inhabitants of swamps, marshes, bogs, and deep forests where they can quickly conceal themselves, many of them are still mysteries to us. This is a family a number of whose members are now threatened, endangered, or recently extinct, and almost the entire family is vulnerable, as the wetlands of the world are drained and filled. And as Ripley says, ‘What a paradox; to fly poorly, to occur so widely, and to evolve flightlessness so easily!’ A fascinating family indeed.

Other requirements would seem to include a dedicated scientist willing to spend years of research in field and study on a single-minded quest; additional months of effort and no little talent on the part of an artist; and finally, a publisher willing to give time, capital, and tender loving care to every detail of the final product.

All these elements are happily combined in this beautiful book. S. Dillon Ripley, already a noted ornithologist and author, and present the innovative director of the Smithsonian Institution, has brought the broad scholarship in the true Renaissance man to this splendid work. J. Fenwick Lansdowne, one of today’s leading artists, has painted the portraits with his usual accuracy and fineness to detail; their reproductions on the pages of this royal quarto volume in a multicolor process are striking.

In plan, the book is standard. Brief chapters (but in this case stimulating and spiced with literary and historical allusions) dwell on a rail family: its distribution, history, habits, and voice. By pages 33 we are into the species treatments, which vary in length, depending on current knowledge, and to races, and 2,000 words of text to two color plates, one map, and one species treated. Except for the ‘unknowns,’ the species treatments are under the headings of system, other names, description, measurements, distribution, status...
and remarks. Ripley is a "lumper": he has reduced the number of genera to 18, and of species to 129, of which 6 are definitely extinct and 2 probably so. Birders will note that the king rail is demoted to subspecific rank (of the clapper). Minus one for the life list! Without getting into a taxonomic discussion here, I have one minor quibble. I dislike the elision of modifiers into single words: whitewinged coot, rustyflanked crake, graynecked wood rail should be joined with marital hyphens, not merged into illicit cohabitation. An extensive bibliography at the end of the work brings the literature through 1974. An important and valuable addition to the monograph is Storrs L. Olson’s synopsis of the fossil rails. Because many of these rails inhabit swamps and bogs, a rather rich fossil avifauna has been discovered. His treatment, with many photographs, covers 38 species and lists 20 more, some as yet undescribed. Included is a lengthy discussion of the mysterious Aphanapteryx bonasia, the Mauritius hen. Most fossils date from the last 500 years, although the family traces back at least to the lower Eocene. Finally, it should be said that this book, produced in Italy, is truly a tactile and visual pleasure. Its fine paper, its elegant typography, its rich color printing, artistic format, and binding—every detail gives evidence of painstaking devotion to the best in book production today. There is almost a sensual pleasure in turning the pages. At $75 the price seems high, but the standard edition is only 4,600 copies, so the publisher is taking considerable risk. But win or lose, all concern with the creation of this exemplary monograph are to be thanked and congratulated.

It's not unusual for visitors to see Margaret lead here and there in The American Museum of Natural History. It has been some base for the famous anthropologist for most of her distinguished career. Here see her in the Discovery Room, a new area in the Museum where children are encouraged to learn by the feel and shape of different objects.

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Our funds, like those of many other cultural institutions, have been cut back considerably. To keep our doors open to eager minds and our collections in circulation, we need the support of businesses and individuals in New York and elsewhere. Your contribution to The American Museum of Natural History will help us to continue providing answers to questions about life on earth from the beginning and from now on.
Additional Reading

Nymphs of Nantucket (p. 10)
The first report on Nantucket’s human babesiosis problem, “Babesiosis in a Massachusetts Resort,” by K. A. Western et al., appeared in the New England Journal of Medicine, vol. 283 (1970), pp. 854–56. Since then, literature on this subject has appeared in other scientific journals. For example, A. Spielman, in “Human Babesiosis on Nantucket Island: Transmission by Nymphal Ixodes Ticks,” American Journal of Tropical Medicine and Hygiene, vol. 25 (1976), pp. 784–81, demonstrated that ticks transmit the disease in one stage of their development after having been infected in a different stage. An ecological study of the island to determine which animals are involved in transmitting the disease has been reported by G. R. Healy et al. in Science, vol. 192 (1976), pp. 479–80 (“Human Babesiosis: Reservoir of Infection on Nantucket Island”). The most recent article is “Human Babesiosis on Nantucket Island,” by T. K. Ruebush et al., in Annals of Internal Medicine, vol. 86 (1977), pp. 6–9.

Madagascar (p. 26)
Virginia Thompson and Richard Adloff have collaborated on a number of books about former French colonies; one of them, The Malagasy Republic: Madagascar Today (Stanford: Stanford University Press, 1965, $15.00), is the first encyclopedic survey in English to describe the political, economic, and cultural developments on Madagascar since the end of World War II. It does so with text, photographs, a glossary, an index, and a bibliography.

Placing the Dead: Tombs, Ancestral Villages, and Kinship Organization in Madagascar, by Maurice Bloch (London: Seminar Press, 1971), is based on the author’s fieldwork with 5,000 Merina people in Imerina, a mountainous region in the heart of Madagascar. Emphasized in this monograph is his characterization of Merina society as “extremely diverse,” in which ties with ancestral villages and habits are balanced against the practicalities of everyday life.

Eucalyptus Bark (p. 36)

Færoe Islands (p. 40)
The Atlantic Islands: A Study of the Færoe Life and Scene (London: Routledge and Kegan Paul, Ltd., 1970, $13.25) was written by Kenneth Williamson, a naturalist whose familiarity with the islands is such that he is able to give us lists of mammals and birds, discuss local customs at length, draw and explain the use of Færoese tools and farm buildings, and provide a glossary of Færoese words and place names, as well as an extensive bibliography.

Two books by Hedin Bronner, Three Faroese Novelists: Jørgen Frantz Jacobsen, Hedin Bru, and William Heinzen (New York: Twayne, 1973) and Faroese Short Stories (New York: Twayne, 1972) reflect the literary world’s interest in the Færoes Islands. These books trace the history of Færoese literature and give the reader a sample of works translated into English. Bronner’s works include bibliographies and are useful for providing a quick historical sketch of the Færoes. A new journal, The Færoese Review, is the only English-language periodical that deals solely with the Færoes Islands. It is obtainable from the editor, E. Thomsen, P. O. Box 160, Tórshavn, Færoes Islands, for $2.50 per copy.

China’s Mariners (p. 48)
Children of the Yellow Earth: Studies in Prehistoric China, by Johan Gunnar Andersson (Cambridge: MIT Press, 1973, $4.95 in paperback), provides an interesting background for the study of prehistoric China. Translated from Swedish by Dr. E. Classen, it was originally published in 1934. More recent is Kwang-Chih Chang’s Archaeology of Ancient China (New Haven: Yale University Press, 1971, $6.95 in paper). In The Southern Expansion of the Chinese People (New York: Praeger Publications, 1972), C. P. Fitzgerald follows the flow of Chinese presence and influence to the south, both by sea and by land, in historic times. C. G. Simkin, who served as an economic consultant in Asia and became interested in the history of prehistoric peoples of the world, has written The Traditional Trade of Asia (London: Oxford University Press, 1968, $10.50). Intended for the general reader, the book contains maps, a chronological chart, photographs, and bibliography. An all-inclusive work is the 3-volume An Ancient Economic History, by Fritz M. Heichelheim (Leiden: A. W. Sijthoff’s Uitgeversmaatschappij, 1958–1970). These massive tomes are available to the reader through interlibrary loan or in larger libraries, summarize our knowledge of early world-wide trade. Finally, for a Western viewpoint of Chinese trade, the journals are a discovery of Asia, from Pho to Marco Polo and beyond to ninetenth-century emperors, are excerpted in Silks, Spices, and Empire, Owen and Eleanor Lattimore (New York: Dell Publishing Co., $9.95 paperback).


Orchids (p. 64)
Fritz Hamer’s two-volume Los Orquideas de El Salvador (San Salvador: Ministerio de Educación, 1974, $40.00) is the first complete work on the Orchidaceae of this country, describes 2 species in Spanish, English, and German. Each species has its own illustration; many are in color. Fourteen additional species have been found in Salvador since the publication of these volumes. Edward Ayensu’s “Beautiful Gamblers of the Biosphere” in October 1974 issue of Natural History (pp. 35–45) discusses the dispersal of the orchid family throughout the world. In the following “Evolution of Orchids and Bees,” appears in “Evolution of Animals and Plants,” edited by Lawrence G. Gilbert and Peter Raven (Austin: University of Texas Press, 1975), and relates male bees and orchids and the scents they produce.

Flamings (p. 72)
Leslie Brown, a government offi
Kenya, became so enchanted with the question of flamingo behavior that six years he spent every nonworking moment following them to the alkaline lakes of Kenya and Tanganyika, flying a small plane when necessary to check them in their most inaccessible feeding and feeding grounds. The result of his work is *The Mystery of the Flamingos*, which is illustrated with numerous black-and-white photographs (London: Country Life, Ltd., 1959). Yet Keir and Nicole Duplaix-Hall are editors of *Flamingos*, a collection of lectures resulting from the International Flamingo Symposium held in Slimbridge, England, in 1973. This symposium, sponsored by the International Union for Bird Preservation, provided information on the conservation, biology, physiology, captivity, and taxonomy of the flamingo. The volume includes excellent photographs, maps, and several pages of bibliography (Berkhamsted: T. and A. D. Poyser, Ltd., 1975).


Wolves (p. 80)


Riley and McBride describe steps taken by the federal government in the early 1970s to protect the red wolf and its habitat at that time.


Pamela Haas

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**Announcements**

**We've Been Here 100 Years**, a photography exhibit to commemorate the hundredth anniversary of the Museum will open December 8 in the Hall of Northwest Coast Indians on the first floor of the Museum. The photographs will depict the bustle of opening day on December 22, 1877, as well as the farms, tenements, and stores that surrounded the original Museum building. The exhibit will run through January.

The traditional pre-Hispanic Music of the Andes will be performed in the Museum's auditorium at 3:00 p.m. on Sunday, December 4, by Tahuantinsuyo, a musical group consisting of Pepe Santana of Ecuador, Guillermo Guerrero of Peru, and Jorge Link of Argentina. The group, which uses more than fourteen traditional instruments of the South American highlands, also performed in the Museum during the "Songs for a Summer Night" in August. This concert is free to those who have paid the Museum entrance fee.

The Roosevelt Rotunda will be a child's wonderland until January 6 as hundreds of origami animals, plants, and even minerals shimmer on the Museum's twenty-five-foot artificial Christmas Tree. Every year for the past five years, Museum volunteers have added to the collection of traditional Japanese folded-paper ornaments, until now there are 1,500—including pandas, crabs, spiders, reptiles, squirrels, and even a dog complete with fleas! A dove of peace will crown the tree and, adding to the magic, a giant mobile depicting the sun, moon, and stars will be suspended from the ceiling.

The December event of the month, Azurite and Gold Crystals will go on display in the Roosevelt Rotunda, beginning December 21. The exhibit, on loan from the Newmont Mining Corporation, includes a matrix specimen of azurite crystals of unsurpassed quality. Valued at $250,000, it was unearthed at Tsumeb, South-West Africa in 1958, where, it is rumored, a trader conspired to sell it to a hotel keeper for $1,000, a remuneration that, it is said, was used for the payment of a small debt. The Newmont Mining Corporation recognized the value, however, and arranged for its recovery. Another feature of the exhibit will be a large specimen of crystalized gold, also valued at $250,000, which was taken from a mud-filled fissure at Empire Gold Mine in Grass Valley, California.

Peru's Golden Treasures, the largest exhibit of Peruvian gold ever to appear in this country, will remain on display through January 1, 1978, in Gallery 77 on the first floor of the Museum.

The Museum's new Hall of Beetles and Amphibians, one of the world's most complete exhibits of these animals, opened on Friday, November 18. The hall is located on the third floor of the Museum.

The Ballad of the Bremen Town Musicians, a light opera for children under twelve, will be performed by the Carolina Center for Music and the Arts, December 27 to 30 at 11:00, 1:30, and 3:00 in the Museum's auditorium. Admission is free to those who have paid the Museum entrance fee.

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Egg nog wasn't the favorite cup of cheer in pre-revolutionary Russia. The package has changed considerably since 1818 but the contents are a version of Peter Smirnoff's original formula (note the No. 27 on the label). 

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