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You of island paradises aplenty in the United States and Canada of art colonies (artists search for picturesque locations where costs are low), of areas with almost a perfect climate or with flowers on the side. Here are the real U.S.A.-brand Shangri-Lan made for the man or woman who’s had enough of crowds. Here, too, are unspoiled seacoast, fine fishing, unlike islands, and dozens of others just about perfect for your retirement or vacation at some of the lowest prices you’ve ever paid for the comme-comeover advantages. That’s all the States and Canada, and for good measure you also read about the low

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Natural History
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THE JOURNAL OF THE AMERICAN MUSEUM OF NATURAL HISTORY

Vol. LXIX JANUARY 1960 No. 1

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COVER: One of the paintings in the Mexican Codex Fejérváry, depicting mythical game between a human and a lizard deity, was adapted for this month's cover. Symbols representing names of weekdays surround the figure. At top right, is "day-sign" for water, below it is the glyph for reed. At left, dots represent number of days, and, in the angle they form, is the glyph for motion.

The cover and drawings for an article on Mesoamerican ball games (p. 48) were rendered by Hans Guggenheim. He has painted interpretations, now owned by the Guatemalan government, of the Popol Vuh, celebrated Mayan manuscript.

The American Museum is open to the public without charge every day in the year. It is your support, through membership and contributions, that makes this possible. The Museum is equally in need of such support for its work in the fields of research, education, and exhibition.

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Lamaist Buddha

An exquisite example of a Tibetan altar piece, this gilded Buddha represents The Buddha of Infinite Light. It is about 6” high on a black wood base, and it is an authentic reproduction in Alabastone of the original in the museum's Tibetan collection.

$10.75 postpaid

Boar

Reduced in size from a famous Florentine landmark, this boar is a fine example of classical sculpture. Mounted on a walnut base, it stands about 6” high. It is cast in Alabastone and finished to resemble the bronze original. A truly handsome addition to any shelf or mantelpiece.

$10.75 postpaid

The World of Jewel Stones

by M. Weinstein. 430 pp. An indispensable reference book, a jeweler's guide, and a feast of good reading for the lover of precious and semi precious stones. It is illustrated with 14 color plates and many more black and white photos, some from the museum's own collection. Chapters on cutting, identifying, buying and prospecting for gemstones.

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The Mammals of North America, by F. Raymond Hall and Keith R. Kelso. Ronald, $8.50; 1,083 pp., 2 vols., indexed; 553 figs., 500 maps.

Occasionally, a single book in some particular field of natural history emerges as a major event. Such a volume might offer an important new theory, or demonstrate that some widely held belief is no longer tenable. Or it could collect the whole of our knowledge in some particular branch of natural history and try to present this wealth of material simply and fully. A work of this kind—detailed, well documented and complete—can be a historic event in its field. The Mammals of North America is such a book. It should be stressed at once that the authors of this monumental compilation have contributed far more than a new checklist. Their two-volume work does, it is true, constitute a checklist of all the kinds of mammals living from Panama northward in the New World. But into this framework Hall and Kelso have, with a frugal eye for space, packed a great deal of information about these animals as well. The authors clearly believe that what one can learn about any animal remains a bit meaningless until one can know what that animal is; indeed, that the means for knowing the correct identity of a particular mammal are an inescapable foundation for knowing, or doing, anything else about that mammal. Accordingly, they attempt to provide, for example, keys for identifying each species of mammal, and have prodigiously compiled five hundred maps on which the known geographic ranges of the species are shown. To cite one seemingly trivial, but telling, example, no other book in print offers the beachcomber—or the scientist—such an array of drawings of the skulls of porpoises, dolphins, and whales that might be found, half-buried in the sands, on any North American shore.

All in all, Hall and Kelso's The Mammals of North America makes a major contribution to biology by its immense scope, thoroughness, and completeness. For the medical entomologist, the game manager, or the ecologist who wants primarily to identify the mammal with which he is dealing, such a contribution is clearly invaluable. The need of such specialists for one authoritative compendium on which to depend for identification, names, and ranges is superfluous. But more generally, this is the outstanding book of its time in North American mammalogy. No other North American fauna of the living mammals approaches it; no recent mammal fauna of any other continent or faunal region approaches it; and many years will probably pass before another book appears to replace it.

Joseph Curtis Moore, The American Museum

Insect Migration, by C. B. Williams. Macmillan; $6.00; 235 pp., illus.

The well-known migrations of certain mammals, birds, and fishes are fascinating, intriguing, and perplexing. Less well known, but equally important, are the migrations of the winged lepidopterous insects, the butterflies and moths, many of which fly hundreds of miles over land and water with amazing constancy of direction. Their flights are here comprehensively chronicled by the British entomologist C. B. Williams, who surveys their activities and compiles excellently records from all over the world, lists points of departure, flight paths, and final destination.

Unfortunately, nothing more is done with these data, which challenge the investigator to analyze and interpret the significance of the adaptations of the organism. A few ideas are suggested about how environmental conditions, such as wind, temperature, and light influence migrations; yet, in the final analysis, there is no consistency in response to these various situations among different species. Some obviously respond, others do not, so the environmental factors cited are not wholly explained.

What, then, are the other factors? Here, the author fails to utilize all the evidence available from other migratory and non-migratory species. Physiology and the behavioral evidence of insects' sensitivity to various stimuli—even if the effects do not fly—might have suggested some mechanisms used by migratory butterflies. A more thorough exploration of early environmental conditions might also have given clues about response stimuli and about the factors which initiate migrations. For example, in locusts, conditions of early environment give rise to either migratory or solitary species, depending on the population density. A survey of early development and surrounding conditions might lead to further insight into the problem.

Dr. Williams compares migratory birds with migratory butterflies. This useful, but the factors involved in both migrations are not necessarily similar to those of insects. The sensory-response systems of each group are unique to the group, and even though the phenomenon is called migration in both cases, it should not imply that the same biological systems operate. Similarly misleading is the title of the book, as only

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other deals with types of migrant insects other than lepidoptera. Notably missing are references to the migratory patterns of army ants.

The last chapters are devoted to the various techniques of studying migration, by Dr. Williams, and to an account of his own experiences in studying the movements of the tree-trunk borer, a species of army ant. Dr. Williams hopes to encourage entomologists to record and analyze their observations to appropriate areas of study.

EVELYN SHAW
The American Museum

JOURNAL, by Raymond B. Cowles, University of California Press, $6.00, pp., illus.

Historically accounts of Africa are exceptional, but the author of Zulu has added a new dimension to this story. Born in Natal, of American parents, he received his early education in Natal and attended college in the United States, spending two additional years in Zanzibar before he began his teaching career at the University of California at Los Angeles in 1927. Sporadic visits to the region over recent decades have sharpened his awareness of the changes taking place there. These, in essence, are the theme of the book, and they are noted with a poignant nostalgia; we can never again see the country as Cowles saw it barely a generation ago.

Interestingly, the author comes to grips with problems arising from the misuse and over-exploitation of the resources. A natural wilderness is being invaded and threatened by increasing demands. In the maintenance of wilderness areas, we are faced with a problem that must be solved in perpetuity without including, as a goal, the fauna, the kind of man who was most active in destroying precisely the things we seek to preserve? When posing such problems, Cowles' writing is a model of clear, active, positive prose that he uses as a naturalist to set the book's tone: warm, generous.

CHARLES M. BOGETT
The American Museum

ROAD TO MAN, by Herbert Wendt, Doubleday, $5.95; 431 pp., illus.

This is another of those epic journeys up the evolutionary ladder, with the added aim of showing that man is a creature of nature, like any other organism, that the creatures forming this interest in each other. Not all skeletons are labeled with modern criteria. Books like this are not always perfect, and the present book is no exception. In addition, the book has been able to discuss only a few examples under each heading, with the result that the text may seem a bit dry and a bit hurried--more like a report than a sustained narrative. As a whole, said, Wendt writes with warmth and sympathy; his book is both informative and interesting, and it is very well suited to readers with photographs.

Mountains in the Sea, by Martin Holdgate, St. Martin's, $5.50; 222 pp., illus.

The story, told by one of its leaders, of a scientific expedition to Gough Island, in the South Atlantic. The book, which is written with modesty, should prove fascinating to those interested in the still undisturbed regions of the earth. It begins with an account of the scientists' stay on Tristan da Cunha, 230 miles to the northwest of Gough Island, and describes that island and its people in some detail. Moving on to uninhabited Gough Island for a six months' stay, the expedition surveyed, bored into the rocks, and recorded bird, seal, and plant populations in spirit, the reader gathers of intelligence, patience, and enthusiasm.

Northwest to Fortune, by Vilhjalmur Stefansson. Duell, Sloan and Pearce, $6.00; 356 pp., illus.

This thorough, studious account, will recommend itself to all those interested in the history of exploration, as well as in the Arctic region, a place which is often seen on one side of the world. The distinguished author has used materials from many sources, including some thoroughly absorbing journals of eighteenth and nineteenth-century explorers in the northern reaches of Canada. He gives a full sense of the scope of these and other explorations, and the quest, as Stefansson relates it here, has a real grandeur.

The Last Paradise, by Helmut Handrick. Chilton, $12.50; 158 pp., illus.

In a world increasingly dominated by the will of man--translated by man into the will of God, Life, or Scientific Ascendency--there is an inclination in some quarters to look upon nature as it were unreal--subject, therefore, to romantic fancy. The Last Paradise yields to this inclination--appropriately so, since the book concerns a relatively untouched area, a private estate in the middle of the industrial Ruhr Valley. And the result--as with perhaps all the provinces of paradise--is the same feeling of unreality: we are on the outside looking in. Despite this drawback, or perhaps because of it, the book is written with fervor and has a wealth of handsome color photographs.

The Fossil Book, by Carroll Lane Fenton and Mildred Adams Fenton. Doubleday, $12.50; 482 pp., illus.

This is probably the most commodious volume on the subject of fossils now available to the general reader. There is scarcely a page that lacks illustration, which is sometimes in color, and the subject is explored in a direct and well-organized manner. Very little is left out that might contribute to an elementary education pleasantly gained.

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THE LANDSCAPES

America's largest and next-to-newest state is a land of startling contrasts and beauty

By Thomas M. Griffiths

WHEN THE SUMMIT of Mount St. Elias was sighted from the Gulf of Alaska on July 16, 1741, by the lookout on board Vitus Bering's tiny vessel, the "Saint Paul," a historic discovery was made for Western man. Bering could not appreciate his discovery; he was ill. He saw only the great difficulties of the return trip to Kamchatka. The naturalist on board, G. W. Steller, reports Bering's comment in part: "We think now we have accomplished everything, and many go about greatly inflated, but they do not consider where we have reached land, how far we are from home, and what may yet happen; who knows but that perhaps trade winds may arise, which may prevent us from returning? We do not know this country; nor are we provided with supplies for a wintering."

Perhaps some foreboding over his impending death was already coloring Bering's outlook: subsequent visitors to the scene have usually taken a more cheerful view. Actually, Bering never saw more than the barest margin of his discovery. Only gradually did his successors in discovery spell out the magnificent extent of the land that he regarded with apprehension.

Could Bering have looked beyond the 18,000-foot mountain, whose summit shimmered across the vacant miles of stormy sea, he would have seen a vast, sprawling territory without a counterpart anywhere in the world, truly a land of superlatives. To sum them up: The highest summit in North America—20,300-foot Mount McKinley—vaults into the brittle sky above the central Alaskan lowland; some of the rainiest slopes on this continent rise from the furred coast of southeastern Alaska; stations in Alaska's interior consistently report the continent's lowest winter temperatures; the whole northern half of the area is underlaid by permanently frozen ground. Even the fauna and flora join in this spirit of superlatives. The world's largest carnivore, the Alaskan brown bear, inhabits Kodiak Island and the nearby Alaskan mainland. Cabbages as big as washtubs and strawberries as big as teacups are regularly recorded. Because of the far northern latitude, the shortness of the growing season is offset by eighteen to twenty-four hours of sunlight during the summer months.

Now this exotic Territory has become our largest state. Not to be outdone by Texas, Alaskan "tall tales" bear a stamp of their own. A few years ago, during the height of summer, an Alaskan mosquito is said to have landed on one of the runways at Fairbanks' Ladd Air Force Base and gratefully taken on five hundred gallons of gas before the ground crew discovered they were not refueling a medium-range bomber. The collection of legends goes on endlessly, as professional Texans are learning to their occasional chagrin.

What sort of land is Alaska? Above all it has variety. From the "banana belt" of the southeast panhandle (map, pp. 8, 9) to the frigid coastal plain in the north, it runs a gamut from a temperate, West Coast marine climate to that of the arctic tundra. In surface features, too, it shows a similar, wide variety.

Here is the northwest terminus of the North American continent. It contains the partly hidden framework of the continent's western structure—if indeed that framework stops at the strait and sea that bear Vitus Bering's name and does not emerge again beyond these waters to continue into Siberia. Within Alaska's borders are found four major physiographic

Mount St. Elias towers over Malaspina Glacier, to left in the photo opposite.
Alaska is divided into four physiographic provinces— from south to north, the Pacific Mountain System, the Interior Hills and River Valleys, the Brooks Range, and the Arctic Coastal Plain. Each of these four provinces contains some feature of adjacent continental areas.
Dr. Griffiths, an associate professor in the geography department of the University of Denver, has traveled often in Alaska, and took several of the photographs that illustrate the article here. He is currently spending the academic year in Sweden, under a National Science Foundation grant.

provinces. Each is an extension of a region that is recognized farther south and east in Canada and the United States proper. From south to north, these provinces are: the Pacific Mountain System, the Interior Hills and River Valleys, the Brooks Range, and the Arctic Coastal Plain.

The first of these provinces—the Pacific Mountain System—corresponds to the Cascade-Coast Range-Sierra Nevada Complex that distinguishes the states of Washington, Oregon, and California. The second—the Interior Hills and River Valleys—have their counterpart in the intermontane valleys of British Columbia, the Columbia Plateau of Washington, Oregon, Idaho, and the Basin and Range province of Nevada. The third—the Brooks Range—is the northwest extension of our continent's Rocky Mountain System. Finally, the Arctic Coastal Plain has its physiographic (if not its climatic) counterpart in the plains of Kansas and the Gulf coastal plain of Texas.

For reasons of structure, regional geology, and the morphology of the land, the physiographer divides these four major areas into subregions and provinces. For our purposes, the fourfold framework will suffice, although we will occasionally refer to some smaller features.

The Pacific Mountain System is a complex province. It contains both the highest mountains in Alaska and an active volcanic belt. These two parts are of quite different natures. The Aleutian chain—which serves as a sort of fine-meshed barrier between the Bering Sea and the North Pacific—contains some eighty recognizable volcanoes, of which at least forty-seven are active. Like a fragmented tongue, the Aleutians flick out westward in a 1,600-mile arc toward the Asiatic mainland. Here, on a basement of young rocks formed only yesterday from white-hot ash and molten lava, stands a procession of smoking cones and steaming calderas. This is a very much alive sector of
Glacier, in Yakutat Bay area of southeast Alaska, is seen above, with Mt. Hubbard rising almost 15,000 feet in background. The glacier's snout protrudes into the sea, and ice blocks constantly break off to drift as bergs.

Penny River, on north side of Mount Stanley, has left this braided stream channel. Streams, formed by water that drains from glacier's snout, are easily blocked by silt that glacier's erosion amasses and must often change course.
mount McKinley—at 20,300 feet, the highest summit in North America—is here seen from northeast, at juncture of two glaciers. Pacific Mountain System, of which it forms part, is southernmost of Alaska's physiographic province.

the terrestrial ring of fire that girdles the great Pacific Basin from the Philippines to Tierra del Fuego.

Along this weak, border zone, the earth’s interior fires can—and often do—burst to the surface. At the root of the Alaska Peninsula in 1912, for example, the cone of the Katmai Volcano collapsed into a void that had been its base. The void was produced by the expulsion of over two and one-half cubic miles of ash and pumice from the adjacent volcanic cone, Novarupta. The finest particles from the great cloud produced by this eruption floated completely around the earth. Today, a glaciologist—whether in Greenland or in Antarctica—can recognize by the particles of ash in his drill cores the layer that fell as snow in 1912; and that has since been buried and consolidated into glacial ice under an overburden of forty-seven years' accumulation.

Mount Spurr, at the very root of the Alaska Peninsula, marks the eastern terminus of the Aleutian volcanic chain. The rugged peaks of the Alaska Range to the north, and the less rugged mountains of the Kenai Peninsula to the south, clamp shut here on the root of the Aleutians like the jaws of a great vise. Farther east, the two jaws hinge in a complex mountain zone, which trends east and southeast—into Canada and eventually into the U.S., where it extends into Washington, Oregon, and California.

This region does not contain a single mountain range (as is essentially true of the Aleutian chain), but rather a whole series of overlapping mountain and valley structures, which make up a zone widening at some points to well over two hundred miles and, at others, narrowing to less than fifty. The overlapping mountain groups have been carved from intensely folded sedimentary and metamorphic rocks, into which have been injected batholithic masses of granite and similar igneous intrusions.

In many cases, these granitic masses serve as the resistant cores from which water and ice have carved the highest peaks. For example, the great mass of Mount McKinley (as we have noted, North America's highest peak) has been sculptured from such a mass of pink and gray granite, which—during Mesozoic times—was injected from below into the dark, pre-Cambrian rocks of the Alaska Range. Today the exposures of this single granite batholith cover some one hundred and eighty square miles. Yet, at the very summit of the mountain are found somber remnants of the old host rocks into which the granite was injected. At few places in the world is such a great vertical thickness of granite exposed to view, no less than fifteen thousand feet of the south and southwest flanks of this enormous mountain.

On the steep slopes of this mountain zone, scores of alpine glaciers have their source. These work away the summit ridges and cawa lethargically down the valleys to end their careers either in a moraine choked jumble at the foot of the high peaks or calving their bergs into the sea. Few regions in the world offer more spectacular examples of mountain glaciation (photograph, above).

Only reluctantly is the great barrier of the Pacific Mountain System broken by routes to Alaska’s vast interior. The Aleutian chain, because of narrow passages and foul weather along the meeting place of cold arctic and warm Pacific waters, has always hindered navigation. Only the Susit
Typical of physiographic zone of Interior and River Valleys is seen in this view from valley of upper Kuskokwim River—with Yukon, one of the two main rivers serving country of low hills and tree-dotted plains.
Flood plain west of Fairbanks is cut by small river that flows toward main stream. Disposition of stands of spruce and birch accent meander scars left by channels that the river has dug during past centuries, as its course shifted.

River-Cook Inlet lowland, the Copper River lowland, and the narrow pass at the head of Lynn Canal (above Skagway and Haines) offer grudging access to the regions beyond.

In 1898, the Klondike miners who struggled over the Chilkoot and White passes into the interior negotiated the barrier at a point so formidable as to be a measure of their gold-lust.

Once beyond the Pacific Mountain System, the visitor reaches the province of Interior Hills and River Valleys. Pictures of this terrain are less likely to grace the cover of Alaskan travel folders than are the alpine scenes from farther south. Yet there is a subdued dignity about the region that comes in large part from its sheer expanse. Here, two great arctic rivers—the Yukon and Kuskwim—gather together hundreds of tributaries, not only from the northern flanks of the Pacific Mountain Sy-

Pingos are made by expansion of water when it freezes in the saturated subsoil.
but also from the south flanks of the Brooks Range, and sluggishly slither their accumulated burden to the Bering Sea. Along the way, they meander over spruce-birch-alder flood plains and sometimes boldly through a ridge line.

The hills are subdued for the most part, although here and there an upland zone has been fretted by glaciers. Seldom do elevations exceed twenty-five hundred feet. Even at that height, the summits are above the tree line, and are clothed in a green brown carpet of tundra and frost- and rock. Timber is to be found in the river bottoms and along the lower slopes of the hills.

Well over half of this area is underlaid by permafrost. The soil is shallow and saturated with water during the brief summer thaw. Spruce, the dominant tree type in this area, is well adapted to these severe winters, shallow soils, and short growing seasons; it is not uncommon to find a four-hundred-year-old spruce trunk that shows well over two hundred annual rings.

During the long winter, the great rivers and the uncounted, curving sloughs occupy cut-off meander scars—solid. In pioneer days, the main rivers served as obstacle-free ways for the dog-team driver. In summer, the ice melts slowly, but eventually “goes out” in a great flood of scumbling cakes that sometimes overtops the banks—plowing out timber and anything else in their way. For several months the ice is gone. Then, the air, motor boat, and, in years of hard winter, the paddle wheel steamer—ply the rivers feverishly, laying in next winter's supplies. Today, the airplane largely, although by no means completely, supplanted these older modes of transport, winter and summer.

Because summer travel in pioneer days was almost impossible except following the major streams, a high percentage of interior Alaska's towns are situated on navigable streams. If the search for gold carried a prospector away from this line of communication, the streamside settlement still remained as his return point of contact. Many a road in interior Alaska still runs a short way in on a river dock (or, today, airstrip) mine or placer deposit that has no other connection with the outside.

Today, as one flies over this immense, interior lowland of Alaska, its
Exposed layers of sea-deposited sediment, *below*, bespeak upheaval that raised Brooks Range late in Cretaceous period. Brooks Range, *above*, is seen in view from south. North* continuation of the Rocky Mountain chain, this range for features are immediately apparent.

Most prominent are the great rivers swinging in loops over their wide, timbered flood plains. Between them swell the bare, tundra-crowned highlands. One cannot but be impressed by the great, empty spaces of primitive solitude; the occasional settlement seems lost in a sea of sloughs, lakes, pond river courses, and the seemingly endless expanse of black spruce forest.

In some sections, a flight of half an hour will show no evidence of man. This is the region where winter's grip is felt most severely. On clear, cold, winter days, when the thermometer hovers near −60°F., moisture in a breath rustles down one's parka front in a fall of clear crystals. Smoke rises for the first thirty feet from a chimney without
Geological structure of Brooks Range includes shales, sandstones, and, below, limestones tightly compressed.

A perfect cast from the chimney's mold. Men do not exert themselves, lest they breathe hard and strain their lungs. On moonlit nights, the howl of a wolf raises hackles, answered by sled-dog clamor, and echoes for five miles. This is the Alaska of romance and fable.

To the north of this interior province lies the Brooks Range (photo, top), named for Alfred H. Brooks, pioneer geologist in the territory and former chief of the Alaskan Branch of the United States Geological Survey. This northwestern terminus of the Rocky Mountain System extends across the full width of Alaska from Canada to the Arctic Ocean.

Before the airplane made it possible to vault over mountains, the
Brooks Range was a sharp barrier and zone of demarcation between Alaska's true arctic environment on the north and the subarctic to the south. The northernmost trees on the North American continent stop up the streams and the south flanks of the Brooks Range and were stopped cold there by a climatic barrier. To the north of the range stretches the treeless tundra of Arctic, until at last it ends at the rim of the Arctic Ocean.

The zone was also an ethnic barrier. South of the range, forest Indians eked out a precarious subsistence in the interior lowland. North of the range, the coastal Eskimo won hard living on the shores of the ocean. Between them lay a dividing line both physiographic and cultural. The first Geological Survey parties to penetrate the Brooks barrier crossed it with great difficulty, taking much of the short summer season for mountain crossing and returning civilization aboard some chance wandering vessel met along the Arctic Coast. Seldom did Eskimo meet interior Indian, except by chance during some extended hunting foray.

Today, planes cross the Brooks Range regularly and land frequently within its confines. A group of coast Eskimos have migrated southward to the Chandler Lake and Anaktuvuk Pass region. Geologic and topographic field crews are tracing the physical structure of the range, while botanists and zoologists are examining in detail its flora and fauna. No longer can the region be classed as unexplored; the probing eye of the aerial camera has examined every foot of terrain. Yet it still remains one of the most inaccessible sections of the Western Hemisphere, and its physical framework today is unchanged by man from what it was when V. Bering discovered Alaska.

In many respects, the Brooks Range is different from the Pacific Mountain System to the south. Some of these differences stem from the fact that the Brooks Range seems not to have been as heavily glaciated as the Pacific system. The highest summit in the Brooks Range is below 10,000 feet. Being farther from the North Pacific, this region receives less precipitation. Spared the consequent, intense glacial scouring, many parts, it appears more subarctic than does its southern neighbor.
KTUVUK Pass, seen from south, is principal low-level through the central Brooks Range, linking John River on south with the Colville to the north. It has always been a main avenue of travel, both for migrant game and for man.

NOLDER Lake, looking south into heart of Brooks Range, supplies glacial valley scoured in mountains. It is dammed partly by material left by glacial action, although glaciers affected Brooks Range less than Pacific mountains to south.
A second basic difference is apparent in the nature of the underlying rocks and the structure of the range. In the geologic past, the present site of the Brooks Range was a vast, shallow seaway in which great thicknesses of sedimentary shale, sandstones, and limestones were deposited. Later, these sediments were compressed, folded, and squeezed into the present uplift from which the features of the range were carved by the erosion of water and ice.

The folding was intense during the mountain-building period; in many places it is possible to see tight folds exposed by subsequent erosion on the sides of valleys and ridges (photos, pp. 16, 17). The surface coating of soil, tundra, weathered rock, snow, and ice is thinner here than to the south, allowing the range's geological bones to lie bare, particularly during the brief arctic summer.

Beyond the northern foothills of the Brooks Range, the Arctic Coastal Plain stretches northward to the ocean. In no sense is this a featureless plain. Although it is alm
it is crossed by many rivers, of which the Colville is the most prominent. Close to the range, these streams cut narrow flood plains, lined with low bluffs, into the imperceptibly sloping surface of the plain. Close to the ocean, these streams meander aimlessly through a maze of sloughs, bay lakes, and lagoons that are slightly above the level of the Arctic Ocean. The sedimentary rocks that underlie the Coastal Plain have been gently folded in the past into domes, anticlines, and anticlines. These folded structures have trapped oil, which is now actively being sought.

Most of the Arctic Coast, from the Prince of Wales north to Point Barrow and from there east to Baranov Point, is guarded by shore sand bars. Many of the sluggish streams empty into shallow lagoons behind these barriers. Shore currents are frequently responsible for curving spits. During four weeks (occasionally more) in July and August, a narrow lead of water opens up between these bars and the drifting, harried pack ice. Along this narrow outlet, whaling ships once made
their way east as far as the delta of Canada's Mackenzie River.

The entire Arctic Coastal Plain, the Brooks Range, and well over half of the Interior Lowland are underlaid by permafrost. This condition, characteristic of all the lands that rim the Arctic Ocean Basin, sometimes extends far south into the continents. In these regions, all soil moisture and ground water is frozen to great depths—sometimes hundreds of feet. In summer, the long hours of sunshine raise the temperature enough to melt a surface layer ranging from an inch or two to several feet.

This surface thaw leads to complications. All the melt water must be carried away by surface drainage and, in extremely flat areas, such drainage may be inadequate. From the air, these regions look absolutely waterlogged during the height of the brief summer's melt season.

Still another group of phenomena are found in permafrost regions. Seasonal freezing and thawing of the "active layer" subjects the surface to alternating expansion and contraction. These forces create a bewildering diversity of stone nets, stripes, ice polygons, frost wedges, icing mounds, pingos, and frost-heave features. Building foundations settle unevenly, roads buckle or load up with ice mounds. Nature exacts a high price from those who would live and work in permafrost regions.

This, then, is Alaska's land—a sprawling, diversified frontier; a land of incomparably beautiful alpine peaks, of smoking volcanoes, mighty rivers, tundra-clothed hills, frost-marked plains, warped mountains and ice-scoured coasts. The modern traveler is sorry that Vitus Bering did not see more of the land that he discovered. Had he lived until today, at Cape Prince of Wales, he could have looked across the strait that he once navigated and now bears his name, toward the eastward-reaching tip of Asia. Across this bridge—or another nearby to the south—trickled the thread of Paleolithic and Neolithic men who peopled the New World. (In 1741, Bering unknowingly was re-tracing a route long since forgotten.)

He could have tarried of a midsummer evening at an Eskimo hunting camp beside Chandler Lake on the north flank of the Brooks Range to watch a successful hunter bring in a mountain sheep's haunch back to camp, or a fisherman in a kayak losing thirty-inch trout from a gill net, or a people from antiquity now equipped with repeating rifles, modern fishing gear, and in airplane contact with a distant world.

On a midwinter night, he could have traced the frozen sweep of the Yukon among snow-crusted hills where the headwaters flow, curtains of blue, green, and pink aurora rippled from horizon to horizon like a magician's ban真心.

He could have paused by Birk Creek, to let his gaze leap up, step by step for thousands of feet, to the top of Mount McKinley—one of the world's truly great mountain walls.

Confronted with even these small segments of Alaska's seemingly unlimited store of physical grandeur, Vitus Bering's somber views of 1741 might very well have been modified.
YELLOWSTONE Quake

The Montana temblor has made changes in this beloved National Park

By John O'Reilly

On the Night of August 17, at 11:35 P.M., a shift in the earth's deep under the Rocky Mountains red an earthquake that split a 300-foot mountain, sending millions of tons of rock down into the valley of the Madison River in southern Montana. The giant slide of the river trapped many campers, taking a toll of lives, with nineteen more persons missing and presumed dead.

And the immediate concern for life was not at first realized. The earthquake was not a local phenomenon but actually affected 550,000 square miles of the surging area. It was, in fact, the most severe earthquake ever recorded in the United States.

While the avalanche roared down the valley of the Madison, ever-changing in the earth's face, taking place in other mountain sections near the quake's epicenter. The greatest of these occurred at Yellowstone National Park, first most spectacular of America's outdoor playgrounds. Following the earthquake, roads were kept open to visitors while heavy road-building machines were put to moving sands of tons of earth and rock. October, 1959, fragmentary reports appeared, indicating there had been major alterations in this famous American vacation land. Photographer Richard Meek and I went to Yellowstone that month to find out what effects the earthquake had on this historic area.

On our very first day in the park, it dawned on me that Meek and I were witnessing the kind of convulsion, which, eons ago, created the wonders that millions of tourists have so long admired. The face of the earth was being reshaped at Yellowstone—more drastically, perhaps, than at any time in recorded United States history.

Dozens of mountains had sent massive rock slides down into the canyons. Boulders as big as automobiles had bounced and rolled like marbles down the mountainsides, cutting swaths through the forests, tumbling across roads and into streams. Highways had cracked and shifted. The underground plumbing system of one of the world's greatest thermal regions had been fouled and twisted, causing all sorts of changes in the spouting, boiling hot geysers.

And the upheaval was still going on. Brand-new geysers were sending boiling mud and steam into the air. Old thermal springs were bursting into renewed activity, and a few geysers, active for years, had ceased to spout. Occasional plumes of steam, rising from the forest, testified to the continued activity that was changing the park before our eyes.

Here are some of the major disruptions that happened during the initial shock, the major aftershocks and the lesser tremors that are still occurring as the mountains gradually adjust themselves to the new fractures in the earth's crust:

Sapphire Pool, in Biscuit Basin, a clear, blue pool that boiled over periodically before the quake suddenly became violently active and now explodes at irregular intervals to send columns of boiling water 175 feet in the air, with clouds of steam rising several hundred feet higher.

Grand Geyser, formerly one of the most spectacular in the park, erupted exactly once after the quake and has not erupted since.

Sylvan Springs, a mile and a half off the highway, produced a brand-new mud volcano on a wooded slope. Its crater is 75 by 50 feet and it churns and pumps continually, throwing out gray, soupy mud and bouncing the tree trunks that fall into it up and down as if they were twigs.

Fountain Paintpot, in the Lower Geyser Basin, demonstrates greatly increased thermal activity. The Paintpot is bubbling and boiling, with new fumaroles sending out smoke and white plumes emerging from cracks in the nearby parking lot.

Mount Holmes, a 10,500-foot mountain, lost part of its northeast face in a rockslide 3,000 feet high and a mile wide at the bottom.

Secret Valley, between Madison River and Norris, disgorge a mud slide which came down the mountain and spread out through the forest.

Obsidian Cliff, between Mammoth and Norris, gave way, covering the road with fragments of volcanic glass. Its new face, jagged and shiny, now glistens brightly in the sunlight.

These are only a few of the more dramatic results of the quake. In the course of our week-long stay, traveling round the park and hiking into the woods with some of the first surveying parties to penetrate these areas, we saw many more.

The most astonishing of the new developments is the activity of Sapphire Pool. Before the quake, the water in this 30-foot crater was a beautiful blue. During its miniature eruptions it sent small quantities of water gurgling out among odd-shaped limestone deposits called "biscuits."

It continued this activity for several weeks after the initial quake. Then, following one of the aftershocks on September 5, the pool began erupting violently. In seventy-two major eruptions at about two-hour intervals it sent boiling water 75 to 150 feet high. This action stopped on September 13, and the pool subsided to a violent boiling until September 29. At 6:35 P.M. on that date another tremor occurred and Sapphire went into action again. Since then it has continued to erupt at intervals of thirty minutes to one and a half hours.

During my investigation of earthquake results in the park I spent parts of three days watching the fascinating behavior of Sapphire. The great limestone mound in which the

YELLOWSTONE Park's facade alters as a result of avalanches, new geysers and mud reveals earthquake's violence.
Mr. O'Reilly and Mr. Meek went to Yellowstone some weeks ago on behalf of Sports Illustrated to see what damage the August, 1959, earthquake had done. Their report is reprinted here through the courtesy of Sports Illustrated (copyright, Time, Inc.)

crater is located was scoured by the hot floods of successive eruptions. "These limestone biscuits around the pool used to be a beautiful green," explained Robert N. McIntyre, the chief park naturalist. "Now you can see that the big eruptions have burned them to a dull gray and the limestone layers over the whole mound are being flaked off" (photo, p. 28).

Steam rose from the water as the pool slowly filled before each major outbreak. I watched a number of these but none was as great as the eruption I was to see at 3 P.M. on October 18.

At that time I was standing about seventy-five feet from the rim of the crater, a distance that had proved safe during previous eruptions. Meek had his camera set up considerably farther away. There was an eruption of some thirty feet and then Sapphire remained quiet for three-quarters of an hour. Water bubbled in the crater and small plumes of steam rose over the rim. Suddenly there was a loud sound—a great thump. The ground vibrated enough to buckle my knees. Then the whole pool seemed to rise, with jets of water shooting high into the sky. A wall of boiling water rolled directly toward me.

Feet got the better of curiosity. I turned and started sprinting down a path of cinders that had been put there for closer access to the pool. I could hear the hissing wall of water close behind. Glancing skyward I could see nothing but white steam. Looking down as I ran I saw fingers of bubbling water boiling up onto the cinder path from either side. Running this gauntlet, I at last reached the safety of a boardwalk.

Breathless, I turned and looked back. The entire mound was awash with hot water. It covered places that had not been covered by previous eruptions. It cascaded in sizzling waterfalls into the craters of other thermal pools and it was still steam ing when it washed into the Firehole River 100 yards away. The eruption had sent water jets at least 175 feet into the air—probably higher.
Before quake, mild thermal activity characterized bright clay of the Fountain Paintpot in Lower Geyser Basin, above.

Limestone "biscuits" in Sapphire Pool before quake, above, were shadowed in clear, blue water that boiled periodically.

After quake, Paintpot area is greatly enlarged, above, with new fumaroles bubbling and smoking with fierce violence.

Twisted and burned rock mirrors new activity. Pool erupts violently, above, sending clouds of steam skyward.
George D. Marler, the park naturalist who has made a two-year study of the park’s thermal basins, told me that in previous eruptions Sapphire had thrown out thirty to fifty tons of water each time. This eruption obviously threw out a good deal more.

McIntyre and his aides are keeping a chart of the pool’s surges and by next spring expect to have wooden walks established at a safe distance for visitors. If Sapphire continues its violent activity, it will be one of the prime attractions of the park.

Another day we joined Ranger Naturalists Robert Alan Melbe and Richard Frisbee on a hike to see what had happened at Sylvan Springs, a thermal basin some distance from the road. After walking for a mile and a half through the woods and across a marshy meadow, we came to a small valley. It was a place, the park men said, that had shown some activity before. Now it looked like an illustration for Dante’s Inferno.

On one slope of the valley a small cone belched up gray, steaming mud. Near it was another cone which was filled with boiling, pale-greenish paste. From both sides of the valley sulfurous fumes issued from rock fissures. At one level spot bright-yellow water boiled in a circular pool. Up near the head of the valley, clouds of steam rose from other pools.

As we climbed a ridge, we could see massive clouds rising from the forest. Making our way through the trees, we came upon a violent mud geyser that had not existed before the quake. Large trees had fallen into a hole seventy-five by fifty feet, their roots and limbs tangled and steaming. As the pool rose and fell with a pumping action, the mass of trees went up and down with it. Trees around the pool were covered with gray mud thrown there by previous bursts. It was evident that more trees would topple into the caldron as the heaving action ate away the banks. We named this brand-new, spectacular steamer “The Mudslinger.”

Miraculously, all these particular changes in the face of nature occurred without loss of human life, despite the fact that there were 13,000 visitors in the park the night the earth began to move. Superintendent Lemuel A. Garrison attributed this good fortune to two things: the fact that the earthquake occurred late at night when...
不变的震后，老忠实依旧按时运作。照片位于页面顶部是1890年代拍摄的，下图显示了老忠实现在的样子。

公园道路空空荡荡，其他的公园人员在安抚惊恐的游客，平息初起的恐慌并清理道路，为成千上万的游客做好准备。有一个被扭伤脚踝的女性，在混乱的夜间冲刺中扭伤的。

“没有恐慌”，加里森说，“我们感到有点痒，但这是一个欣赏自然的机会。”

许多人睡觉时以为发生了事情，但醒来时以为是熊在打门寻找食物。一个公园的自然学家坚持说他去赶熊并说“赶熊去门廊。”之后，很明显，熊和人们一起离开了。

“当工作人员认为滑坡阻塞道路时，就在卡斯卡德斯的火洞河找到了一只被夹在岩石下的熊。”麦克尔特尔说，这只熊在岩石下呆了八天。他们移动了巨大的石头，才把一只倒下的树干放进去。熊爬上去就跑了。我敢肯定他在逃命。

最初，有些著名的溪流在公园里会受到地震的影响。来自霍尔姆斯山的地震，包括加德纳河、格雷林溪、鸭溪，都呈黄色，现在正在清理，不管鱼是否受影响，直到明年春天才会知道。

马迪森河迅速清理，大鳟鱼可见于其水中。我访问了一些区域，滑坡已推倒了许多树木。麦克尔特尔解释说，他们担心这个巨大的枯木因为昆虫的侵蚀而影响树木，而一个林业官员正在做一项木材损毁的调查。

超级助长加里森和公园的其他官员都将地震视为自然的干扰，但不是所有的。
After a careful analysis we have placed the damage to roads, buildings, and other man-made installations in the park at 
200,000," Garrison said. "We wanted to put it too high because we taxpayers, too. The public 

appraisal resulting from the quake some erroneous reports that came first have cost us about 200,000 dollars who would have come to the 

park if the earthquake had not occurred. On the other hand, it is the 

price of our national parks to instill nature to the public. The results 

of this earthquake give us plenty 

opportunities to interpret nature in 

one of its most violent moods."

Slides have been cleared 

from the roads and highway 

bridges are being made in the interest 

of safety, but beside the roads 

scars have been left untouched 

at next summer's visitors may 

see the effects of an earthquake at 

hand. McIntyre is in charge of a 

group of ranger naturalists who will 

stay as far into the winter as possible 

to survey the changes in thermal 

activity. Many of these changes will 

subjects for interpretive lectures 

by ranger naturalists. 

New as a result of the thermal studies 

new walks for visitors have been 

added and the locations of others 

being staked out at safe distances 

from the enlarged geysers. In some 

instances, the walks cannot be located 

next spring, when the geysers 

ceased their erratic 

behavior and settled down into a new 

rhythmic routine. 

Park facilities are now closed 

to the winter. Next May, when the 

park reopens, the buildings will have 

been repaired, the walks through the 

natural areas will have been rearranged. 

the park will be ready for the season with added attractions.
Unperturbed survivor, American bison stands silhouetted against vapors in vicinity of Old Faithful. Bears and other animals fled region during earthquake, and trout may have been affected, although this will not be known until...
Horsetails and Club Mosses

By E. Laurence Palmer

In his "campanula" Liberty Hyde Bailey wrote:

"And often when I've toiled with men
Or passed my day with plans and pen
Or fled afar on starry seas,
I join the camp of moths and bees
And wander by the minty pools
To sedge and fern and campanules."

He concludes with:

"There are two worlds that I know full well—
The world of men and petal bell."

In no place in this verse does Bailey refer to the subject of this insert but he does propose a frame of mind that would be useful if there is to be an interest in horsetails and club mosses.

Broadly speaking, our modern economy is so tied to this group of plants, academically, it is so challenging, and historically, the antiquity of the group is so great that the opportunities for rich experiences are so frequent and varied they should not be neglected. Alice in her Wonderland experienced the thrills of changing her size. Bailey in his "Campanula" found relief in entering a realm of tempered fantasy. Sit down on a natural bed of club mosses or in a "jungle" of horsetails and let your imagination carry you back in time to when the diameter of horsetail stems was measured in feet rather than in fractions of an inch.
This may take you back possibly 300 million years, but when you get there you will find more reality than Alice could ever show you and what you would find has significance in understanding much of the coal and fuels that turn the wheels of our modern industry and give us heat, light, power, everyday gadgets, and probably the very ink used in printing these words.

The horsetails and club mosses belong to a group of plants that includes also the ferns, the quillworts, the water ferns and so on. They are neither "hosses" nor mosses but belong to a historically significant group that lived contemporarily with some of the most phenomenal changes in life that the world has ever seen. The lycopods to which the club mosses belong reached unusual development in the Carboniferous period, when in some areas the dominant tree, Lepidodendron, soared over a hundred feet into the air, supported by trunks whose fossil remains can be seen today in Illinois coal mines where they measure over two feet in diameter. It may seem to be a far cry from a club moss in a modern Christmas wreath to another club moss 300 feet underground in an Illinois coal mine but the story is there. One of my most distressing experiences in World War I was to be forced as a goby at the Great Lakes Training Station to break up the finest specimen I had ever seen of one of these fossils and shovel it into a furnace to heat an unoccupied barracks. Had I known nothing of the story of that stump I might have been happier, but I have never regretted knowing what I was doing in that case.

Many of the readers of this page will have walked through patches of club mosses in the autumn and stirred up great clouds of spore dust. Others may have seen the fleshy stems of field horsetails in spring and noted the clouds of spores that come from them when they are jarred. Given an opportunity, all of these spores are capable of germinating and forming new plants. Obviously, there is not enough room on the earth for this to happen. If we select a hypothetical club moss spore we will find that if it falls on suitable territory it may develop into a structure known as a gametophyte. This means that it bears gametes or sex elements. Depending on the species, that gametophyte may develop into a wrinkled, fleshy structure or possibly into a carrot-shaped body. Sometimes these bodies serve as hosts for rootlike fungi which help supply the gametophyte with some of its needs. It may take as much as three years for the spore to merely germinate, and after it gets started it may take as much as fifteen years for the gametophyte to reach maturity, so don't form the opinion that you can grow all of these things in a single season, though there are some species in which this is possible.

It is common in the club mosses for the gametophyte to bear both male and female sex organs on the same plant, and since these can be only a millimeter apart and another plant may be inches, feet, or miles away it is rather certain what the ancestry of a new generation will be. This does not lead to the production of much variation, and we do not find the variation as comparable to that in organisms in which one parent comes from one side of the earth and the other from the opposite side, as is eminently possible in many other plants and in many animals, including ourselves.

In the horsetails, it often happens that a spore will develop a gametophyte that bears only organs that produce male sex cells, while another spore may develop a gametophyte that produces only female sex organs.

Offhand, this might sound promising but examine few horsetail spores under even a low-power microscope to see what happens. Each spore develops what looks like a set of springs and these hook on what ever may be near. The chances are good that even before the spore leaves the parent plant it has hooked itself to a spore from the same plant. Even though they produce a structure that yields sperms and the others produce a structure that bears eggs, the chances of another plant crashing the family tree are decided limited. Under these circumstances, it is no wonder that horsetails of a given species or club mosses of a given species vary little from generation to generation or that they have not varied fundamentally since 300 million years ago, when coal was being made. Studying our horsetails and club mosses of today may help us to understand those of millions of years ago, just as studying the ones of millions of years ago may help us understand those of today. To have a 300 million-year perspective with which to work is helpful in some things but possibly a bit disturbing in others. This, however, makes life more interesting.

The horsetails and club mosses of today more closely resemble the horsetails and club mosses of the Carboniferous than the horse of today resembles his ancestors of his antiquity. Horses date back a history some fifty million years while the horsetail may go back six times as far. The horses have changed more in their fifty million years than have the horsetails in six times as long. In all probability it is more
ely that the horsetails will continue on the earth after the last horse has vanished.

If we go on with our life history of a club moss or horsetail beyond the fertilized-egg stage, we will find the plants developing as we watch them. At first, the developing club moss may resemble a common haircap moss, but what we see in the haircap moss bears true sex cells and is a gametophyte, while what we see in the club moss develops spores, not sex cells, as an androecium. The conspicuous part of a club moss then sporophytic while the conspicuous part of a haircap moss is gametophytic. Botanists consider that plants which the sporophyte is the most conspicuous may be more recent and higher in the evolutionary scale than those in which the gametophyte is more dent. For this reason we cannot so logically group the mosses with the club mosses as we can group the club mosses with the horsetails. Should we elect to use the common name moss as a basis for our groupings, we would find in our category of the mosses Irish moss, which is an alga, reindeer moss, which is a fungus and an alga, pincushion moss, which is a true moss, Spanish moss, which is a flowering plant, and even some animals that are known as moss animals and are not plants at all. Truly, the word moss suggests a very loose classification, if it represents any at all.

*YOU* acquaint yourself with the horsetails and club mosses by any means you may notice that most universally they live at or close to the surface of the earth. You will notice that many of them develop long branching structures that form nets or webs over the surface of the earth or just beneath it. There is a bit in this habit. When you realize how easy it is to lose soil to be blown or washed from one place to another at the surface, you may get some idea of the valuable these plants are in anchoring soil and preventing wind or water erosion. Remember too that erosion of which we hear so much may be dangerous, not only because of the soil that is removed but because of the fact that loose soil may pile up in a waterway, on a field, or somewhere else where it is not wanted. You may have noticed how frequently the best stands of horsetail are to be found on raw, bare, railroad embankments. Dig down into such soil as you find there and notice how quickly you find horizontal roots, which serve as an ideal anchoring net that holds the bank in place, protects the embankment from losing low spots.

ORDINARILY we do not think of the club mosses and horsetails as playing an important role in wildlife management. If you read through the tabular material on the horsetails, you will find that some constitute a favored food, particularly of muskrats and mink-tailed deer. Club mosses are not commonly listed as being of forage value to wildlife, but opossums have been known to eat them. If they escaped the craw of the opossum they might well be about the only living thing with such a record.

A person who has hunted rabbits, pheasants, and similar small game recognizes that many of these horsetails and club mosses have superior value as cover to which the game can escape. A rabbit that can save its life by dashing into a patch of field horsetail may live to father some more rabbits and keep up the game supply for another year. These days we hear much of the importance of ecology in natural history, that is, of the relation of organisms to their environment. If we examine the ecology of the different species of club mosses and horsetails, we will find that in one form or another they may be found in almost any type of habitat. Some favor dry, exposed areas. Some do well in deep, moist forests. Many like dry sand, while others do well in flooded areas or even out in standing water. The soil or the water in which they grow may be neutral, acid, or alkaline, so, unless man has interfered, these plants may be found in almost any place and, since many are evergreen, at any time of the year.

You may notice when you begin studying horsetails and club mosses more closely that they cannot always survive competition from other plants, even though they can survive soil conditions that are too poor for other plants. Again let us think back that 300 million years and you would find a world in which there were no competitive grasses, a world in which whatever forests there were did not have trees that shed their leaves. It probably was a world in which great areas were bare and completely destitute of plants and, of course, of animals. To these bare areas our horsetails and club mosses could move just as today they occupy bare soil in many places.

THE chances are excellent that if you can develop an interest in these groups in which there are few species you may become something of a local authority on them. The chances are superior that, if you learn to know these plants well, you will have a much better understanding of the natural history of the past than if you depend on dinosaur stamps or models as a source of information. You may get a real feeling for the world as it was 300 million years ago and genuinely appreciate of such plants, whose ancestry extends back through that length of time. Truly the horsetails and club mosses are worth knowing.
| **FIELD HORSETAIL**  
*Equisetum arvense* | **MEADOW HORSETAIL**  
*Equisetum pratense* | **WOOD HORSETAIL**  
*Equisetum sylvaticum* | **MARSH HORSETAIL**  
*Equisetum palustre* |
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<td>Vegetative stems to 20-inches high, or decum- bent. Crowded or single, annual, green, hollow; two surrounding rows of tubes, which equal number of external ridges—may be 6—14. Outer surface rough. At joints appear sheaths with sharp-pointed teeth. Branches, if present, solid, 3—4 angled, arising in whorls at joints, the lowermost usually being the longest.</td>
<td>Stems of 3 types, the sterile or vegetative, the fertile, and the fertile that may become sterile. Sterile stem may become 2 feet high or more, is unusually slender, pale greenish, with 8—20 grooves, smooth below but rougher above. Branches are whorled, to over 5-inches long, slender, 3-angled. Rootstock is deep, black, wiry, horizontal.</td>
<td>Sterile vegetative stems appear after the fertile stems. Vegetative stems, and in a few instances, the fertile, are 3—feet high, slender, with 12—18 grooves separated by mildly roughened ridges. Lower joints do not bear branches but the upper ones yield whorls of slender, feathery, branched branches, the lowermost up to 6-inches long, horizontal, drooping at the tips. Stem hollow by over one-half diameter.</td>
<td>Stems may or may not bear cones. Height is usually 2½ feet. Erect, prostrate, or spreading, on floating or rooting shoots. 7—10 ridges, wide band of pores in furrows. Noza sheaths widen into a Central cavity about 1/2 stem diameter. Prostrate or branched or unbranched, with lower the longer, making somewhat flat, topped shape, slender branched and 5—plus angled branches.</td>
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<td>Family Equisetaceae with but one genus, which includes about 25 species and many forms or varieties of which we show one. This species ranges through northern North America, Europe, and Asia, and ranges south in North America through most of the United States, but usually relatively rare in southern border states or in their southern portions.</td>
<td>Family Equisetaceae. Genetically closely related to field and wood horsetails, Range of this species is decidedly northern. It occurs from Alaska to Newfoundland, and south to New Brunswick, New York, Iowa, North Dakota, Montana, and southern British Columbia. It is also to be found in Europe and in Asia at about the same latitudes.</td>
<td>Family Equisetaceae. This species close to the field, the meadow, and the marsh horsetails in that each has cones borne on special stalks, like that of the field, the marsh, and the swamp horsetails, lacks evergreen stems and buds, and appears in late July, August and early September. It is found in Europe, Asia, and America—ranging from the Arctic Circle north to the Rocky Mountains and east to the Atlantic.</td>
<td>This is a species rangine from Asia south to Oregon and around the globe at about that latitude. It shows many forms recognized, based largely on variation in vegetative types including growth, foliage, form, stiffness, and arrangement. United States range extends south to California, Illinois, Vermont, and Maine.</td>
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<td>Fruiting stems appear early spring before sterile stems, are to 8-inches high, unbranched, to 1½-inch thick. Cone at top of stem, closely crowded spore-bearing structures, which bear spores in marginal structures, each of which is wrapped in 6 long hairs, which act like springs. The sexual stage develops from spores into green structure, bearing both eggs and sperms.</td>
<td>Spore-bearing cones at the end of stems, which may not survive spore-bearing, and which bear unusually large sheaths, the cones being borne at the end of unusually long stalks above the uppermost joint. Other stems with narrower sheaths may bear cones at the tips and, at the same time, a few weaker of weak branches, which may develop after cones and spores are shed.</td>
<td>Fertile stems are to 8-inches tall, erect, at first flesh-colored, with terminal cone, which is shed early, after which stem develops much as those that are sterile. Small whorls of branches appear with the cone or before, these being smaller than in the sterile stems and less profusely borne on special stalks. Like the field, the marsh, and the swamp horsetails, the fertile horsetail is often found in and around water of wet woodlands and bogs.</td>
<td>Cone is borne at end of short stem, with branched stem or sometimes at end of branch, as well as these are smaller than the terminal one, which may be to 1-inch long. They are free of the stroble and bear the “sporangia,” which bear the spores, which are wind borne and developed into “gametophyte” stage.</td>
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<td>This species varies greatly in form and habitat, favoring stream banks usually rich in sand, but may be common in woodlands, meadows, roadsides, railroad embankments, but probably is most common in damp, sandy, somewhat shaded, loose soils and once established may persist. Grows in sun or in shade, in pure stands or mixed with other plants.</td>
<td>This species is known by some as the “shade horsetail.” It may be found along shady stream banks in neutral or rich soils, on rocky exposures or stream borders, but usually in the shade. This species is found near water but does not flourish in water. In the sterile stage, the horizontal branches may droop close to the main stem before leveling off to the horizontal.</td>
<td>Found in and around water of wet woodlands and bogs. The deeply buried rootstock bears reproductive tubers and buds. The tubers are larger and more oval than those of the field horsetail and the smaller buds may develop next year into fertile stems.</td>
<td>Highly variable in habitat and while it favors horsetail areas it is not too common in water. Found mostly along margins of ponds, cold streams, water swamps, floating land and similar areas, rather commonly in the shade. It is not a common horsetail but it does appear in pure stands and it does so many species do. It becomes general in a particular region.</td>
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<td>Primary value of this species probably that of being a soil anchor in loose soils with the deep rootstocks playing important role.</td>
<td>Probably of no great economic importance, but of interest to botanists because of stem variations, as described above.</td>
<td>Of no economic importance, but, by many considered one of the most beautiful of all non-flowering plants.</td>
<td>This may be attractive because of its feather appearance but its moisture requirements are such that it is not as popular a ornamental species.</td>
</tr>
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Swamp Horsetail

**Smooth Horsetail**
*Equisetum fluviatile*

- Fertile and sterile stems not differentiated. Stems commonly annual, to over 3 feet tall and to 1/4-inch thick at base, usually unbranched, relatively smooth, with about 18 rounded ridges. Sheaths at joints to 1/3-inch wide, spreading upward to form funnel, dark banded, and with white-margined, sharply pointed teeth. Rootstock branching.

**Rough Scouring Rush**
*Equisetum hyemale*

- Evergreen stems, to 8-feet tall, unbranched, slender, dark green, with rough surface, arising in clusters, with about 30 broad ridges with conspicuous rough bands of bark, horizonal and central cavity about 2/3 the stem diameter. Sheaths at joints nearly cylindrical, tight, with sharply pointed teeth that soon wither. Rootstock branch.

**Northern Scouring Rush**
*Equisetum variegatum*

- Evergreen, perennial, uncommonly branched, to over 15-inches tall, with equal length for sterile and cone-bearing stems, dark green but with conspicuous black and white ridges, sheaths at joints persistent, spreading upward. Ridges, 5-12, rough or smooth, leaves 4-angled. Rootstock horizontal, slender, black, shallowly buried.

**Seaside or Dwarf Scouring Rush**
*Equisetum scirpoides*

- Stems evergreen, to about 10-inches long, prostrate, or curving upward, not commonly straight, slender, arising in tufts — but, if branched, then at very base, green, solid, about 1/25-inch thick. Leaves at joints, 3, not connected, with persistent broad, black, white-bordered teeth, apparently 4-keeled, becoming dark brown to black.

Family Equisetaceae.
- Some forms of the species recognized, basically on branching, thickness, and nature of cones. This species ranges through the Sonoran and Transi- tion Zones of North America and of Europe. It is found from Alaska and to South America.
- In the horizontal, Virginia, it is originally described in the genus *Equisetum*.

- Family Equisetaceae. Closely related to rough horsetail, in which the sheaths are nearly as long as broad, and cylindrical, while in smooth horsetail they are much longer than broad, and funnel-shaped. It is found in Upper Sonoran Zone ranging from British Columbia through Minnesota to Ontario, south to New Jersey, Missouri, Texas, and southern California.

- Family Equisetaceae. Rather closely resembles smooth horsetail, which see for differences. The species is found in Europe and Asia and in North America from Alaska to Nova Scotia and south to California, Texas, and Georgia with a number of distinct varieties in the eastern and western part of the range in North America.

- Family Equisetaceae. Our smallest living horsetail, found in northern North America, Europe, and Asia with American range from Alaska to Labrador and south to Washington, Montana, Michigan, Illinois, and Pennsylvania. Single plant may produce to 100 stems from a more or less common base. No commonly accepted forms or varieties seem to be established.

- Trees may be borne on rate stems, which may or may not branch. Branches are about 1-inch and about 1/2 as long as the trunk and may terminate main branches in or in cases the secondary branches. Cones relatively long supine and when drop off.

- Cones are usually under 1/2-inch long, slightly thicker than the supporting stems, in general egg-shaped but terminated by a rather sharp point. When the spores are shed the bare axis, which supported the cases, may persist, giving these stems a distinctive end (strongly apiculate).

- Cones are small, black, terminal, stemless, with sharp-pointed tips, appearing as snow disappear and beginning spore-shedding when snow vanishes, continuing shedding until late summer. Reproduction by rootstock division probably sooner than by spores.

- Found in zone north of 42nd parallel to beyond Arctic Circle with records in all of the states bordering Canada. Found in areas rich in lime, often following lime outcroppings, but may be found in woodlands, meadows, beeches, sand slopes, and bogs. Margins still favoring lime deposits, but not always demanding such situations.

- Sporadically common in evergreen woodlands, swamps, springy banks, borders of ponds, brooks, and waterways, and even on wet ledges or gorges clinging to rock crevices but may appear in open fields upon occasion. Not so commonly conspicuous in pure stands where some other horsetails and may be almost wholly buried in loose soil and mud of environment.

- Of no great economic importance but may serve to anchor the mud of shorelines and have slight role in water control. Favored of deer, muskrat.

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- Of no great economic importance but may serve to anchor the mud of shorelines and have slight role in water control. Favored of deer, muskrat.
**Common or Staghorn Club Moss**
*Lycopodium clavatum*

**Fir Club Moss**
*Lycopodium selago*

**Shining Club Moss**
*Lycopodium lucidulum*

**Bog Club Moss**
*Lycopodium inundatum*

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**DESCRIPTION**

**Fir**

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Found

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damp, cool,

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ledges and pro-

tected areas but a vari-

city, patens, may survive
drier areas. Spore cases

may appear to be borne

in annual zones, and

leaves of this species

may appear to be more

uniform and crowded.

Favors deeply shaded

areas over rocks and scid

soil, and may crowd

stream banks closely in
gorges, often overhang-

ing streams. The plants

do not do well in warm

areas but are exception-

ally hardy and may sur-

vive for months after be-

ing pulled from original

site if the water supply

is restored. Do well in
evergreen woodlands.

This species produces

lycopodium powder in

good quantities from

Russia, Sweden, and

mid-Europe. This was

formerly used in flash-

light powders but is now

used to coat pillows to

prevent them from

sticking and has been used

in high-class face powders

to absorb moisture.

Plants make superior

Christmas wreaths.

No particular economic

importance is recog-

nized. For the most part

it is used as a cottage

herb, in ointments as

counterirritant, in mak-

ning intoxicants, as ingre-

diant in making gunpowder.

There seems to be no

sound economic use for

this plant and none of the

fairy-tinged reputation of

the horizontal stems does

not seem to have en-

croached any major in-

fluence on the plants that

relish such reputation.

The bumpy fruiting po-

sition is less developed

than in the closely re-

lated foxtail moss club

*Lycopodium alopec-

roides.*
that indicates structure. If so, it is interesting to note that this form is commonly found in Alaska to Newfoundland and south to South Carolina and Georgia.

Family Lycopodiaceae. This is one of a group of genera in which the branches are either spike or treelike. The common name tree club moss does not indicate the resemblance of this species to a tree form. It ranges from Alaska to Newfoundland and south to South Carolina and Georgia.

Family Lycopodiaceae. This species is probably most closely related to the ground club moss, Lycopodium tristachyum. The fact that reputable books give the name ground pine to both may be taken as evidence. This species is found in Europe and Asia, in North America from Alaska to Labrador, ranging south in some forms into South America and Asia.

Family Lycopodiaceae. This species is found in Europe and Asia, in North America from Alaska to Labrador, ranging south in some forms into South America and Asia.

Family Lycopodiaceae. Closely related to common club moss, L. clavatum, from which it differs by having fruiting portion of upright stem not separated from leaf-bearing portion. This species in one form or another, ranges through Europe and Asia. It is also found in North America from Alaska to Labrador and south to Washington, Michigan, and Virginia.

The fructifying cones are to 2 inches long on stems 3 to 5 inches long and borne in groups of 1 to 4. Leaves are dark green, rather large, and less than 1 inch long. Spores are shed from July through September.

Erect stems grow to over 1 foot high and are definitely treelike in their general appearance. Fruits are borne on the lower branches the broader and the upper forming a flat-topped structure above which rise the spore-bearing whorls. Each sprout is a second-generation structure, which develops a structure that bears male and female sex organs.

This species is found usually in dry sandy or gravelly soils. It is not found in areas where the soil is acid. The color is a most attractive dark blue-green, which increases popularity of plant and encourages flower-collectors to take it as a specimen but its underground system is so great that transplanting is difficult and usually unsuccessful.

This is a rather northern species and favors cool, shaded, well-drained wooded areas or may almost exclusively cover the forest floor in some spots. The common names of stiff club moss are ably descriptive, and common name interrupted club moss refers to the sometimes obscure divisions between the growth of the different stems.

Fruiting portion of upright stems continuous with the leaf-bearing portion, with transition often obscure, grows to 1 1/2 to 2 inches long, yellowish, with kidney-shaped spore case at base of each leaf, bearing pale yellow spores which spread out in an abrupt point. There is little difference between the stem leaves and the cone leaf—but for the spore cases.

Erect fruiting branch may be to 10 inches high but is usually much less and is unbranched. The terminal cone is composed of crowded spore-case-bearing leaves, whose tips may spread outward, yellowish green, 1 to 3 inches long, pointed at tip and narrowly lipped at base. In South, cones may be to 4 or more inches long, while in North they are commonly shorter.

Sterile stem clings closely to ground, bear roots, are to about 4 inches long, covered with leaves about 1/2 inch long, sharply pointed with spreading tips, entire in 6 ranks, with the upper ranks broad and the lower 4 narrow and scalelike. The stem bearing the cone is erect with leaves in whorls, one stem per plant.

Carolina Club Moss Lycopodium carolinianum

This is our smallest club moss net if found in fruit is easily recognized. It clings so closely to the ground it is pulled with difficulty. This species is found in the United States from New Jersey to Florida but near the coast. Possibly invalid reports indicate it is not found in Europe but is found in parts of Asia.

Bed for the most part relatively sparse but may be dense in marshes or marshes in areas of high moisture. It appears to require an acid soil. The chiefly rooted varieties differ in that it has the cross union of erect stem and leafy leaves while the other shows a flattened structure of two primarily.

Six stages of the different club mosses include a vegetative state, a spore-bearing stage, a spore-case stage, and a mature stage. Each spore case is derived from a single spore. The spore case is composed of two parts: the spore case and the spore case wall. The spore case wall is the outermost part of the spore case and is composed of two layers: the spore case wall and the spore case cap. The spore case cap is the inner part of the spore case and is composed of two layers: the spore case cap and the spore case cap wall. The spore case cap wall is the outermost part of the spore case cap and is composed of two layers: the spore case cap wall and the spore case cap cap. The spore case cap cap is the innermost part of the spore case cap and is composed of two layers: the spore case cap cap wall and the spore case cap cap cap.
There was a time "pony tails" were a major interest in schoolrooms. There was also a time when horsetails represented the dominant population of much of the earth. There was a time when it was felt that children should do only what they wanted to do in school. There may come a time when disciplinary situations may return the rod to popularity. It may seem far-fetched, but we propose here to suggest that horsetails and club mosses, properly handled, may bring a new activity into school that would cut down on disciplinary difficulties because of the interest they create, and would provide a sounder basic science than is now gotten from the average school science text; or we suggest that our science texts be checked more carefully with basic academic sources. As a general thing, the major natural history museums of the country may be of great assistance here. It is hoped that the section immediately preceding this section may be useful in developing a new school interest.

No one can deny that young folks have a consuming interest in dinosaurs and the environment and times in which they lived. But dinosaurs are no more, though we do have some diminutive representatives of the reptile group. Many dinosaurs lived in areas in which the landscape boasted enormous horsetails and club mosses, and their diminutive relatives may be found at some time of the year in almost any part of the country—in wastelands, marshlands, sandy country, or lush meadows and woodlands. Why not set the students the task of trying to represent the past in which their beloved dinosaurs lived, by beginning to understand local plants related to those that supported the popular reptiles by providing the food sources?

This insert introduces you to eighteen cosmopolitan plants of this group, some of which may be found at almost any open country spot in the continent. At Christmas time, many of these plants are brought into the schools as wreaths and some old wreaths may be found in attics, storerooms, in schools, or even in florist shops. If the students decide that they wish to make their own collections, a beginning in conservation education may be made by asking that they use reason, and collect only small amounts of material so that local supplies may not be diminished.

Many museums have for sale small plastic dinosaurs. One of these set up in a terrarium in which small horsetails and club mosses may have been established, may have effective educational possibilities and may create a better "atmosphere" for appreciating the animals than is provided by the showcase or laboratory shelf.

If the above is attempted it may become evident that it is not always easy to transplant club mosses and horsetails successfully. The little Tree Club Moss, for example, would be exactly the kind of plant one might wish to have in a terrarium. However, this species has a deeply buried horizontal stem on which the vertical stems depend, and without this established, the desired plants may not survive. It would be much like picking off an apple twig and expecting the twig to survive if it were stuck in the ground. If you will look over with some care the "write-ups" in the insert, you should find a few species that may be available locally, under conditions that you may duplicate in your terrarium. Be sure not to try growing a plant that normally grows three feet tall in your terrarium that is less than on foot high. Unnecessary difficulties may arise if you do so, and the plant will certainly suffer.

In rapid review of the preceding text let me remind teachers that any study of coal resources in geography or of conservation should be enriched by studying plants closely related to those which formed coal, and this may be of tremendous economic importance throughout the country.

The study in geography of the coal resources of the world may help one appreciate the changing climate of the world by remembering that in all probability club mosses and horsetails have prospered in the same climates they now find suitable, and that, if we find coal in remote sections of the earth, we can have reasonable assurance that at one time the climate in those places was about the same kind of climate as that in which these plants now live.

Some schools may have youngsters who would like to become leaders in some one field. If there are such why not start with a plant group that has relatively few local representatives? Then a good outdoor student may find that he is the authority for the school or the county on this group or a portion of the group. If he wants a real challenge let him set out to try to find the sex stages of the club mosses of the county or of any club moss for that matter, preserving them in alcohol and making an exhibit that has real scientific merit.

Should a school be interested in trying to raise some of these plants, it would be a sound plan to assign to some student who may be seeking recognition in a science-talent contest the job of getting samples of each of the units in a complete life history of any club moss horsetail, or fern. If any student wishes to try this for that matter, it might be well to try as a start, sowing the spores of different plants of the group on different labeled pieces of filter paper placed under a jar where they may remain moist, and having for display and explanation some gametophytes of some of these plants. This may sound more difficult than it is, unless, of course, you try to raise all the kinds to be found. Specialization will produce better results.

If you wish to study these plants by "playing" with a compound microscope, few things will provide more interest in the plant group than watching what happens when a bunch of horsetail spores are sprinkled on a moist surface. If you can get some student who can learn how to make some particular one of these apparently identical spores produce male plants while others produce female plants he may be able to earn a doctor's degree and come back and tell the school what is what.

Dr. E. Laurence Palmer, for many years director of Nature Magazine's educational program, continues his special inserts in the pages of the combined magazines.
EA BED AMBUSH

Echinoderm has odd trapping method

By James W. Atz

The conglomerate of branches on these pages is not a queer leafless plant or a mass of vessels gone mad. It is a well-specialized animal of definite architecture and specialized behavior. This is a basket star—a unusual type of brittle star and a distant relative of the known starfish. Like the starfish, it consists of a centrally located body and five radiating arms, but unlike the starfish, each arm divides and subdivides again and again, ending in myriads of fine, orange-brown branches. Basket stars live at the bottom of the sea, sometimes at considerable depths, and often grouped together. This specimen was collected in the Bahamas by Dr. Carleton Ray of the New York Aquarium, where it was put on exhibition and photographed. When fully extended, it was about eighteen inches high, with a basal radius of about six inches.

Basket star, clinging to rock in New York Aquarium, has no stinging cells.
PREY IS ROLLED UP IN THE BASKET STAR'S LACY LIMB

In nature, basket stars feed on copepods (tiny relatives of the crab and lobster) and other miniscule animals that swim or float in the sea. The specimen at the New York Aquarium was fed brine shrimp. These were put into its tank daily, or whenever the basket star expanded several of its arborescent arms to their utmost, apparently an indication that it was ready to feed.

Each of its arms is girdled with tiny hooks that probably assist in holding its prey. When shrimp blundered into the animal, the sensitive “twi” quickly rolled up on themselves, forming small “knots” at the center which were the struggling shrimp. Eventually, the whole arm slowly curled downward and under the basket star’s underside. Transfer food to mouth has not been witnessed.

Dr. Arz is the Associate Curator of the New York Zoological Society’s Aquarium, located in Coney Island.
SHRIMP are fed to fully extended basket star, left. Arm tips knot around prey, above, and begin to curl.

Several tips now embrace struggling brine shrimp. At this point, the entire branch begins to roll slowly downward.

In frond appearance of basket star is plain when coil completed. Now the contracted branch transfers shrimp to animal’s mouth, located on underside of its central disc. Exact method of this transferal process is not yet known.
Efficient traps of the basket star are evident here. The several, fully extended, almost motionless branches look like harmless marine vegetation. These are stimulated to action when bumped by small, floating or swimming organisms.
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CELESTIAL EVENTS
A selective calendar of astronomical occurrences in the first half of 1960
By K. L. Franklin

JANUARY

January 3: The Quadrantid meteor shower should reach its maximum about midnight, EST. The swift streaks of light will appear to emanate from a point in the northeast sky near the handle of the Big Dipper.

January 4: The earth, in the yearly circuit of its orbit, is closest to the sun—91.4 million miles away.

January 9: The moon will approach Aldebaran during the entire night, finally occulting the star about the time of moonset for the eastern seaboard—around 4:00 A.M., EST, on the morning of January 10.

January 21: Those who rise early in the morning will be able to identify bright Venus low in the southeast, about 1° north of fainter Jupiter.

January 25: Venus, Jupiter, and the waning crescent moon will appear to planet-watchers as they raise their eyes progressively above the southeastern horizon. This is the scene illustrated, above, from an imaginary position on the New Jersey bank of the Hudson River. Saturn and Mars are also to be noted, to the left and near the horizon.

January 26: Early this morning, the moon, now even lower in the southeast, will be found between Saturn and Mars (Mars will be higher in the sky).

January 26: Mercury is at superior conjunction, 131 million miles away from the earth beyond the sun.

FEBRUARY

February 7: Venus will appear startlingly close to Saturn—less than 0°.2 away about 6:00 A.M., EST.

February 17: Venus will appear about 1° north of Mars just before dawn today.

February 24: Mercury is 1° east of the sun this evening. One must look carefully just south of west to spy this difficult-to-see planet shortly after sunset.

MARCH

March 4: Aldebaran will be occulted by the moon very early in the evening, too early for observers in western U.S. Those living in the northeast may see the event with telescopes or binoculars before 5:00 P.M., EST.

March 10: Mercury is nearly between the earth and sun today, at inferior conjunction, 58 million miles away.

March 12-13: The moon will become full during the morning hours of Sunday, while in the midst of earth's shadow. This total eclipse of the moon technically begins about 12:30 A.M., EST, on March 13, but little change will be noticed for thirty or forty minutes. The dense part of the earth's shadow, the umbra, will appear on the lunar surface at 1:36 A.M., EST, and totality will begin at 2:41 A.M. The moon begins to leave the shadow about 4:15 A.M., the deepest part of the eclipse occurring.
3:30 a.m. The spectacular part of the eclipse ends when the moon completely leaves the umbra at 5:18, making its technical ending coming at 6:22 a.m., EST. This will be visible over the entire Western Hemisphere. 

**March 20:** Spring comes to the Northern Hemisphere at 3:43 a.m. EST; Autumn begins south of the Equator.

**March 25:** Two days before new moon, the moon is at the planet Mercury, about 7:00 a.m., EST. Tele-scope should be used to see this event from the eastern U.S., for the sun will have risen an hour before.

**March 27:** A partial eclipse of the sun will be visible much of Australia and Antarctica.

**April**

**April 7:** Mercury is as far west of the sun (28°) as it will be this season. Look at dawn low in the southeast.

**April 21-23:** The Lyrid meteor shower should reach maximum on the night of April 22. Appearing to come from the small constellation Lyra—near the bright star Vega—this shower has occasionally been spectacular. During the past few years, the rate has been between two and twenty meteors an hour for the single observer.

**April 24:** At 2:02 a.m. on this date, people in most Standard Time regions will advance their clocks one hour to 3:02 a.m., starting Eastern Daylight Time.

**May**

**May 1-10:** The waxing moon may interfere with observation of the Eta Aquarid meteors, which will reach a maximum rate of about twenty an hour for the single observer on May 5.

**May 17:** Mercury is again at superior conjunction (see January 26), beyond the sun, 123 million miles away.

**June**

**June 9:** The full moon occurs 13 hours before perigee (when the moon is closest to the earth, 222,000 miles away). This combination will work to produce unusually low and high tides for a few hours.

**June 19:** Mercury should be fairly easy to see in the western sky shortly after sunset. It is as far east of the sun (25°) as it will be this season.

**June 20:** Jupiter is opposite the sun in the sky, appearing due south in the midnight sky.

**June 21:** Summer starts at 5:43 a.m., EDT, in the Northern Hemisphere; Winter begins south of the Equator.

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Dr. Franklin of The American Museum—Hayden Planetarium, prepares this summary each six months.
AMERICA'S BALLGAME

These dashing New World contests seem to have influenced the form of several team sports of today

By Stephan F. de Borhegyi

But for the sporting enthusiasm of our Indian predecessors in the New World, competitive rubber ball games—as we know them today—might never have come into existence. Not only were the enterprising people of Mesoamerica responsible for the discovery of rubber—and its usefulness in the form of an ingenious, bounding, rubber ball—they may also have done much to influence the form in which some of our modern games of ball are played.

When the Spanish conquerors arrived early in the sixteenth century, they first witnessed a New World ball game in the Antilles, on the island of Haiti. Later, they saw ball games played on the Mexican mainland. They especially marveled at the ball (olin), which was solid and heavy and yet bounced so vigorously. The Spanish chronicler Torquemada (in 1613) described this unusual object from hearsay: “These Indian peoples know (as among us was known) the ball game, although different from ours. The place where it is played is called tlach which is like tennis among us. They make the ball from the sap of a tree which grows in the hot country, from which trickle some white thick drops when it is punctured, and which very soon jell, which when mixed and kneaded turns out blacker than pitch. Of this ulla they make the balls which although heavy . . . were very fitted for the way in which they played. They bounced and jumped lightly as air-filled balls, and were better because there was no necessity for blowing them up.”

An earlier account, by the chronicler Duran (1581), combines direct observations with detailed reporting: “This ball is—as some people may have seen—as large as a small ball used in playing nine-pins. The material of which the ball is made is called olin, which I have heard to be called ‘batel’ in our Spanish, which is
Indian witnesses of such play were Spanish explorers, to whom Indians presented game’s trappings, above. Earlier, Columbus had brought back a marvelous ball that “jumps and rebounds”—probably the first rubber ball to reach Europe.

Of a special tree which when boiled becomes like a rubber. It is plentiful and used... both as medicines and shining. It has one property which is that it jumps bounds upwards, and continues jumping from here so that those who run after it become tired before catch it.”

It is no surprise, then, that Columbus brought back an ample of such a ball, along with other wonders from the New World. Las Casas, writing from New Spain in 1529, remarked, “I saw one, as big as a small jug, which Admiral brought to Seville.” It can therefore be stated that, not long after Columbus’ second voyage—and the rubber ball—were brought back in some trinkets to Spain and to the rest of Europe, along with the accounts of the New World ball games. The ball seemed to have been introduced to Europe in the year 1528 by Cortés, who staged several games for the court of Charles V. One of these performances was witnessed by the German traveler Christoph Weiditz, on a trip to Spain in 1529. Shortly afterward, he published a description of his trip, the excellent illustrations of which included a sketch of two Indian ball game players and, in the text, some brief rules.

In Torquemada’s description of New World ball games, which he calls “juego de pelota,” he mentions their similarity with the essentially sportive European ball games—in particular, court tennis and the pelota vasca, or jai-alai. However, prior to the Spanish Conquest, all the ball games that were played in Europe made use of leather balls that were either filled with hair or contained an inflated bladder. Indeed, the Spanish word for ball is still pelota—deriving from the word pelo, meaning “hair.” The most popular ball games in Spain, France, and Italy...
Ball player being sacrificed with obsidian knife, above, can be seen in frieze on ball court at El Tajín, Veracruz.

"Palmate stone" and yoke, above, may have been worn in play, but were more probably used only in game ceremony.

THE BALL GAME PRIOR TO A.D. 1500

LEGEND

- Southwest U.S. courts — A.D. 800-1100
- Game survived Conquest (no courts)
- Mexican-type courts — A.D. post-1100
- Lowland Maya courts — A.D. pre-900
- Highland Maya courts — A.D. pre-900

Middle American ball games were played on varieties of courts indicated on map, above, during pre-Conquest period.

Pottery whistle, right, is effigy of ball player. Note pads on arms and legs, and headdress in form of ani
Illustrations by Hans Guggenheim

Santa Cruz figure depicts player wearing stone or wood yoke.

Elaborately carved stone yoke is from Veracruz area.

Chest incision in carving identifies a sacrificed player.

Ches during the fifteenth century were pallone or balle (words that have the same root as the English word "balloon," since the game was played with an air-filled ball) and court tennis, which was a hand game (jeu du paume), played with a hair ball.

Both these games derived from Roman prototypes and had even earlier Mediterranean origins. These and all other European ball games prior to the sixteenth century, seem to have originated in ancient, spring rites practiced in southern Europe, Egypt, and the Near East. The two-sided aspect of the game probably represents the philosophic dualism of nature. In this ritualistic pairing, we may have the origin of "teams"—mock combats and contests dramatizing the eternal conflict between day and night, or dying winter and approaching summer. However, the emphasis was apparently on each individual's skill: there seems to have been no serious attempt to organize the opposing players into co-operative teams. Thus, the New World idea of two teams engaged in competitive play was quite possibly an innovation to Europe.
The Middle American ball game, as described to us by Spanish chroniclers, was a combination of our modern sports of basketball, volleyball, soccer, and jai-alai. It played in high-walled, paved courts (usually 100 to 200 feet long and 20 to 50 feet wide), called tlachilco or tlachco, the floor plans of which were in the shape of a tal 1. As described by the Spaniards, the game had as key the knocking of a solid, five-pound rubber ball, eight inches in diameter, through stone "hoops" vertically in the center of each of the two long walls. The main objective of the play does not seem to have to gain ground—as was the case with most of the 15th-century European ball games—but to score. The inner diameter of the stone hoop varied from twelve inches, making a "goal" as easy a task, never, the game varied from place to place, and in some areas, hoops were not used at all. In these cases, scoring must have been calculated on some other basis. The number of players varied. There were amateur and professional teams and nearly every pre-Columbian settlement of any size boasted at least one ball court. In some contests, quite large teams—nine to eleven players strong—were used. In others, only two or three expert players took part. To quote Torquemada again: "They played in teams, so many against so many, such as two against two, and three against three, and sometimes two against three, and in the main courts or tlachco's the lords and nobles and great players, in order to embellish their markets principally on feast days and on many other days, went to play in them."

How the ball was first put into play remains unknown. But, once begun, the players performed with such skill and dexterity that there were times when the heavy rubber ball did not touch the ground for as long as an hour, during which it flew from one end of the ball court to the other. A team "scored" whenever the opposing ball-handlers missed a shot at the vertical hoop, or when the team made the ball reach the opponents' "end zone." Playing the ball off the side walls was quite important, and many of the finer tricks of the game were apparently based on the players' skill in this maneuver.
The most important score, however, was accomplished by putting the ball through one of the stone hoops. When this occurred, all other scoring points were discounted and the game was thereby concluded in great excitement and applause. Torquemada testifies: "This way of putting the ball through the hole, which we have seen, which seemed a miracle to the spectators (although it was by chance), they used to say and swear that the person must be a thief or an adulterer or that he would soon die, since he had had so much luck; and the recollections of this victory lasted for many days until another happened which made it forgotten."

The star player who accomplished this remarkable feat not only won the game for his team but was entitled, for his skill, to collect the jewels and even the clothing of those who were watching. Generally, a merry scramble ensued and there was a mass exodus of all present.

Star players were highly honored by chiefs and commoners alike, but the game was so strenuous that it is hard to imagine that the stars could have remained at top of their form for long. The heavy ball was not allowed to come into contact with bare hands, feet, calves, but was kept in play with a sort of hand-held stone "flatiron" or with elbows, knees, and hips. Protection the players consisted of quilted cotton elbow and knee pads, and around their waists they wore heavy belts, yokes, of leather or basketry. Sculptures and paintings often show ball players equipped with these stone "gloves" and wearing yokes, as well as curious objects known "palmate stones" (illustration, p. 50). Both yokes can
stone and the palmate stones, themselves, have been offered by archeologists. It is not known, however, whether this bulky equipment was actually worn in play, or whether the stone versions were made solely for ceremonial purposes. Evidence tends to show that the stone versions, some weighing as much as fifty pounds, might have been used in some areas, to give the ball a better bounce. The palmate stones, on the other hand, are quite bulky, and it is unlikely that they could have survived the oros of actual play.

All their protective costume, casualties happened during the course of the game. Says the eyewitness: "Some of them were carried dead out of the ring, the reason was that as they ran, tired, and out of breath, after the ball from one end to the other, they

would see the ball come in the air and in order to reach it first before others would rebound on the pit of their stomach or in the hollow, so that they fell to the ground out of breath, and some of them died instantly, because of their ambition to reach the ball before anybody else.

...They were so quick to hit their knees or seats that they returned the ball with an extraordinary velocity. With these thrusts they suffered great damage on the knees or on the thighs, with the results that those who for smartness often used them, got their hamsches so mangled that they had those places cut with a small knife and extracted blood which the blows of the ball had gathered."

In spite of the fact that players often were severely hurt and occasionally were killed, the rewards of being a star were so great that such dangers were evidently considered inconsequential. Yet, there was even greater risk involved for the team captains. While the winning captain was overwhelmed with honors and gifts, the unfortunate captain of the losing team was not infrequently sacrificed to the gods! This fact we know from the Spanish chronicles. It may also be reflected in the dramatic depictions in low relief on the ball courts, at El Tajin, in Veracruz, and at Chichen Itza, in Yucatan, and in the illustrations contained in such documents as the Codex Borgia.

Although such treatment of the losing captain may seem harsh, it was closely in keeping with the penalties imposed by the spectators upon themselves when they lost at the gambling that invariably accompanied the game. Both players and spectators laid wagers on the outcome of the contest, the stake varying with the status and wealth of the individual. As the chronicler Sahagun (1529) reports: "What the low class people gambled was jewelry of small value and worth and as he who has little wealth on hand usually loses it, they were in necessity of gambling their houses, fields, maize stores, maguey plants and of selling their children in order to gamble and even of gambling themselves away and of becoming slaves, to be sacrificed if they did not redeem themselves in time, as has already been told. Their way of gambling was that when they had finished losing the valuables which they carried, such as cloaks, beads and feathers, they would gamble on their word, saying that they had certain valuables in their houses."

Rulers might even play for principalities or kingdoms, as when Axayacatl, the ruler of Tenochtitlan (today, Mexico City), wagered his entire yearly income against that of Xiuhtemoc, the ruler of the neighboring city of Xochimilco. Lesser nobles and chiefs played for jades and turquoises, jewelry of gold, feather robes, articles of clothing, cocoa, cornfields, houses, and for slaves and concubines. With so much at issue, it is little wonder that there were times when, not content with the element of skill, such high-stake participants invoked the aid of the supernatural. According to Duran: "...these gamblers by nightfall took the ball and placed it on a clean plate with the leather loincloth and the gloves, hanging it all on a pole and, crouching before these instruments of the game,

Heavy betting preceded ball games, with jewelry, slaves, and even kingdoms changing hands. Gamblers would invoke aid of spirits, left; placing trappings of the game on pole and praying to the gods of luck to favor them the next day.
Spectators watched game from top of court walls, above. Courts were usually 100 to 125 feet long and from 20 to 50 feet wide, but game methods varied. In some courts, scores were made by knocking balls through stone hoops on walls.

They worshipped them and spoke to them with certain words of superstition and incantations with much devotion, praying to the ball that it ... be favorable that day."

All this might give the impression that, by the time of the Spanish Conquest, the Middle American ball game was a completely secular activity. Duran even describes it as "...a game of much recreation to them and enjoyment especially for those who took it as a pastime and entertainment." Nevertheless, the religious overtones that reflect the sacred origins of the game were apparent to Torquemada, who recalled: "Each ball court was a temple because they placed two images in it, the one was the god of the game and the other of the ball, on the top of the two lower walls, at midnight, on a day of good omen, with certain ceremony and witchcraft and in the middle of the floor they made similar ceremonies, while singing songs; thereafter one of the priests with some of his ministers came to bless it with certain words (if the detestable superstition can be called blessing); he then said the ball four times in the ball court and with this they said that the court was consecrated, and they could play in it and not before them."

In the codices, we continually see the gods associated with the ball court. Those most frequently illustrated were Quetzalcoatl, Texcatlipoca, Xochiquetzal, Xochipilli, Huitzilopochtli, Coatlicue, Xolotl, and the Lords of the Day and the Night. These deities were even believed to be ardent players in their heavenly courts, like the vigorous athletic gods of the Greeks, and the ball game was their favorite means of settling their divine disputes.

From the various legends, we learn that Quetzalcoatl was an unusually skilled player and had many ball courts dedicated to him. Historically, Quetzalcoatl seems to have been the culture hero of the Toltecs and ruler of the city of Tula. His defeat by his rival and arch-foe, Texcatlipoca, and his subsequent flight to the south has been passed on to us through a legend, recorded by Sahagún.
The invention of the rubber ball and its use in a ball game very likely took place through experimentation in an area where rubber-bearing plants were grown. This would suggest the lowland rain forests of Central America as a point of origin. Verifying this hypothesis, we find the earliest ball court known thus far at the important jungle site of Copan, in Honduras. This court has been dated at between A.D. 200 to 300, in the Early Classic period. Since there is nothing primitive about this Copan ball court, we can probably assume that others—representing the experimental beginnings of the game and so far not yet found—may pre-date it by several hundred years. As a matter of fact, archaic figurines, representing ball players, were found at Tlatilco, Mexico—which suggest that some form of the game was known in the Valley of Mexico as early as 1500 B.C., although it may not have been played in a formal ball court.

Just where the game originated is yet to be determined.

The twin brother of Quetzalcoatl, Xolotl, was throughout pre-Columbian Mexico as the divine of the game. In this, one may detect an inherent relationship between this god of twins or siblings and the implicit in competition: a factor that, as we have already mentioned, was also present in the origins of Old World ball games. We can suspect that, as in Europe, the underlying tone of the Mesoamerican ball games was to provide an outlet for aggressions toward neighboring groups in order to keep the peace. As a matter of fact, archaic figurines, representing ball players, were found at Tlatilco, Mexico—which suggest that some form of the game was known in the Valley of Mexico as early as 1500 B.C., although it may not have been played in a formal ball court.

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Dr. Bornecy is an anthropologist and the Director of the Milwaukee Museum. A specialist in Hispanic cultures, he has concentrated on studies of Mesoamerican archeology.

The type of classic ball court at Copan consists of an open-ended court, with a central playing alley between parallel, sloping side walls. Three elaborately carved, square or circular stone slabs apparently represented floor markers. At the top of each side wall were three vertically tenoned, stone parrot heads. Since these parrots were carved with large, round eyes, it is possible that they represent a precursor of the stone hoops found in later, Mexican courts. The floor markers were also important in scoring. This type of court was characteristic of the lowland Maya region of Guatemala, Honduras, and Mexico and survived to the end of the Classic period, possibly as late as A.D. 1000.

In the highlands of Guatemala and southern Mexico we find another type of ball court during the Classic period (A.D. 300 to 1000) that resembles a wash basin in its shape. This court is, in general, like that of the lowland Maya, but differs in being completely enclosed by a wall, which also incorporates some extra space, at both ends of the playing floor, to form end units. Although we find no evidence of stone floor markers, we cannot eliminate the possibility that goals of some sort may have been painted on the paved floor. The carved stone heads used to decorate these highland courts were characterized by horizontal—rather than vertical—tenons, frequently in the form of serpent and human heads, rather than parrots.

By the close of the Classic period, most of the lowland Maya centers were mysteriously abandoned. In the highlands of Guatemala and southern Mexico, after A.D. 1000, a new type of ball court came into fashion. Prior to this time, all ball courts were built on the ground level. But in these later courts the playing alley was lowered to a depth of several feet below the surface. It is very possible that this type of "sunken" court was introduced from Mexico, where the game, as we have seen, may have been known since 1500 B.C. Since these post-Classic courts were built below ground level, they all had elaborate drainage systems. Although they retain the sloping side walls and the enclosed "capital I" shape, they show no signs of tenoned stone heads or floor markers. Goals, of course, may have been painted or made of perishable material.

While such "sunken" ball courts were characteristic of the post-Classic period (A.D. 1000 until the Spanish Conquest in 1524) throughout Guatemala and southern Mexico, still another type came into vogue in central and western Mexico and in Yucatan. It is this type that is described in detail by the Spanish chroniclers. Although the playing alley was in the "capital I" shape, it was built at ground level and the side walls were vertical rather than sloping. In the center of each side wall was an elaborately carved, horizontally tenoned, stone hoop.

Little is known of the ball courts in the region north of Mexico City. However, in Arizona, two types of courts have been recognized, both of the "sunken" variety. The one excavated at the Snaketown site is large and oblong and possesses end units. Apparently it was in use between A.D. 300 and 900. Smaller, circular courts—built during a later period (A.D. 900 to 1150)—are characteristic of the Flagstaff area. In these, the end units were replaced by small openings in the surrounding wall. There is no doubt that the prehistoric inhabitants of Arizona learned of the ball game from their Mexican neighbors.

Since the shape of the courts varied in different peoples and in different regions, it is easy to conjecture that the rules of the game must also have varied. Unfortunately the only eyewitness accounts of the pre-Columbian game are those preserved in the Spanish chronicles. Nevertheless, however, the genetic relationship is clear: there is a corridor-like playing field, the ball is made of solid rubber and there is the obligation to strike it with the hip or thigh. Religious feasts are favored for play, accompanied by lavish betting.

The reason that only one poor example of a great game has survived to the present day is apparent in the chronicles. The historian Comora states—an annal corroborated by Cervantes-Salazar and Torquemada—that: "Each court was like a temple, because they put images of the gods of the ball game on the lower walls of the court. Motolinia adds, "... and for this reason they were destroyed." Later historians piously argue that the Maya game was destroyed by the conquerors out of a desire to protect the Indians from the very real dangers of playing it; however, such an assumption of altruistic motivation at the very least, open to suspicion.

In spite of its virtual extinction, the competitive type of the game of Middle America lives on through its influence on the modern ball games of Europe and America. Although there is no indication that the rules of the New World game were ever incorporated directly into the European sport, it is obvious that the element of a vigorously bouncing rubber ball considerably altered the rules of the ancient game of tennis, and had its effect on the formulation of rules for such kicking games as soccer, volleyball. Team effort to keep the ball constantly by side to side survives in modern volleyball.

There is also some reason to suspect a connection with the distinctly American game of basketball—which owes its beginnings, in 1891, to Dr. James E. Naismith, a physical education instructor at the Young Men's Christian Association Training School at Springfield, Massachusetts. In the late 1890's, a great stir was caused in the country with the rediscovery of the ruins of the ancient Maya ceremonial center, Chichen Itza. In 1891, the English archeologist Maude published the first article on the ball court there, calling it a tennis court or gym. Naismith, Dr. Naismith, understandably interested in any new type of sport, may well have read about the ancient ball games of Mexico and incorporated the idea of putting the ball through a hoop—albeit horizontal rather than vertical—in his ingenious new game of basketball.

Today, three types of ball games—football, soccer, and basketball—are played throughout most of the Western world. Now thoroughly secularized, they often are accompanied by the same excitement—and gambling—that characterized the Middle American ball game.
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SKY REPORTER

The ninth planet, Pluto, was at last discovered only thirty years ago

By Simone Daro Gossner

It all started with the discovery of Uranus by Sir William Herschel in 1781. Until then, every known planet was visible to the naked eye and it is reasonable to assume that the appearance of these five was familiar to Paleolithic man. The newcomer, on the other hand, posed a new problem in planetary astronomy: it was necessary to compute an orbit for Uranus in order that its sixth planet might be located for subsequent observations by astronomers.

The years that ensued, every effort to predict the orbit of Uranus with accuracy met with failure. Observations revealed that the planet was deviating constantly from its computed orbit. In 1846, the mathematician Leverrier showed by means of Napier's equations that the erratic behavior of Uranus was undoubtedly caused by the attraction of still another planet—yet unknown. He even predicted this planet's position in the sky and persuaded the astronomer Galle to look for it. On the first of his search, Galle found the planet within a degree of its predicted location. Thus ends the story of discovery of Neptune, but not of the peculiar behavior of Uranus.

After the latter was revised to account for the discovery, it was found that the effect of Neptune was not sufficient to remove the observed discrepancies. It appeared that the search would have to be extended to another, even more distant, planet. Here in Flagstaff, a few astronomers undertook to duplicate the mathematical feat of Leverrier. Percival Lowell, founder of the Lowell Observatory at Flagstaff, Arizona, and William Pickering, of the Harvard College Observatory, were without doubt the most persistent and dedicated in this task.

The mathematical procedure followed by Lowell was patterned after the method of Leverrier and made use, once again, of the irregularities in the motion of Uranus. Pickering, on the other hand, devised a semigraphical method—using the irregularities in the motion of Neptune, which had also begun to depart slightly from its computed course. Both methods predicted the position of the unknown planet but, alas, to no avail. Under Lowell's guidance, the search began at Flagstaff in 1905. As the observations remained fruitless, Lowell continued to revise his calculations. His death, in 1916, came before his theories were verified.

The long search ended just thirty years ago, shortly after a new, thirteenth-inch telescope was installed at Flagstaff. In January, 1930, the young astronomer Clyde W. Tombaugh used the new instrument to take a number of photographs of the star field surrounding the position predicted by Lowell. After a careful comparison of the plates, he discovered the planet on February 13, 1930—within five degrees of the calculated place (photos below). Announcement was withheld until March 13, 1930, to coincide with Lowell's birthday. His initials, P.L., inspired the choice of the name Pluto, thus honoring him without breaking the tradition of using mythological designations for astronomical bodies.

Every photos of January, 1930, are shown, above. In one exposed on January 23, Pluto is seen beside arrow. Pluto's shift to new position six days later (arrow, above) was proof that faint image was the long-sought ninth planet.
THE SKY IN JANUARY

From the Almanac:
Moon at first quarter: January 5, 1:53 p.m., EST.
Full Moon: January 13, 6:51 p.m., EST.
Moon at last quarter: January 21, 10:01 a.m., EST.
New Moon: January 28, 1:16 a.m., EST.

The earth reaches perihelion on January 4. This is the nearest approach of the earth to the sun in 1960.

For the visual observer:
A very unusual grouping of planets will greet the early riser this January. All major planets are in the morning sky and all are close to each other. At dawn on January 11, Venus, Jupiter, and Mars (in that order) will be seen rising in single file over a period of approximately ninety minutes, starting about three hours before sunrise (see illustration, right). Saturn and Mercury will follow the same path shortly thereafter, but they are so close to the sun on that date that they will be lost in its glare.

Mercury will be very low over the southeastern horizon and poorly placed for observation throughout January. It will be in superior conjunction with the sun on January 26 and will enter the evening sky on that date.

Venus will rise three and one-half hours before the sun on January 1, three hours before on January 15 and two hours before on January 31. Its magnitude will decrease slightly (from -3.7 to -3.5) in the course of the month, but nevertheless it will remain very brilliant.

Mars will rise about ninety minutes before the sun throughout January and will be found very low in the sky at sunrise. It will be seen only by those who have an unobstructed view of the southeastern horizon.

Jupiter, in Ophiuchus (magnitude -1.4), will be found to the northeast of Antares. It will rise ninety minutes before the sun on January 1, two hours and fifteen minutes before on January 15, and three hours before on January 31.

Saturn, in Sagittarius (magnitude +0.8) will be lost in the glare of the sun during most of January. It will become slightly more favorable for observation as the month progresses. By the end of January, it will make its appearance about ninety minutes before sunrise.

For binoculars and small telescopes:
The following objects, appearing in the evening sky in January, may be seen with a small instrument (see map):

The Great Nebula in Andromeda, faintly visible to the naked eye as a hazy patch. This giant spiral galaxy is believed to resemble closely our own Milky Way. Its distance is currently estimated at two million light-years.

The Pleiades, a cluster of stars embedded in faint nebulosity. Under various names, the cluster appears in many legends of ancient and primitive civilizations.

The Great Nebula in Orion. This is one of the most beautiful gaseous nebulae. Its fan-shaped structure is readily seen even with binoculars.

Praesepe (the Beehive), a loose aggregate of stars, characteristic of the type called an open cluster.

The Double Cluster in Perseus, a pair of well-defined, star clusters of almost equal size.

MRS. GOSNER, who first studied astronomy in her native Belgium, came to this country after World War II to work at the Harvard Observatory. Astronomy Editor for Nature Magazine, she continues in that role for Natural History.
MAGNITUDE SCALE
-0.1 and brighter
0.0 to +0.9
+1.0 to +1.9
+2.0 to +2.9
+3.0 to +3.9
+4.0 and fainter

TIMETABLE
January 1 10:30 p.m.
January 15 9:30 p.m.
January 31 8:30 p.m.
(Local Standard Time)
THERE was a hiatus between two sessions of the same Congress, which some observers have equated to the eerie silence that sometimes accompanies a sudden, unexpected event. The Congress was reconvened by the House of Representatives on June 6, 1966, after a recess of forty-five days.

The legislation that had been passed during the first session was still under consideration when the Congress reconvened. The House and Senate were both working on bills that would affect the federal government's role in the preservation of natural areas. The legislation included proposals to create new national parks and forests, to expand existing ones, and to protect wilderness areas.

Congress took a different view, and the House passed the Blatnik bill (H.R. 3610), which provides specific appropriation for grants-in-aid, by a vote of 255 to 143. The House approval was for an appropriation of one hundred million dollars a year for ten years to encourage pollution control. The Senate cut the appropriation by half, and then voted 61 to 27 to approve an appropriation of eighty million. This difference in the two bills sent the matter to a conference committee, and there the issue was reposed as the session ended.

Wilderness Legislation

A number of bills were introduced in the House and Senate that would provide for the preservation of wilderness areas. These bills were sponsored by members of both parties, and they were supported by a wide range of organizations, including environmental groups, conservationists, and wilderness enthusiasts.

Water Pollution

Several important pieces of conservation legislation are now awaiting the second session of the Eighty-sixth Congress, which thus far has not attained a notable record for action in this field. One bill concerns stream pollution, a problem that has plagued conservationists for many years. The Federal Water Pollution Act of 1956 authorized Federal grants-in-aid to speed construction of municipal sewage treatment plants approved by the states. The Administration and the Bureau of the Budget took a dim view of such grants, and proposed a cut of twenty-five million dollars from the forty-five million appropriated for the current fiscal year. There were indications, moreover, that no grants would be recommended thereafter.

Congress emphasized that presently designated wilderness areas could quickly become unprotected by simple administrative order. The wilderness issue is an important one to the nation as a whole, especially physically and philosophically. The Congress was on the verge of being reported favorably when the first session ended. Now, early consideration has been promised in the second session.

Park Programs

Although Congress appropriated funds to allow the National Park Service to continue its “Mission 66” program (which seeks to meet the probable 1966 public demands upon the national park areas), there was no final action on the significant National Park legislation of the session. The proposed Chesapeake and Ohio Canal National Historical Park made some progress, thanks to a favorable report by the House Committee on Interior and Insular Affairs. However, the bill was not cleared by the Senate Committee in time for a vote in this session. Other bus bills that would authorize a program to preserve certain remaining shore parks on the Atlantic and the Pacific coasts, the Gulf of Mexico, and the Great Lakes, failed to come to the House. Individual bills in favor of the Cape Hatteras National Seashore, the Oregon Dunes National Seashore, and the Dunes National Shoreline Park in Indiana are still to be heard. However, the latter area is already being prepared for a steel mill and dredged for a harbor. Its future as a park is definitely clouded. The question of shore line preservation is sure to be given consideration at the second session of Congress.
Insecticides

Issue with which Congress did

tue to grips was that of studying

effects of economic poisons - es-
special emphasis on insecticides with highly lethal

effects on birds, fishes, and other

wildlife. Many new poisons are

being introduced, and relatively little

is known about their side effects on hu-

mals, and the soil. Far more

research is essential, and the

U.S. Fish and Wildlife Service has

approved two and a half mill-

ions a year to conduct thorough

investigations on this question.

Soil Bank

The affirmative action concerned

Conservation Reserve Soil Bank

Schemes, under which land is devoted

to the production of crops instead of to addi-
tional crop production. Positive values

are achieved by this program, which has

already been implemented, with wildlife populations

growing as a result of more satisfac-
tory management. Congress granted the same

amount last year - three hundred and

five million dollars - for the pro-
nunciation, the Soil Bank Act ex-
december 31, 1960, so the issue is

likely to be an important and

controversial matter during the

next year.

Conference City

LY, Washington is the conserva-
tion capital of the country for two

reasons. First, Congress is the source

of all appropriations flow, and the

product of these funds is mandates that shape the outlook of adminis-
tative programs. The major agencies charged with man-

agement and conservation of our natural

resources - renewable and non-renew-

able - are under the jurisdiction of the

Department of the Interior, and the Department of Agricul-

ture. Second, Washington is the cen-

tral administrative hub for the

national agencies involved in conser-
vation, and the federal government is the

principal source of funds for conservation

projects.

Washington, D.C. is also an important

cultural center, and the nation's cap-

citol is a place where many conser-
vationists meet to discuss issues.

Typical of such conferences was a

national meeting recently assembled by the

U.S. Fish and Wildlife Service to con-

side two very different ornithological

questions. One problem concerned the

farm crop depredations, at certain times of the year, by blackbirds. The

other dealt with the uneasy coexistence of the

Army's Early Warning Wing and the

Midway Islands, with the resident

albatrosses.

Blackbirds, including the redwing and

yellow-headed blackbirds, cowbird, and

grackle, were described as periodically

causing large losses in corn, rice, and

other grain crops. The Fish and

Wildlife Service found itself caught between farmers asking for controls, on the one

hand, and the hard fact, on the other, that some of these species are protected

under the terms of the Migratory Bird

Treaty Act and the pacts thereunder with

Canada and Mexico. The Service

admittedly found itself inadequately

supplied with information about control in

trouble spots. It was also cognizant of the

fact that, at various seasons of the year,

the birds are immensely valuable in con-

trolling insects. What the Service sought,

therefore, was public reaction to the

issue of permits for control that would

protect the controller in case other

protected birds were accidentally

destroyed. This seemed to be an aca-

demic issue, since no satisfactory method of control now seems to be available.

Much more dramatic is the problem

of Midway. About one-third of the

world population of Laysan albatrosses,

considerable numbers of black-footed

albatrosses, and sooty terns breed on

Midway. Fish and Wildlife biologists

have made several studies in an endeavor

to devise some way in which the birds

might be induced to change their habits

of nesting.

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WILD LIFE OASIS
IN ARIZONA

By Annette Richards Parent

LIGHT ON THE DESERT has always presented to wondering nature a variety of homes for desert life. The giant saguaro rises to heights of twenty to thirty feet, and creates a true cactus forest. Because there is little surface water in the area, the Museum sank wells and established pipe-fed water holes. At one such man-made oasis, a small building houses a photographic blind from which Museum members may take pictures of the varieties of wildlife that come to drink at night.

The blind has four windows, and is equipped with chairs for comfortable waiting. A fifteen-watt bulb burns twenty-four hours a day so that, even on moonless nights, watchers can see their quarry drinking a dozen feet away. Outside the blind is mounted a battery of “strobe” lights that can be fired simultaneously. Some of the pictures on these pages were taken at this blind, some at a similar water hole five miles away.

To these oases come representatives of most of the desert population. During the daytime, the pools are preempted by the birds, and become centers of flashing color and of movement. Mearns’ gilded flicker, the home-builder of the desert, is a regular visitor. This handsome, foot-long bird plays a special role in its desert habitat. With its powerful bill, it digs holes in the tall saguaros, in its search for insects. These holes, in turn, become nesting sites for martins, sparrow hawks, flycatchers, or elf owls.

After night comes to the desert and the birds have left the water holes, the four-footed creatures move in. Rarest, perhaps—at least to a watcher—are the coyote, the gray fox, the ring-tailed cat, and the raccoon.

One of the most regular and exciting visitors to the water supply is the mule deer. This handsome creature is reddish in summer and blue-gray in winter. Its large ears and separately branched antlers distinguish it from its eastern cousin, the white-tailed deer. This purely western species stands three to three-and-a-half feet high, weighs from 125 to 200 pounds, and usually travels in herds. The mule deer’s approach to a water hole is one

Mrs. Parent is a free-lance writer who lives in Tucson, Arizona. She is an enthusiastic reporter of life in the desert, and her work is familiar to regular readers of this magazine.
Tusked Javelina, or peccaries, the fierce wild "pigs" of the Sonora Desert, usually travel in herds. Their approach to the water hole is a retreat signal for other wild. Kneeling on stubby forelegs, above, a group drink noi.

Badger, above, is a member of the Family Mustelidae, to which belong the skunk and the weasel. Although usually a peaceful animal, the badger will give battle when it been cornered. Its short legs make it a powerful dig.
ports and stops, of smelling and being, of fearful anticipation and grays. Usually, the buck is the drink. Gradually, he is joined by one or two does. The moment the lights go off, however, the deer wildly into the sheltering darkness. Deer are notoriously curious, often they will freeze just outside the ring of illumination thrown by the photographer adjusts strobe until thirst sends them back to the cool again. Some nights, as many as a mule deer will visit a water On another night, oddly, not a one will appear.

The same erratic pattern is followed by the javelina, or peccary — the wild “pig” of the Americas. The javelina, with its short, powerful tusks, much like an Old World boar, is a frizzled, sturdy beast, found only in the extreme southern section of the Sonoran Desert, ranges far down into Mexico and beyond. Often javelina

Hooded Skunk’s neck hair is usually spread out in a handsome ruff. A white line down its nose is an identification aid. It is not found north of Arizona.
travel in herds of three to fifty—e.g., worms, insects, reptiles, nuts, roots, but preferring the succulent fruits of various cactus plants.

In addition to tusks, the javelina carry another powerful deterrent to interference in a set of musk glands when they approach the water hole. All other wildlife prudently leaves. Many as a dozen may cluster at the water's edge, getting down on their calloused knees, grunting, blowing, and lapping noisily. Occasional skirmish will break out but eventually the herd drifts off into the night, allowing the more timid animals to return to the pool.

The low-slung badger is another regular. A heavy-bodied, yellowish cousin of the skunk and weasel, it is also equipped with musk glands. A powerful digger, it lives in ground burrows that it excavates with the help of the extraordinarily long claws on its front feet. It prefers the less country and can be found in the West from Mexico to Canada.

The beauties of the desert are hog-nosed and hooded skunks. Although superficially similar in appearance, the hooded skunk can be distinguished by the white line down the center of its nose. In one phase, the back of the hooded skunk is nearly entirely white—from its roots to the tip of its plumelike tail. In another phase, its back is black, a pair of white stripes on each side. Like the javelina, this skunk ranges south from the Arizona Desert.

At the right is the exquisite, Arizona gray fox, captured on film as it ventured from some hidden canyon in nocturnal foray. This legged eared fox of the saguaro forest has a remarkably well-furred tail, and generally gray coloration is dramatically accented with red. It is rarely seen in the daylight.

Perhaps the most memorable aspect of water hole observations lies in the realization that an apparently harsh terrain has not drastically limited the kinds of life it embraces. Instead, plant and animal communities have formed advantageous relationships that permit them to adjust to extremes of heat and cold, famine and plenty, and eternal lack of water.

Legs taut in anticipation, an Arizona gray fox, right, hunts in desert mud...
MATHEMATICS OF CHANCE: What are the chances that the top ball will fall into the left-hand slot? A trivial point? Not to a great mathematician. When the deeply religious Blaise Pascal answered a similar question to settle a gambler's argument in seventeenth century Paris, he gave mathematics one of its most important tasks—prediction. Using Pascal's famous triangle of numbers, the probable number of times that a given event will happen by pure chance can be determined. In the 300 years since then, the mathematical laws of probability have helped establish the insurance business, enable scientists to predict the molecular behavior of gases, forecast the results of cross-breeding plants or animals, analyze the value of a new serum. The mathematical insight that made all this possible is now being applied to weather forecasting, psychological testing and public opinion research. Probability has become a science that calculates in advance the chances of success of an untold number of events for man's benefit.

*For example, the third line from the tip of the triangle tells us there are four different ways two coins can land: the chance of both falling heads up is 1 in 4; of one head and one tail, 2 in 4; and of two tails, 1 in 4.
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NATURE AND THE MICROSCOPE
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COVER: The Eskimos, despite—or perhaps because of—their harsh, but existent, have created a unique art form in their sculpture, in which the objects and its animals predominate as subjects. The hunter on this month's cover, photographed by Lee Boltin, was carved by Eshaloak, from the Port Harrison area of Hudson Bay; his quarry, a seal, by Kannieeguk from Repulse Bay.

Natural History is indebted both to Nelson R. Perry, the private collector, and to the Canadian Department of Northern Affairs and National Resources for making available the examples of Eskimo art shown on pages 34 to 40.

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The publication of The Evolution of Culture marks the fruition of ten years of labor by Leslie A. White, Professor of Anthropology at the University of Michigan. In order to appreciate the significance of this work it is first necessary to know something of the climate of opinion out of which it arose and to what it was a reaction.

Few persons outside the field of anthropology are aware that the concept of evolution, which has become almost the guiding principle of most other natural scientists, has been for decades rejected by cultural anthropologists. But it has not always been thus. Under the influence of such men as E. B. Tylor, Lewis H. Morgan, and Herbert Spencer, ethnology began with a strong evolutionary outlook; and evolutionary anthropology made many fruitful and enduring contributions to our knowledge of the origin and development of human institutions. For example, the general sequence of events by which man advanced from a hunting, fishing, and gathering economy to a simple agricultural mode of life—and then on to a complex civilization—was established by evolutionist writers by the end of the nineteenth century.

Some of the early evolutionists did, however, commit errors of a sort characteristic of a science in its pioneer stages. An instance of this is Morgan's now-discredited theory that primitive promiscuity and group marriage preceded monogamy in the history of human marriage. This evolutionary sequence probably would never have been proposed by Morgan had more information been available to him concerning the marriage practices of the most primitive peoples then extant.

By the middle of the 1890's, a movement had begun, under the leadership of Franz Boas, to expunge from ethnology those theories of the early evolutionists that, like Morgan's views about the succession of forms of the family, had proved untenable. But the movement led by Boas did not stop at pointing out errors in the early evolutionists' schema: At its height in the 1930's, it had engulfed almost all professional anthropologists, who tended to turn their backs on virtually every kind of evolutionary formulation. Instead, anthropologists concerned themselves largely with the facts of their own field work, or with studies of distributions, diffusion, and the like.

It was in this antievolutionary tradition that White himself was trained. However, as he tells us in his preface, he could not maintain his allegiance to it: "The author absorbed the antievolutionist doctrines of the Boas School as a graduate student. But as he began to teach, he found, first, that he could not defend this point of view, and later that he could no longer hold it."

Thereafter, White began to recultivate the long-neglected garden of cultural evolution. In 1943, his first major article on the subject, "Energy and the Evolution of Culture," appeared in the American Anthropologist, and its publication may be taken as the turning point in professional opinion regarding cultural evolution. Today, even though evolutionary formulations are still modest and tentative, there is a growing confidence that, as the evolutionary approach is applied more extensively, a correspondingly greater understanding of the enormous body of anthropological data will arise.

While a few other anthropologists—notably the late V. Gordon Childe in England and Julian H. Steward in the United States—have played a part in redirecting attention to cultural evolution, the resurgence of interest in this field has been due in large measure to Leslie White.

The work under review, although written and published to stand alone, is intended also as the first of three volumes, which together not only will survey man's cultural development from the Paleolithic to the present, but will also extrapolate current trends into the future. As White tells us: "The present volume will take the reader to the collapse of the Roman state. We propose to follow this work with a study of the Fuel Revolution and its institutional concomitants. And, finally, we hope to project the curve of a million years of cultural development in a modest way and to a limited extent in a third volume on Recent Trends and Future Probabilities: 1958-2058." With this as background, let us see a manner of book White has brought forth. Summarized briefly, The Evolution of Culture can be described as a general treatise on the structure, function, and evolution of human sociocultural systems. It is not, as some may surmise, an episodic account of the history of man's cultural achievements. In fact, throughout most of the book persons, places, and events are all lacking. Rather, the work is intended to be an analysis of the primeval processes, and mechanisms of cultural evolution. Its focus is on the general course of development of human
and on explaining this progress in terms of the forces that White gave it impetus and direction. His is a study of the evolution of culture, and not merely of the forces that White gave it. The title, however, is not dominant the volume to the extent one might suppose. Part I, entitled "Primitive Culture" and occupying nearly three-quarters of the book, is essentially a presentation of the more important customs and institutions of primitive society. The analysis of how they operate is not the continuous struggle of all things for survival and security. This part of the book is concerned more with the origin, structure, and function of things as kinship systems, the division of labor, the clan, and the Indo-European, than it is with tracing their development over a million years of human history. It is not until Part II, "The Agricultural Revolution and Its Consequences," that the exposition becomes fully evolutionary.

The opening chapters contain a forthright statement of White's views regarding the place of culture in nature, and that of the science of culture in the system of the sciences. These views merit close attention. One of White's major premises is that cultural phenomena, as part of the natural world, must be interpreted from the viewpoint of science:

"Uniformities, regularities, and continuities are found everywhere, in systems of all kinds. Custom is merely the name of these attributes within the class of cultural systems. The concept custom thus serves to place sociocultural systems in a context as broad as science itself. . . ."

Furthermore, "The problems of the social scientist in general and of the culturologist in particular do not differ in nature from those of scientists in the physical and biological realms. The basic problems of all science are those of structure and function, of differentiation and integration. The astronomer's objective is to discover the structure of the cosmos, galaxies, star clusters, and the stars and to interpret their behavior. The physicist is concerned with the structure of the atom and the interrelationship of its parts. The biologist wants to know how living things are constructed and how they behave. Like his fellow scientists in other fields, the culturologist analyzes the structures of cultures in general and of social systems in particular and interprets their behavior."

It follows that human behavior and institutions, like other spheres of na-
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Dr. Carneiro, an ethnologist of the staff of The American Museum is a specialist on South American.

degree of solidarity varies inversely with the size; the larger the group the less the solidarity; an intensification of solidarity would mean a diminution in size. The relationship between size and solidarity with reference to the efficiency of the co-operative group can be expressed with precision in the following simple formula: $E = \frac{S \times N}{S + N}$, where $E$ stands for the effectiveness of the co-operative group; $S$ for the solidarity and $N$ for solidarity. If the degree of solidarity remains unchanged, a decrease in size of the co-operative group would make it more effective in the struggle for existence. If ever, the group lost through diminution of solidarity as much as it gained in increase in size, the net result would be zero; it could even lose if it suffered more from a weakening of solidarity than it gained by increase in size, desirable goal of social evolution, the standpoint of success in the competitive struggle for existence, is therefore increase in size without loss of solidarity. But since the factor of solidarity may vary also, we may formulate the following generalization: every society tends to behave in such a way as to achieve that balance between solidarity and size that will give it the maximum effectiveness in carrying on life-sustaining activities.

For decades, anthropologists have tended to classify each other as belonging to a historical, a functional, or an evolutionary school. Members of the historical school studied the events, which they dealt with as particular and unique. Functionalists concemed themselves with the ways in which cultural elements functioned in the societies they studied. Evolutionists noted their attention to tracing the development of significant cultures from one form to another. While this classification is something of an oversimplification, persons identified with a particular school have tended to work within limits of theory and method characteristic of that school. Anthropologists in the functionalist school have been indifferent to problems of theory and development of human institutions. They have studied intensively how societies work within a narrow range of time, but have not turned their attention to examining how and why large-scale changes in human society occur. Accordingly, the belief has grown that evolutionism and functionalism were antagonistic and even mutually exclusive. White, an evolutionist par excellence, destroys this illusion. Not only...
reconcile evolutionism and anthropology as approaches, the sub-lunary work makes it clear that there is a functional relation between these components. That is, because all parts of the system are more or less closely aligned, when, in the context of the technological aspect of evolution, it thereby brings about the emergence of successive transformations, each affecting every part of the Cultural evolution is nothing if not this process writ large.

mentioned, the second part of the book deals with the invention of agriculture, and with the revolution that occurred in man's economic, political, and religious institutions. Here, one chapter discusses processes and steps by which Paleolithic bands were transformed into complex, civilised states. There, it is shown that White concentrates on evolution. Especially important and useful reviewer's opinion, some remarks about the sequence and effect that led from the beginnings of agriculture to the Civilisat.

Traditionally, anthropologists have told this story somewhat as follows: by making it possible, and practical, for a man to produce food rather than rely on his family, agriculture automatically led to surplus of food. Once surplus existed to draw upon, individuals ceased food production and devoted their time and energies to the elaboration of arts and political organization, and, above all, to building.

The difficulty with this traditional view as White points out, is that agricultural peoples exist today in the tools and the time to produce surplus of food—and therefore, theory runs, to go on to bigger and better things—yet these peoples do not produce surplus of food at all and perennially. Evidently, the means of producing an agricultural surplus are, by themselves, insufficient to bring such a surplus about. In the end, there are several factors-economic incentives that, especially, political and military—seem to be necessary for food surplus, with all its social changes, to emerge.

We have already noted that White is interested in the sequence of evolution of any particular region of the world: instead, this is with the evolution of culture as a whole. In pursuing this course of universal evolution White takes pains to avoid the pitfalls attributed to the early evolutionists. For example, he is careful to state that no particular society has to go through any fixed series of stages. That the Bantu tribes of Africa went directly from a Stone Age to an Iron Age, skipping a Bronze Age, contravenes nothing. It is only in the evolution of culture as a whole that a Bronze Age necessarily precedes an Iron Age. The process of diffusion renders it unnecessary for each individual society to recapitulate every stage of the development of culture as a whole. When he does refer to the culture histories of specific peoples, White neither ignores nor minimizes their differences. He notes that, in addition to diffusion, different environmental conditions may give rise to variations in the course of development of particular societies. In discussing the origin of agriculture, for example, he writes:

“We are still faced with such questions as, 'Why did agriculture begin, in the Old World, about 8000 B.C., rather than 50,000?' and 'Why did it begin where it did rather than in other places?' We must look to environmental-climatic and physiographic-factors...for the answers to these questions.' This recognition of the influence of particularly raises no theoretical difficulties in White's view: "...the culturologist is trying to formulate laws of behavior of cultural systems in general. Like the physicist, he wants valid universals. If one wishes to deal with particulars, with particular cultures or particular falling bodies, then allowance must of course be made for particular conditions in each instance."

Those who have followed White's writings on cultural evolution, and have looked forward to the publication of this work, may find it less in the way of evolutionary formulations than they had expected. They may also feel that, while the contrast presented between primitive society on the one hand and early civilization on the other is most enlightening, the process by which the transformation from one to the other took place might have been discussed in more detail. The reviewer suspects that much of this will yet appear in the still-to-be-published second volume of the trilogy.

But let no one think that the present volume cannot stand alone: it most certainly can. Indeed, it is a work that will richly reward anyone seeking to go beyond facts to interpretations. As an introduction to human societies as working systems and as an exposition of the motive forces underlying the great changes in the history of human culture, no other book is in the same class.
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THE SKY IN REPLICA

By Joseph M. Chamberlain

MACHINES designed to show the relative motions of the sun, the moon, and the planets have been constructed since the beginning of the Christian era—and, possibly, at even earlier dates. The first of these mechanical models in modern times was that built by Christiaan Huygens (1629-95), Huygens, the Dutch philosopher and mathematician, solved many of the mathematical problems involved in the relative motions of the planets, which entailed the same problems that must be solved for present trains of similar instruments today. In England, a similar orrery type was built for Charles Boyle, the Earl of Orrery (1676-1731), in which the name “orrery” is still applied to the models of the solar system. Machines usually consisted of a number of globes, each representing an object in the solar system. The globes were supported by metal rods, were driven by gearing at a central point. Some elaborate orreries demanded the planetary satellites as accurately relating the satellites’ movements to those of the planets. The elaboration of the latter’s gear trains could only be appreciated.

One of the most elegant of these orreries was on exhibit for several years at the Franklin Institute in Philadelphia. Known as a Rittenhouse orrery, it was built for the College of Philadelphia in 1771. A remarkable device, accurately indicating as it did the Keplerian laws of the planets, both the Fels Planetarium and the Buhl Planetarium and Institute of Science in Pittsburgh today exhibit the modern part of these orreries, the so-called “planetarium” built by M. Sendtner of Munich. In addition to representing the planets, Sendtner’s planetariums have the advantage that observers may look through one glass surface of the enclosing sphere and, on the opposite surface, see the stars and their characteristic formations with the planets in changing positions and changing locations among them.

Another variation to the orrery or planetarium was constructed in 1913 for the Deutsches Museum in Munich. A model of the solar system according to Copernicus’ distinguishing features were its size and its earth-like rotation. Attached to the center of the ceiling of a room forty feet in diameter was a “sun” globe, ten inches in diameter and containing a light that provided illumination of the entire room. Mercury, Venus, the earth, Mars, Jupiter, and Saturn were represented by balls with diameters about an inch and a half to about eight inches.

They moved around the sun with speeds proportionate to their natural velocities (the earth, for example, completes a “year” in about twelve minutes).

Earth orientation was achieved by mounting a single-passenger carriage at the point where the ball representing the earth was attached. This carriage moved around the earth. An observer riding in it, and seeing the planets through a periscope as lighted by the sun against a background of constellations painted on the walls of the room, could readily appreciate the Munich orrery’s similarity to our own solar system. In effect, he saw an artificial sky that imitated the skies as seen from the earth. Of course, all comparative sizes and distances were distorted, and only one observer at a time could ride on the earth carriage. Fortunately, the Munich orrery was destroyed during World War II. The American Museum-Hayden Planetarium and the Morehead Planetarium at Chapel Hill have similar models, but without the carriage-and-periscope arrangement.

Another type of planetarium gives a somewhat superior reproduction of the skies to a few more viewers. One of the oldest examples is known as the Gottorp Globe. Finished in the 1760’s, it was eleven feet in diameter, weighed three and a half tons, and was so constructed that twelve persons could enter it, stand on a platform within it, and see the sky as viewed from the earth, rather than from space somewhere beyond the earth. The Gottorp Globe had a typical map of the sky on its inner surface, and many stars were represented. Originally driven by water power, it rotated once every twenty-four hours.

Before the start of World War I, Dr. Oskar von Miller, creator and director of the Deutsches Museum, approached the Carl Zeiss firm in Jena regarding construction of a planetarium that would show the movements of the heavenly bodies, on the interior of a hemispherical dome, in the same manner as they appear to an observer on the earth. The first idea was to represent the stars by small electric bulbs attached to the dome, while the dome rotated around an axis parallel to the earth’s. The sun, moon, and planets were to be represented by illuminated disks, driven by suitable gearing in such a way that the orbits of the objects would be demonstrated. It soon became evident that it was impossible to solve the problem in this manner, and the outbreak of World War I then put a stop to the work.

Dr. W. Bauersfeld, of the Zeiss works, is credited with the suggestion that the problem be solved by means of projectors. “The great sphere (the planetarium dome),” he
After the War, work was begun once again. In August, 1924, after nearly five years of design and construction, the first modern planetarium instrument was produced. The illusion of reality surpassed the expectations of Miller and even of the Zeiss people themselves.

The prototype instrument was limited in latitude motion and had only one spherical star projector, but these faults were soon corrected. The dumbbell-shaped device that since became synonymous with popular astronomical projection was designed and put into production. Twenty-six of these later models were built; most of them were sold in Europe, and six have been erected in the United States. The projection apparatus is about twelve feet long, a large globe at each end. Each globe contains projectors for the fixed stars, one for the Northern Hemisphere sky and another for the Southern.

The main structure, containing all the projectors, is designed to turn independently about any one of three axes. It may turn about an axis parallel to the polar axis of the earth. When this motion is used alone, the effect is to transport the images across the dome in exactly the same manner as the daily rotation of the earth apparently moves celestial bodies across our sky each twenty-four hours.

Second, the machine may rotate about an axis perpendicular to the plane in which the earth moves about the sun. But other motions in use, the effect of this is to swing the North Pole of the sky around the circle that it makes in 26,000 years in the course of the precessional "wobble" of the earth's axis. Thus one can, in effect, go forward or backward in time. For example, the lecturer can reverse the instrument back some 5,000 years to 3000 B.C., when Draco was our "North Star." Or, by putting the instrument ahead some 12,000 years, he can show Vega at the North Pole of the heavens, and the Southern Cross visible from the latitude of New York.

Finally, the instrument embodies a horizontal axis rotated from the east to the west. Rotation about this axis transports the images on the dome as if the viewer of the show were traveling along a meridian of the earth from pole to pole. This motion is used to demonstrate the zodiacal appearance of the skies from different latitudes, at one time or another, the apparent movement of the sun across the sky, and stars from the North Pole or traveling south, past the Magellanic Clouds, Canopus, and the Southern Cross as they are seen below the Equator.

The slides for the star-field projectors are pieces of superimpression on a silver base with small, round holes punched in them for the stars. These punchings vary in size according to the brightness of the real stars they represent. Nearby objects, such as the planets, the sun, and the moon, which move to the background of the stars from day to day, are represented by separate projectors having independent motion on the main part of the machine.

The prime movers for the machine are small, three-phase, alternating current motors; reversal of phase accomplishes reversal of direction. Transmission and interconnection are accomplished by gearing. Motions that are additive are joined through planetary transmissions. The motions and lamp circuits are all controlled from a switchboard in a lecturer's stand near the wall of the room.

Today, the United States contains ten major planetariums. Six of these—in Chicago, Philadelphia, Los Angeles, New York, Chapel Hill, and Pittsburgh—are Zeiss projectors. Two—at Flint and Colorado Springs—are instruments produced by the Spitz Laboratories, of Yorklyn, Delaware, and two—in San Francisco and Boston—were constructed specifically for previously established museums according to their own engineering specifications.

All ten share several physical characteristics; each produces a highly realistic artificial sky in which can be demonstrated diurnal and annual motions of the earth, latitude change of the observer, geocentric motions of the naked-eye planets, and the 26,000-year precessional cycle of the earth's axis of rotation. The domes vary in size from fifty to seventy-five feet and the seating capacities range from about 250 to over 800 persons. In each, the projector is the central attraction in an astronomical museum, which in most instances is a part of a larger organization. All cater to public audiences, and all—but to a widely varying extent—accommodate school and youth groups. Topical demonstrations of an astronomical nature are presented daily, with a change of theme monthly or bimonthly.
most operate with subsidies or other support from a board of trustees or a city-related management board. None has a profit motive beyond the healthy goal of fiscal solvency, and all (except for the Air Force Academy installation) charge admission fees, though not for all visitors.

Over a hundred and eighty smaller planetariums have been installed in colleges, high schools, museums, and private homes across the country, in domes with seating capacities of twenty to one hundred persons. Many are used to supplement astronomy instruction in the schools, and may be utilized regularly for scheduled classes. Others are used much in the manner of the larger units, but on a smaller scale. Some have been so well planned and so expertly administered that their value within their home communities may be said to rival that of the major installations.

What of the “homemade” pair? Late in the 1940's, it was decided to establish a planetarium in San Francisco. Funds were raised by the California Academy of Sciences for the purpose, beginning with a gift of $200,000 from the estate of Alexander F. Morrison. A Zeiss instrument was not available at the time, however, so the Academy constructed a projector of its own design in the excellent shops that had been used to repair optical instruments for the Navy during World War II. Certain basic features of the Zeiss instrument were incorporated but many improvements were made.

The San Francisco projector is quieter in operation than earlier instruments. The hemispheres containing the star plates have been brought closer to the center, giving better distribution of weight and improving the instrument's appearance. The planet projectors, which are in construction, have been placed at the two ends of the instrument, instead of at the waist, as in the Zeiss design. The moon is not just a round, white disk but an actual photograph of the moon projected on the dome. The stars themselves give a greater illusion of reality.

The other “homemade” planetarium was recently unveiled for public demonstration at the Charles Hayden Planetarium of the Boston Museum of Science. Although the planet, sun, and moon devices are not yet complete, demonstrations using the stars have been given since October, 1958. The projector is being built by the brothers John and Frank Korkosz of Springfield, Massachusetts, who built a smaller planetarium for the Springfield Museum some years ago.

The Korkosz instrument, like the one in San Francisco, is based partly on Zeiss principles, but has the star projectors mounted near the center rather than at the ends. Also, the machine has a "semisphere" and four "quar
Stars of the first magnitude are projected from the semispheres, those of the third, fourth, and fifth magnitude are projected from the quarter-spheres. A thousand-watt bulb is used in each unit for the bright stars, five-hundred-watt bulbs for the fainter stars, and still smaller bulbs for very faint stars. Eighty-eight projection units cast images of dual bright stars. The resulting sky contains no star greater projected diameter than one-half inch.

Planetariums built by the Spitz Laboratories, to be in Flint and at the Air Force Academy are designed comparable to the Zeiss instrument. In appearance, they are similar, but there are several differences. As in the Eisinga orrery, with wooden clockwork, was built about 1775 in Netherlands. Six planets move around pivotal "sun."
SINCE 1953, a number of scientists and mechanics have been working at the Zeiss factory in Oberkochen, West Germany, on a new planetarium series with numerous technical improvements and amplifications. Perhaps the most significant improvement involves the representation of star magnitudes. The problem of restricting the diameter of the projected stars to a certain limit, while retaining the natural relative brightness of the images, has been solved by using special projectors for the forty-two brightest stars. These special projectors, as well as three special projectors for the three variable stars and two special projectors for the Milky Way are all situated between the star balls and the planetary frameworks. The remaining nine thousand stars shown by the new Zeiss instrument are produced by a new photochemical method on fixed star plates. Improved, coated optics further enhance the quality of projection. Other changes include a redesigned moon projector and a greatly amplified range of motions to enable the lecturer to control the moving sky more fully. The first of these instruments in the U.S. was installed last month at The American Museum-Hayden Planetarium in New York.

The competing Zeiss factory in East Germany has also re-established a planetarium department since World War II, having produced a new model instrument for Stalingrad in 1954, and others since. There, too, attention has been directed to reducing the size of the projected images of the bright stars. Copper foils embedded between glass plates serve as transparencies for fixed-star projection, as in the earlier instruments. However, in the former foils, the sizes of the holes ranged from .023 to .075 mm. In the newer model, the holes range only from .023 to .045 mm. Another significant change is the provision of infinitely variable drives for diurnal and annual motions.

The time may not be far distant when planetariums will be as numerous as museums. In this age of emphasis on science, such a trend is more than welcome; it is mandatory. For, in modern context, "planetarium" connotes a great deal more than a model of the solar system. It refers not only to the instrument and its great hemispherical dome; the word goes on to embrace exhibits concerning astronomical, navigational, and related subjects, and instruction in a field of interest that weighs ever more heavily on today's imagination—accomplishments along the new frontier of outer space. In the second half of the twentieth century, centers of information in this field are no longer the playthings of latter-day Earls of Orrery; instead, they are very nearly necessities for most modern communities.

NEW PLANETARIUM's parts are numbered in drawing, right. Ruffs at bases of two large spheres (1) project the forty-two brightest stars. The two spheres (2) project all other stars. Tiny spheres at each end (3) project constellation outlines, while pair of cages (4) house projectors for sun, moon, and planets. At center (5) are motors that move the instrument, gear housing, and the supplementary projectors.
Ways of the Wolverine
Wolverine on the alert is seen in typical pose here, as it sniffs the air. More cautious than most animals, even in safe situations, creature will habitually seek high ground when awake, but when exhausted will go to sleep anywhere.
animal inhabits a vast area which it is peculiarly adapted

By Peter Krott

LARGE MAMMALS were as little known as the wolverine, until recently. In fiction, this animal is cast in a role best described as “the demon of the snow,” a role which it is peculiarly adapted to. Yet we should not be surprised at this: the wolverine lives in very small areas and is a shy, extremely cautious animal. Therefore, even the most enthusiastic mammalogist, roving the northern forests, will seldom, if ever, see a wolverine, let alone be able to study one closely.

A large part of the wolverine lore upon which writers of fiction and zoologists alike depended was derived from the people of the northern regions—trappers and, in Europe, the Laplanders. And reliable these informants were! Indeed, there is no reason to doubt that the people of the northern regions detest playfully; but playful exploration is part of animal’s way of learning.

During almost twenty years of residence in Northern Europe, I have come in very close contact with this strange animal. As I grew more and more interested, I finally decided to remove to the land of the wolverines for a certain time, so that I might literally live with them and study their behavior. This seemed the only practical way to learn something of the habits of these shy animals.

In the forests of Sweden, where I undertook my major experiment, four wolverines—which I took from their

Wolverine at play momentarily pauses while rolling in the snow, a very frequent habit even when animal is traveling.
nest as cubs and bottle-fed at home—were invaluable animal assistants. My wolverine children were always able to move about freely. When they did not need the bottle any more, they began to roam far out into the land of the wolverines, which extended for many miles beyond my cabin door. But these hand-raised animals never lost their ties to me and my wife. They visited our cabin, allowed us to follow them on their secret paths, and finally also brought us in contact with the wolverines living wild in our area.

Wolverines are the largest of the mustelines—a subfamily that includes the mink, marten, weasel, and ferret—and they are closely related to the martens, with which they share some common characteristics. The Old World and New World wolverines have been considered in the past to be different species, but most students presently regard them as only subspecifically distinct, with Gulo gulo gulo in the Old World and G. g. lugens in the Western Hemisphere. My own opinion is that even subspecific separation is based on characters too trivial for this degree of recognition. The skull material which I have examined and compared does not reveal distinct differences between the two. Nor can they be divided on the basis of the size and the quality of their pelts. The fact seems to be, rather, that geographically, from Alaska in the west until one reaches Manchuria in the east, wolverines decrease in size continually but insignificantly and that, proportionately, the quality of their pelts decreases somewhat. But the differences are very small and one is amazed at the uniformity of the species in its vast area of distribution.

Today, the wolverine is an animal of circumpolar distribution, primarily inhabiting the northern coniferous forest region. It cannot, however, be found everywhere in this region and, even where found, it is only sparsely represented. In contradistinction to most of the northern beasts of prey, the wolverines' area of distribution has hardly decreased in historical times. Man has driven them only from some southern fringes of their habitat, such as some parts of the U.S., southeast Canada, Estonia, Latvia, Lithuania, northeast Poland, and some Russian provinces.

The length of the wolverine's body is little more than three feet, and eight inches of this length consists of the tail. The height at the shoulder is about seventeen inches; weight can be upward of seventy-seven pounds, but the average weight of adult males I have seen in Europe is about fifty-five pounds. Females are a quarter to a third lighter and also smaller. The animal is built for endurance. Indeed, it is lumbosacralized. The extrinsic muscles are acutely angled when the animal is at rest, and the soles of the feet are thick and the whole muscular system is highly developed. The wolverine's locomotion on the ground can be compared to the snapping of a spring. The wolverine becomes sexually mature in its fourth year, but the sutures of the skull are grown together at this time, the teeth are also fully developed.

Like most mustelines, the wolverine has numerous very active glandular organs, of which we mention a pair of anal pouches that secrete a malodorous, yellowish green fluid (in my opinion, however, of a far more unpleasant odor than that of the skunk). The wolverine is, incidentally, to spray this fluid for a distance of nine feet. The yellowish spot on the animal's abdomen further points to the existence of glands in front of the genitalia, something not often found in the animal kingdom. Like the marten, the wolverine also has a special throat area: in the wolverine, however, this is not smaller. Frequently it is scattered in little dots, and sometimes the spot is missing altogether. The possible glandular nature of this has not yet been investigated.

The fur of the wolverine is, I believe, the most wonderful fur ever borne by an animal. Presumably due to the specially wide angle of insertion of the strangle bristles and of the long, only slightly curled, and matted woolen hair, the coat never hardens, even when subjected to freezing temperatures. The Eskimos prize the fur of the wolverine for facial protection and pay the trapper a good price for it.

It seems odd that a virtually omnivorous beast of considerable size should be ecologically bound to the northern coniferous forest region. Still, this is a fact, one for which in my opinion the wolf is responsible. The wolves apparently confine the species Gulo to the swamps areas of the coniferous forest region. Populations of wolves are much smaller in these wooded locals than in treeless ones. Furthermore, the wolf cannot rear young in large swamps during the snow-free season. Finally, a wolverine, when engaging a wolf in a powdery snow, the wooded areas, proves superior—as I have had occasion to see. If the wolverine has to deal with such...
he can always rescue himself by climbing a tree. In treeless mountains and tundra proper, on the hand, the wolverine enjoys none of these advantages. For that reason, they have seldom been found in the past. But, interestingly enough, the wolverine is a rather nomadic animal, as many people have discovered. Each inhabits a definite—although very large—territory. In Scandinavia, I found one male to have an area of about a half-million acres. These territories have a rather distinct population structure. A male wolverine shares his realm with two or three bitches, and does not allow another male to enter his territory. Yet the male does not associate with the bitches for only a few weeks during the rutting season. Each bitch, in turn, inhabits her own subterritory within the male’s larger preserve all year. In such a subterritory, another bitch is not admitted. It was very interesting for me to observe that the boundaries of the wolverine territories are marked by mutual, strict respect for these limits.

Individuals recognize the territory peculiar to each individual by its feces, by the scent of the individual’s spoor and, above all, by the scent marks that the animals post regularly by rubbing their ventral sides at certain points. Besides all this, the wolverines mark their territories—as do dogs—by the discharge of urine.

Wolverines do not wander aimlessly about their territories, but stick to certain trails. These, however, are not narrow paths but, rather, strips of terrain about half a mile in width. These trails are not like those of other northern game; for the most part, they run in a wide, serpent-like line with frequent changes of direction. The vast extent of wolverine territories makes it impossible to say where, exactly, the wolverine will appear at a certain point on its trail. When the animal scents carrion or suspects danger, it leaves the trail at once.

The diet of the wolverine is markedly different from that of other carnivores. Above all, it is a carrion-eater, preferring this to any other food. But the wolverine feeds on other things, too. In the early summer, for example, the eggs of ground-breeding birds are a favorite meal. It searches for clutches mainly on the banks of rivers and lakes, and in swamps, and does not despise the eggs of even the smallest warblers. Later in the summer, the larvae of wasps constitute the daily menu, despite the stings of the furious insects. Be the nests terrestrial or arboreal, for days on end our animal does nothing

Habitat is shown here. Type of country remains the same both seasons, but in winter the animal can cover a wider area safely, hence is more predatory. During summer, its range is narrowed and its diet also includes vegetation.
Trail of footprints is broken when wolverine takes a roll in the snow. The animal's tracks are comparable to those of the bear, although shorter and much narrower. Its habit gait is a gallop and, when hurried, a leap; trotting is r
search for and greedily plunder the wasps. Then it replace wasp larvae as a favorite food and, for a time, the wolverine, like the bear, feeds only on the softest parts of the tundra plants. By the far, however, the warm season begins. From the far north and across to the far south, the summer, snow-free season, our animal has, of course, no need to do this; the other northern game is far superior in abundance and speed. Further, wolverines, as you know, cannot move with swiftness. They make, in fact, no effort at all to suppress their appetite, compared to them, bears move almost inaudibly. In the summer, therefore, the intended victims of the wolverine are almost always warned of an approach in time to escape.

In winter, this situation changes fundamentally. The winter, of course, allows the wolverine to make a more efficient approach. But, more importantly, in the snow our animal is far swifter than its victims. With widespread caches of food, the wolverine moves effortlessly even in the softest snow, excelling all other northern mammals. In the snow, then, it becomes a terrible enemy, preying even on the moose and the lynx. In Northern Europe at this time of year, wolverines are the scourge of the Lapland's domesticated reindeer while in summer, when reindeer calves are born, they are less harmful.

The appetite of the wolverine is relatively modest. Once the snow covers our animal is not even interested in an arctic hare that may arise out of the snow only a few yards away. Furthermore, it is not generally known that wolverines possess large "food depots." Digging deep holes either in a frozen swamp, in soft ground, or in the snow, they store the remainder of the prey they have killed or the carrion they have found. These caches are neatly covered with snow or with snow, but the animal is able to find them again with unmistakable certainty. If the nature of the ground is not suitable for building such caches, the wolverine takes its food up into a tree—in most cases a pine tree—and hides it very skillfully at the angle of branch and trunk. The food is pressed so tightly into these angles that not even severe storms dislodge it.

The rutting season of the wolverine comes between April and August. Like many other members of the weasel family, wolverines have a prolonged gestation period. The bitch brings forth an average of two to three young some time between February and April. The beginning of the rutting season and, of course, the birth season, seems to be related to the latitude and altitude of the wolverine's territory: high latitude and a far northern latitude cause a delay. A bitch is in heat only every two to three years; the male therefore need associate only with one of the bitches in his territory for a short time each year.

The cubs, which weigh only some three and a half ounces at birth, remain blind for about four weeks. They are suckled by their mother up to ten weeks. Their first solid food are pieces of carrion from the caches set up

Climbing a tree, wolverines try to reach food cached in branches. Normally, food is hidden in holes in the ground.
Eggs are found in ground-breeding species' nests by rivers or swamps.

by the mother. She carries these gobbets—well mixed with saliva — to the den and regurgitates them in order to give them to the cubs. The young remain in their nest for six to eight weeks, and then leave it under the watchful eyes of their mother and move gradually farther and farther away with her. Already, in their first autumn they will follow her on long hikes. As early as the fifth month, they are well acquainted with the ways marking a territory and are masters in the hiding of food in caches and trees. However, the young wolverines are able to prey independently on larger living animals or in the second winter of their life.

The young, who have no contact with their father, stay with the mother up to the age of two years. For the length of time, they are also tolerated by the male within the confines of his territory. Later, the young bitches are driven away by their mother and young males by their father, unless there is a vacancy in the territory.
Unlike many other animals, the wolverines do not know inactive periods. Most of the time, they adhere to a peculiar rhythm of sleeping and waking: three to four hours are devoted to sleep, they are active for the remainder of time, and then the cycle repeats. However, they will sleep through days of heavy snowstorms unusually heavy rain. On the other hand, dry weather with a stiff wind, a full moon, or a bright aurora will keep a wolverine specially active and it will not rest for full twenty-four hours. Strong hunger also keeps a wolverine awake.

Our animal spends most of its life on soft ground, in snow or in swamps. Its normal gait is the gallop, the snow is very powdery or the wolverine is in a hurry, it leaps. Unlike the dogs, wolverines seldom do. Their tracks show mostly the characteristic pair-step of the martens: they take maximal advantage of the wind. In deep snow a wolverine digs itself forward like a lemming and, particularly when playing, rolls along with repeated somersaults. Our animal likes to climb and can climb head-down but, unlike arboreal martens, never jumps from one tree to another. However, I have observed a wolverine hanging by hind legs only from a strong branch nine to twelve feet above the ground and swinging freely!

Wolverine endurance in locomotion is incredible: they are able, when pursued, to cover over forty miles without rest. I once checked the distance covered by an eight-month-old male in one night. It was twenty-one miles!

It seems to me that the wolverines' sensory organs are not more highly developed than those of other mustelines, even though some advantage might be assumed for an animal that holds its own so successfully. The wolverine's senses of smell and hearing, while excellent, seem inferior to those of the wolf. On the other hand, wolverines take precautions more often than other animals. Even in what appear to be safe situations, they move to elevated terrain features, climb rocks and treetops or cock themselves on hind legs like a hare. They will even on occasion rise on their hind feet like a bear.

The wolverine plays more than other beasts of prey, almost more than the otter, which is well known as an animal extremely fond of play. The wolverine may play by itself, with an object, or with a partner; he plays...
Ready to leap, a wolverine stands tensely poised. Easily covering five feet in high jumps, creature is less skillful both as a cub and as an adult animal. The consequences of the wolverine’s fondness of play are all too well known to northern trappers. They break into cabins, carry away traps, snowshoes, and skis, tear covers and tents, and make general havoc. But the great activity of the wolverine expresses itself not only in playing, but also in the animal’s ability to learn, which is considerable. By ability to learn, I mean the individual animal’s capacity to change behavior in certain situations, without these changes of behavior being caused by nervous processes accompanying growth and maturation. Our animal behaves very plastically; in many sensory phases, the wolverine is able to learn something that is quite new to its innate modes of behavior.

This love of play and ability to learn are, I believe, the basis of the wolverines’ extraordinary ability to evade dangers. In that respect, they are far superior to any other northern mammal, including the wolf. They soon learn what is and what is not dangerous. Of course, many elements play a role in helping the wolverines to evade dangers that other inhabitants of their territory cannot escape: their unusually great endurance, even in deep snow; their habit of describing wide, serpentine lines that frequently change in direction; their strength, extraordinary for their size; their formidable dentition; and, above all, their habit of fleeing whenever something appears to be strange. I have often seen a bitch forsake her young unhesitatingly—and, in most cases, in good time—when a hunter came close to the nest. On the other hand, a cornered wolverine is the worst enemy one can imagine.

After all we have seen here, we should not be surprised that it is extraordinarily difficult to hunt the wolverine. A diminution of their numbers is possible only if one locates their nests, kills the young, or takes them alive to the zoo. But even that sounds simpler than it actually is, for the natural habitat of the wolverines is vast and their nests sparsely scattered and hard to find. One seldom succeeds in catching a wolverine in a trap. Even when so caught, it bites off the trapped limb and escapes—as a cripple. In addition, wolverines show considerable immunity to poison. They can even take strong doses of strychnine without dying, as I had an opportunity to observe in Finland. Indeed, the bad name these animals enjoy rests not so much on the actual damage they inflict upon man, but rather on the fact that they are so difficult to catch or to kill; for we detest most what we cannot subdue. All the superstition of the North regarding the wolverine can be attributed to this apparent invincibility.

Wolverines are, of course, also capable of quite different behavior. With the same perfection with which they learn to avoid dangers and evade man, wolverines brought up with the bottle learn how to live with man. My wife and I raised thirty young wolverines altogether and we concluded that no wild animal brought up by man becomes more faithful to his nurse and remains so even as an adult. At first, this may sound strange, but it is not. It is only striking—like so much in nature which is always full of wonders.
COUNTRY RUN is caught by camera. Wolverine moves fixed trails, but these are not narrow paths. Rather, they are strips of terrain up to half a mile wide, usually winding and seldom coinciding with routes of other animals.
SKY REPORTER

By Simone Daro Gossner

Although the Pleiades are now included in the constellation of Taurus, they were regarded as a separate asterism by the early Greeks. They are one of the original constellations described by Aratus (third century B.C.) in his poem Phainomena. According to the prevailing myth, the Pleiades were daughters of Atlas and Pleione. Aratus lists their names as Alcyone, Merope, Celaeno, Electra, Sterope (or Asterope), Taygete, and Maia. In so doing, he was possibly quoting from a history of Atlas and his descendants composed in the fifth century B.C. by Hellanikos of Mytilene. Aratus adds that, although there were seven sisters, it was possible to see only six of them in the night sky.

This reference to a lost Pleiad is so general in the legends of ancient peoples that it must stem without a doubt from a genuine astronomical “disappearance” in the remote past. Unfortunately, the ancients left no clue concerning the correspondence of the seven names with individual stars in the cluster. They were themselves at a loss to say which sister—let alone which star—disappeared. As recalled by Hyginus, one legend claims that Merope’s light was dimmed because she was the only one who married a mortal; he also tells of Electra’s sorrow at the fall of Troy (founded by her son Dardanus) and of her withdrawal from the mundane activities of her sisters.

Medieval and Renaissance editions of Aratus’ Phainomena have yielded some remarkable illustrations, in which the artists have shown, as a rule, much greater concern for aesthetic effect than for the accurate depiction of the asterism. The charmingly cross-eyed Pleiades shown at the right grace a fifteenth-century German manuscript. Their more classical counterpart was engraved by the Dutch artist Jacques de Gheyn for the Gratius edition published in Leiden in 1600.

The names of the sisters and their parents have been retained to the present. The modern attributions have been superposed on a photograph of the cluster, upper right, from Mount Wilson and Palomar Observatories.

The importance attached to the Pleiades by the ancient Greeks may have been due in part to their peculiar position in the sky. The times of the year at which they rose or set with the sun were closely related to the farming calendar of the Mediterranean Basin. They were said...
Pleiades’ position, in constellation of Taurus, is seen at left. The nine modern attributions are surprinted, above.

...other parts of the world, the names by which the cluster was known were as varied and colorful as the stories from which they sprang. In India, it was the eye of the fire god; the Chinese saw in it the seven stars of industry; the Hottentots called it a company of nurses who had shut out their husbands; the Abiponeans of Paraguay revered it as their grandfather. Not to be outdone in variety, European folklore yields a sieve in Finland, a group of old wives in Poland, a setting hen in Russia, and a chick incubator (poussinière) in France. The Pleiades are no less interesting from a purely astronomical standpoint. The visual telescopes of the eighteenth century had already revealed the existence of a patch of nebulosity around Merope. After the introduction of celestial photography in 1851, it was discovered that not only Merope, but the whole surrounding field was embedded in nebular material. This is a mixture of gas and dust, which is dimly illuminated by the light of the stars that it surrounds.

Although a person with average vision may see only six stars in the cluster, one endowed with an unusually keen eye might count from eleven to fourteen. In fact, there are about twenty-five stars just beyond the range of human vision, and the telescope reveals several hundred more within a radius of less than a degree from Alcyone. All stars within the cluster share the same motion in space and undoubtedly have a common origin. It has been estimated that the cluster lies at a distance of approximately 400 light-years. Thus, the fight we now see left the Pleiades in the times of Elizabethan England.

Most remarkable feature of this region has been detected by means of radio telescopes during the last three years. Radio telescopes observe radiation at wave lengths that are outside of the optical range. They can thus reveal the presence of celestial objects that are too cool to be luminous. By observing the 21-centimeter radiation of neutral hydrogen, it was found that there are a number of isolated sources of such radiation within the limits of the Pleiades cluster. The mass of each source may be estimated roughly from the intensity of the signal; the values obtained for these masses were in remarkable agreement with the mass of a star in formation, as predicted from theory. Thus, it is reasonable to assume that stars are still being born among the Pleiades. The French poussinière may not be so far fetched after all.
THE SKY IN FEBRUARY

From the Almanac:

- Moon at First Quarter: February 4, 9:27 A.M., EST.
- Full Moon: February 12, 12:24 P.M., EST.
- Moon at Last Quarter: February 19, 6:48 P.M., EST.
- New Moon: February 26, 1:24 P.M., EST.

For the visual observer:

With the exception of Mercury, all the planets will appear in the morning sky in February. Mercury will be at its greatest eastern elongation on February 23. It will be too close to the sun for observation during the early part of February. Although it will become slightly more favorable as it moves away from elongation, it will appear very low over the western horizon and will remain difficult to see. It will set approximately an hour and a quarter after the sun from February 15 to 29.

Venus (magnitude -3.4) will be a brilliant morning star. It will rise two hours before the sun on February 1, an hour and a half before the sun on February 15, and an hour and a quarter before sunrise on February 29. On February 7, it will form a close pair with Saturn, the two planets being only two-tenths of a degree from each other on that date. On February 24, Venus will pass about four degrees south of the waning moon.

Mars (magnitude +1.5) will rise approximately one and three-quarter hours before sunrise during the whole month of February. By sunrise each day, it will still be low over the southeastern horizon.

Jupiter (magnitude -1.5) will be found east of Antares, in the constellation of Sagittarius. It will rise three hours before the sun on February 1, three and a half hours before sunrise on February 15, and four hours before sunrise on February 29. By the end of the month, it will be low in the southern sky by sunrise.

Saturn (magnitude +0.3) will also be found in Sagittarius, trailing Jupiter by somewhat over an hour. Accordingly, it will rise approximately one and three-quarter hours before the sun on February 1, two and a half hours before on February 15, and three hours before on February 29. It will be low over the southeastern horizon at sunrise.

Constellation study:

Early evenings in February afford the observer his last look at the winter skies. Many of the brightest stars visible in the Northern Hemisphere are conveniently grouped above the southern horizon, providing the beginning student with a guide to their respective constellations.

Facing south, at about 10 P.M., one should first locate Orion, slightly to one's right. This large, lopsided quadrangle with three stars (Orion's Belt) strung across its middle, is a striking and easily recognized group. The star map will help identify Betelgeuse and Rigel, composing the upper left and lower right corners, respectively, of the quadrangle. The bright red star to the right of Betelgeuse is Aldebaran, in Taurus, with the Pleiades a little farther beyond. On the other side, the first bright star to the left of Rigel is Sirius, the Great Dog Star. The Little Dog, Procyon, forms an equilateral triangle with Sirius and Betelgeuse. A straight line from Rigel to Betelgeuse leads directly to the constellation of Gemini with its twin stars, Castor and Pollux, close to the zenith.

The former Astronomy Editor for Nature Magazine, Mrs. Gossner, continues in that role for Natural History.
Majority of Eskimo sculpture shown on these pages comes from east coast of Hudson Bay and Baffin Island.

ART OF THE ESKIMO
The sculpture of these people captures the spirit of the chase.

By EDWARD M. WEVER

Bound inseparably to a hunting life from early times, the Eskimos have produced an art that, like their philosophy, their poetry, and their daily conversation, is redolent of the spirit of the chase. Various phases of this art may be distinguished. Archeological specimens, for example, prove that the artistic flair of the Eskimos is ancient. Elaborate, curvilinear designs ornament the hunting weapons of the Old Bering Sea culture of about 2,500 years ago. Stylized figurines and carved animal forms are found in some of the later stages. The acquisition, at least a thousand years ago, of iron from Siberian tribes influenced the engraving of bone in the Punuk period, producing abundant "compass-drawn" circle-and-dot designs. The Eastern Eskimos, in turn, received iron from the Norse, probably as early as the twelfth century A.D. But is was apparently not until early Russian traders encouraged the production of hunting scenes in walrus ivory that such subjects became a characteristic form of Eskimo art. Realistic figures in stone, like the ones shown on these pages, came even more recently. They depend for their execution on a varied supply of scrap metal—the castoff files, saws, and other implements of Western man.

PHOTOGRAPHS BY LEE BOLTIN

A single man has played a prominent role in stimulating the Eskimos to produce this type of art. Returning from the east coast of Hudson Bay in 1948 with a representative collection, James Houston was encouraged by the Canadian Handicrafts Guild, a non-profit organization, to procure enough pieces to test their appeal on the general public. The next year, Houston brought out about a thousand objects, and a one-week fair was arranged in Montreal. All of the pieces were sold in the first three days.

Eskimos all the way from Hudson Bay to Ellesmere Island in the far north were encouraged to carve, and a majority, including youngsters in their teens, responded. By 1954, sixteen traveling exhibits had been organized and about 25,000 pieces sold. The income received by the Eskimos has provided an important cushion against the economic difficulties they have suffered in their adjustment to contact with civilization. And they enjoy the work.

Man with ivory fish seems to be thanking heavens for bounty. Lucassie of Port Harrison carved the piece.
Hunter, coping with slain walrus, gives a sense of Eskimo concern for food. By Peter Angutikok of Povungnituk.

Every effort is made to keep the artistic tradition of these artists free from alien influences and mass-production pressures. But complete success in this can hardly continue for very long. Fortunately, the native artist shows disinclination to make two objects exactly alike or to copy his neighbor's work. But there is a temptation to grind out "souvenir" pieces. In one locality, Povungnituk (see map, p. 34), the better artists have formed a group to preserve artistic standards. They hope to sculpt a series of salient scenes from Eskimo mythology.

The Eskimo artist is apt to display extreme modesty about his ability, saying that a given piece is hopelessly bad or that no one should think of giving anything for it. But payment is always made—even for the lesser creations—and no one else need ever know what evaluation was written on the chit the sculptor received. The Eskimo artist may seem careless when he stuffs the slip of paper under his furs, but it is said that not one chit has ever been lost.

Dr. Weyer, for many years Editor of NATURAL HISTORY, is a well-known Eskimo authority. Mr. BOLTIN is an expert photographer of primitive art.
Iling with a seal, this hunter has a firm grip on his quarry. It is by Levi Kumaluk, a leading Povungnituk artist.
Baby walrus was captured by Eskimo sculptor in a moment of playfulness or surprise on the edge of the ice.

Most of these stone carvings are of a size easy to handle. In aboriginal times, heavy stone was a handicap during seasonal migrations, and the art of the Eskimos was probably inspired largely by religious motives. Small pieces were worn under the clothing as amulets, and miniature replicas of useful objects were placed at the grave of a departed relative to serve his spirit in the future life. Small figurines may have been used as dolls and toys.

But these modern carvings are intended to be handled and enjoyed as works of art. They reflect the personality of the artist, although they may arouse thoughts of a well-liked legend or memories of an episode in daily life. Many of the pieces shown here were exhibited in New York through the courtesy of the Canadian Government and sold at St. James' Episcopal Church to benefit Eskimo mission activity.

Somnolent young walrus is shown, above, curled restfully on a snowy bed. Note accent of inset ivory tusks.

Narwhal, in steatite, sports an ivory tusk, right. Piece, by a Povungnituk artist, is from Perry Collection.
Stolid lines of a musk ox are well captured in this ivory-accented piece by Isapik of Povungnituk.

Flowing motion of an otter, prey in mouth, is deftly conveyed, above. The eye is an inset of ivory.
Massive bulk of mature, bewhiskered walrus was rendered in steatite by Eskimo sculptor of Port Harrison.

Bird of prey, possibly an owl, clutches a mink in beak and talons. A work by Joannesse of Povungnituk.

Couched reindeer, left, carries set of ivory antlers. Serpentine piece is by Kalinga of Povungnituk.
Triumphant hunter hoists the ponderous burden of a slain sea mammal before returning to his winter house.
paitent fisherman, with a simple hook of ivory at end of a thong, pans over hole in ice with packful of fish on his back.
Man in kayak faces dilemma. With dead adult bear in tow and cub in hand on deck, how will he paddle home?

Running hunter, ivory club in hand, may be pursuing seal cornered on the ice. By Tamusseapik of Povungnituk.
The seasoned hunter a broken file and a piece of steatite or serpentine, and let him reminisce. His mood conveys the images of his memory to his long and facile hands, the stone takes shape. Sometimes he holds the work with his feet, the better to ease his hands on it. In time, a caribou, musk ox, or Inuit emerges, and the artist smooths the figure with other stone and with stone dust. When he wishes to drill a hole in a pendant or to inlay an antler or eye dot, he uses the prehistoric bow drill—twirling the shaft in a socket clenched between his teeth while manipulating the carving in his free hand. He soaks the finished piece in seal oil for a few days and finally polishes it to a satiny luster with his hands. By his shaping, the Eskimo artist has made one of the less resistant materials to be found in his resistant world respond to his concept of something beautiful, significant, humorous, or awesome; something to be displayed when relatives visit.

There are variations in quality, but it is no wonder that many modern Eskimo carvings are valued highly. The finest of them proclaim their individuality with a noble economy of line and display the creativeerve that is a delight to all true lovers of the arts.

A moment of rest behind sheltering snow wall is used to stimulate seal-hunter to massage cold feet.
WINTER WOODS
Billions of organisms, constantly attacking nature's trash, insure each spring's greenery

By Jack McCormick

The spectacle of kaleidoscopic autumn color has long since faded from our deciduous forests. Now they are marked by the somber browns, grays, and blacks of naked trunks and limbs, periodically silhouetted against a white backdrop of snow. The vivid scarlets, brilliant golds, yellows, oranges, and the deep violets of autumn are all but forgotten as the leaves lie in a dun-colored carpet on the forest floor. To many, these drifts and windrows of leaves seem to form a lifeless trash heap that requires consideration only when its components clutter a tidy lawn or hide obstacles in a woodland footpath.

Each year, in eastern North America, some ten million leaves drift down from the trees to each acre of the forest floor. These leaves, together with an almost continuous addition of shrub leaves, dried herbs, flowers, fruits, twigs, limbs, logs, and animal remains and wastes, add up to nearly two tons per acre. If this weighty blanket were allowed to lie where it fell, mosses, ferns, wildflowers and tree seedlings would quickly smother, with their light and air cut off. In a few years, the entire forest would be buried in its own wastes. There are relatively limited supplies of available carbon, nitrogen, and other elements essential to the life and growth of plants and animals, and these must be circulated again and again to construct food and tissues. If they were immobilized in a carpet of remains on the forest floor, life above—deprived of these materials—would cease.

Although few of us have given the matter much thought, it is obvious that these forest wastes are not allowed to accumulate indefinitely. In some way, they must be disintegrated, reduced to simpler chemical forms, and then either mixed with the soil or returned to the air where they again are available to the leaves and roots of green plants.

These processes of reduction are the work of minute plants and animals that make their homes in the forest floor—in reality, the most densely populated stratum of the forest community. The number of organisms that live to a depth of three inches in any square foot of the forest floor can total 104 billion—about forty times the human population of the entire earth! Microscopic fungi (Actinomycetes) make up about fifty per cent of this fantastic mass of life. Bacteria account for another forty per cent, protozoa for five per cent, and true fungi for half of one per cent. Of the total 104 billion organisms in this square foot, animals large enough to be seen with the naked eye constitute only .000001 per cent! To give a better idea of the multiplicity of this life, it has been calculated that in the top three inches of a single acre of forest floor, the microscopic organisms alone may weigh more than a quarter of a ton.

The few relatively large animals that live on the surface of the litter are usually so well camouflaged in form and color that they blend almost imperceptibly into their surroundings. Others shun light and live in the dark recesses below the surface. They pass their lives burrowing through the soft leaf mold and the upper portions of the soil. Because of their secretive habits, these creatures are often termed "cryptozoa," or "hidden animals." Thus, the casual visitor to the forest is not aware of its teeming populace: his eye is taken, instead, by the minority population, such as the vociferous birds, squirrels, or chipmunks.

The floor is both a unique and a vital segment of the forest community. It is doubly protected—sheltered first by the canopy of trees and

Two tons of leaves, animal waste and other debris yearly litter each acre of woodland in eastern North America.
Upper Layers of Forest Floor Teem With Life

Woodland soil and its cover of decaying debris support a variety of organisms that aid in breaking up forest wastes. A few larger forms are: at top, daddy-longlegs, beetle larva, rove beetle, millipede, sowbug, ant, acorn weevil. Among mycorrhizal root masses are an earthworm, pseudoscorpions, varieties of mites and, in the soil, a pupating acorn weevil at the end of its tunnel.

Shrubs above, and then by the carpeting of dead leaves that form its upper surface. In climate and structure, as well as in locale, the floor is intermediate between the aerial and subterranean strata of the forest. It is cool, moist, free from wind, protected from sudden changes and extremes of temperature. Its matrix is more compact than that of the upper portions of the forest, but less so than that of the soil. Its atmosphere is low in oxygen, high in carbon dioxide.

During a summer’s day, the surface is dimly lit by rays that filter through the leafy canopy above. At night, winter or summer, it is quite dark. Just beneath the surface, there is a diurnal shift from mere twilight to darkness. A few hundredths of an inch deeper, it is perpetual night.

The thickness of the forest floor may vary from a fraction of an inch in one place to a foot or more in another. It responds to changes in the ground’s contours and in underlying rocks, to variations in the density of tree trunks and shrub stems, the rate of decomposition of the litter, and the effect of trampling by forest inhabitants. At the surface, it is composed of complete leaves and large leaf fragments, twigs, logs, the excreta and corpses of insects—all mixed with other materials that “rain down” continuously from the higher strata of the forest.

A little deeper, there is a layer of partially decomposed but still identifiable fragments that are internmixed with the excrement of floor-dwelling animals, dead larvae, cast skins, infertile eggs, and the disarticulated skeletons of insects. Beneath this lies a relatively compact but spongy layer of more thoroughly decomposed organic materials in which the individual components are no longer identifiable. This is “humus,” a brown-colored, colloidal material.

There is usually not a distinct separation between this lower, humus layer and the mineral soil beneath. Instead, the “basement” of the community is a zone in which considerable humus is mixed with the mineral...
The floors of different types of forests vary considerably in structure, depth, and composition, reflecting differences in the ages and density of trees and shrubs that compose each forest, in the floristic and faunistic composition of the litter accumulations, in geological and topographic circumstances, in climate, and in the frequency of forest fires. The kinds of trees that compose the forest also exert a strong influence on the characteristics of the floor. The chemical composition of the leaves and wood of the trees largely governs the rate of decomposition. The leaves of coniferous trees, which have a high proportion of resins, waxes, and similar substances, are much slower to deteriorate than are the leaves of hardwood trees in the same locality. For example, the leaves that fall from tulip trees and other hardwoods that grow in moist coves in the Great Smoky Mountains may decompose in one year, while the leaves of pitch pines on nearby ridges may remain for four years or longer.

Forest floor life is extremely varied. Numerically, as we have seen, microscopic plants and animals—particularly bacteria, fungi, and protozoa—predominate. Macroscopic animals, those visible to the naked eye, number only about 300 million per acre; about three-fourths of these are sightless invertebrates. Various species of mites predominate among these larger forms. Springtails are usually the only group, other than mites, present in large numbers, although as many as one hundred and
fifty kinds of animals may occur in the top three inches of a foot-square slice of forest floor.

Some organisms—such as bacteria, fungi, mites, springtails, and sowbugs—are permanent residents of the forest floor, spending their entire lives there. Populations vary seasonally, however; they are generally highest in autumn and spring, and lowest in summer and winter.

OTHER organisms, such as acorn weevils, spend only one phase of their lives in the forest floor. These species may pupate, estivate, lie in wait for prey or potential hosts, or merely seek temporary shelter in the floor. Still others spend most of their lives above the surface, invading the floor only to feed, nest, or lay eggs.

Moles, mice, chipmunks, shrews and ground squirrels are the larger members of the community. The burrows and passageways made by these animals are characteristic features of all forested areas. In addition, snakes, toads, frogs, salamanders, lizards, and tortoises range over the forest floor in search of food.

During the summer, individualized requirements for food, light, warmth, breeding sites, and other conditions operate to sort various species of animals into relatively distinct groups characteristic of different strata of the forest and of different habitats in the region. In winter, however, shelter is the dominant requirement of all species. The selection of a site for hibernation is a serious matter, and each animal is very specific with regard to the type and amount of shelter it requires.

However, selection is rarely so rigid that the leaves or wood or other parts of a particular species of plant are necessary. Even sheets of tin are accepted as shelter by many forms that normally hibernate in the litter. The niches provided by the dead leaves, decaying logs, stumps, and limbs and the burrows, tunnels, and cavities in soil of the forest floor offer adequate shelter for a great many animals. Many insects and related animals from fields and meadows and from the treetops, shrubs, and herbs of the forest migrate into the forest floor to hibernate in autumn. Thus, the striking zonations and stratifications of the summer disappear as the animals merge into the forest floor in search of shelter.

Springtail (top) and mites feed on organic matter at top of soil and in leaf mold. Pseudoscorpion (lower left) is predator, feeds on the springtails.

Soil fungus, when enlarged, reveals round fruiting bodies on tiny hyphae.

Many species show a distinct preference for a certain type of shelter, such as a well-decayed log, so that these kinds of shelter are inhabited by a distinct group of hibernating animals. Other species seem to have very simple shelter requirements and apparently hibernate in the first place that provides an easy entrance and enough cover and moisture.

Measurements of temperature by A. M. Holmquist in the forest of the Chicago region demonstrate that the layer affords considerable protection against the rigorous winter weather. Before the first snowfall, temperatures beneath the layers of dead leaves and insulating logs fluctuate with the mean temperature of the air. Even so, the temperatures of the leaf layer varied on 27°F., and those in logs varied on 17°F., while the air temperatures ranged from 12° to 63°F., a variation of 51°F. In December and January, when an insulating blanket of snow covered the forest floor, air temperatures dropped as low as 12°F., but temperatures in the forest floor were never lower than 17°. This is well above the lethal temperatures for the hibernating insect. Another important aspect of the microclimate of the forest floor is that while air temperatures varied more than 30°F. in a single day, the temperatures within the forest floor varied less than 2°F. Thus, the hibernating forms were protected from rapid temperature changes, which...
when the hibernation period ends. At this time, while the trees are still leafless and sunlight floods the forest floor, the temperatures in the litter may rise briefly to 120° or 130°F., while air temperatures are near 70°. At night, the insulating qualities of the litter conserve heat and allow the litter to remain warmer than the air. These high temperatures appear to be of importance in breaking the dormancy of buds of many low plants and in ending the hibernation of the animals. Creatures emerging from their hibernacula may remain on the forest floor for a few hours or for a day or more before joining the great migration to summer homes that reverses the trend of the previous autumn.

The majority of the forest floor population is concentrated in the upper layer of litter, composed principally of leaves that clothed the trees during the summers past. Fungi and bacteria, the most numerous of the floor-dwelling plants, are especially abundant in the litter, although both forms are also found in the lower horizons of the soil.

A study in North Carolina showed that sixty-five per cent of the animals of the forest floor are found in the litter; thirty per cent in the first two inches of the soil, where there is considerable humus, and only five per cent in the zone from two to five inches deep.

Many of the microscopic residents of the floor community, particularly the algae, the protozoa, rotifers, nematodes, and flatworms, may be called its "water biota." They are restricted in occurrence to the water-filled spaces within the tissues of leaf fragments or between soil particles, or to the thin water films that adhere to the surfaces of soil particles (illustrations, above and below). When both litter and soil are completely dry, these water-dwelling organisms either form spores or perish.

The roots of trees and other plants make up an extremely important component of the forest floor. Soil-forming processes occur most intensively in the zone into which roots release their exudates and from which the colony does not return to normal until the end of the month. Although the hibernation period varies with different species, in the Chicago region it generally begins in mid-November. In late March, the hibernation period ends. At this time, while the trees are still leafless and sunlight floods the forest floor, the temperatures in the litter may rise briefly to 120° or 130°F., while air temperatures are near 70°. At night, the insulating qualities of the litter conserve heat and allow the litter to remain warmer than the air. These high temperatures appear to be of importance in breaking the dormancy of buds of many low plants and in ending the hibernation of the animals. Creatures emerging from their hibernacula may remain on the forest floor for a few hours or for a day or more before joining the great migration to summer homes that reverses the trend of the previous autumn.

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roots extract water and nutrients. In addition, the roots compact the soil as they grow, and—after they die—they are themselves transformed into humus at various depths in the mineral soil. The tough, resistant bark of dead roots remains intact long after the soft, inner parts have been decomposed, so that pipeline networks of hollowed-out, dead roots thread through the forest floor. These are usually littered with the minute feces dropped by tiny animals. When rainwater drains along the dead root aqueducts, it washes these minute drops of rich fertilizer with it, and carries them to the lower levels of the soil where they are deposited near the living roots of other plants.

During the warmer periods of the year, a majority of the forest floor population engages in round-the-clock feeding that gradually reduces fallen leaves and other debris and transforms them into the gases and nutrients that can be utilized once more by green plants to manufacture food and living tissue.

In southern forests, where the warm season is long, leaves may be completely reduced in less than two years. In the cool, northern forests, the process requires much longer time. In general, even though the reduction of the litter is more or less in balance with its deposition, the decomposition processes lag far enough behind to allow an accumulation of from two to twenty tons of litter per acre in mature upland forests. The amount of litter in a given forest is not constant throughout the year, however, because of the rapid addition of materials in the late autumn and the gradual reduction of the litter by the floor population during the following spring, summer, and early autumn. In bog forests, where no equilibrium between leaf fall and decomposition exists, dead materials accumulate—in the form of peat—to greater and greater depths with each passing year.

Although the minute forms of the forest floor require the same chemical nutrients as do the larger plants and animals of the forest, only a fraction of the material on which they feed is incorporated into their own bodies. Each day, for example, bacteria will decompose matter that totals from one hundred to one thousand times their own weight. Even the little material that they do incorporate is soon released, for the lives of most such microscopic organisms span only a few weeks or months.

The population of the forest floor is divided into two relatively distinct groups. First, there is a basic group that is directly responsible for the reduction of the litter and for various changes in the soil. Then, there is a secondary group that consists of parasites and predators. These secondary organisms do not enter into the reduction processes, but rather prey upon the basic group and serve as effective checks on their numbers.

The actions of fungi and bacteria in the basic group result both in the chemical reduction of plant remainders and in the decomposition of animal feces and remains. Only a few animals—such as millipedes, earthworms, and sowbugs—can feed on plant debris before it has been softened and predigested by bacteria and fungi. Such animals, however, play an important role in many forests. It has been estimated that, on a single acre of forest land, more than two tons of litter may pass through the digestive tracts of the millipedes alone in the span of a year.

Once the initial softening and predigestion of the fresh litter has been accomplished, myriadds of other small animals—such as mites and springtails—go to work. They chew and grind up the relatively large fragments of litter, digest them, and redeposit them in the form of minute feces. In the process, these animals increase the exposure surface area of litter fragments, thus allowing bacteria and fungi to speed and expand their work.

Some bacteria are known to be unable to attack plant material until these have passed through the digestive tract of an animal. Other bacteria (and certain protozoa) live within the digestive tracts of insects, termites, and other litter-feeding animals, where their activities enable the animals to digest wood. Thus, in the course of their reduction, litter material may be passed through, or become a part of, a long and intricate chain of tiny, interdependent plants and animals.

The principal agents in the reduction of leaves and other litter into humus are the fungi. By bulk, they are the most prominent organisms in the forest floor: their weight probably ex-
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In charge of vegetation studies at the American Museum, Dr. McCormick has done intensive ecological studies of the forest. He treats these fully in a recent book, The Living Forest.

Because of the abundance of dead organic matter, the prevailing moist condition, and the relative freedom from disturbance, forested areas support a greater variety of woody and fleshy fungi (the conspicuous shelf fungi, mushrooms, and toadstools) than do cultivated or open areas. Some of these are parasitic on the larger plants of the forest, a few live co-operatively with the roots of other plants, but most are saprophytic—that is, they feed exclusively on the remains of plants and animals.

The larger fungi play an important role in the initial phases of tree decomposition, attacking the dead trunks and the larger limbs. As these huge fragments are resolved into ever smaller ones, other fungi—usually less conspicuous in appearance—act upon them, soften them, and separate still smaller pieces from the larger one, until finally the wood is reduced to a form suitable for the use of a host of small animals. The final steps in the reduction of the complex organic compounds of the wood are probably accomplished by microscopic fungi, such as species of Penicillium, by the smallest litter animals, and by bacteria. There is also a succession of fungus forms in decaying leaves, but the majority of the leaf-colonizing species of fungi are microscopic.

Certain fungi that inhabit the forest floor penetrate the living roots of trees, shrubs, and other plants, causing structural modifications. These can take the form of premature termination of growth (stunting), and the degeneration or non-production of root hairs. However, such an association of root and fungus—known as a mycorrhiza—is apparently beneficial to both the fungus and its host. The fungus seems to derive food from the root: in turn, the threadlike hyphae of the fungus gather water, minerals, and other nutrients—particularly compounds of nitrogen—that are absorbed by the roots of the host.

Most of the forest floor bacteria concentrate on the decomposition of cellulose, lignin, and related compounds that occur in the woody portions of the litter. Some bacteria work to decompose proteins, chitin (found in the remains of insects and other small animals, and in fungal structures), and similar complex nitrogen compounds into simpler ones. These simpler compounds form the principal sources of nitrogen for the trees and other green forest plants. Still other, free-living bacteria—especially species of Azotobacter—are able to take nitrogen from the air and combine it with other elements to form compounds that plants can absorb. The work of these nitrogen-fixers, however, is probably of little importance because the forest humus is already rich in nitrogen recovered from plant and animal remains and wastes.

Algae are often abundant in the forest floor. Aerial forms are found on rocks, tree bases, and twig tips. Surface forms live on or just beneath the surface of the litter or soil. Subterranean forms may also be found in the water films around and between soil particles, but these are largely, if not entirely, surface forms that have been carried into the soil by rain water, or buried accidentally by animals. These latter algae, resting below the lighted zone of the forest floor, can neither manufacture food nor reproduce. They are important then, chiefly as food for litter animals and soil-dwelling animals, and as an additional source of organic matter when they die and decompose.

The surface forms of algae, however, consolidate the soil in hilly areas, afford a seed bed in which small seeds can readily germinate and provide a source of food for many of the small litter animals.

Some floor-dwelling animals feed upon the myriad of fungi that thrive on the carpet of decomposing organic matter. They check the development of the fungi, which otherwise might clog all the air spaces within the soil and develop into hard, impermeable mat of ramifying hyphae on the soil surface. Mites, springtails, beetles, thrips, and gnats are included among these fungus-eaters, who thus occupy a position among the secondary group mentioned earlier. But the lines of division are not very distinct. Other animals, such as certain mites, flies, larvae, and some beetles, feed on the decaying refuse that fall from the aerial portion of the forest above. Still others eat the bodies of dead or dying animals and thus belong to the basic group. Spiders, daddy longlegs, centipedes, pseudoscorpions, many beetles, and some mites are among the lions and wolves of the forest floor: they prey indiscriminately on herbivores, the saprophagous species that feed on dead matter, or on other predator forms. Many species of floor animal are omnivorous. One observer, after studying the forest floor fauna, concluded that a typically omnivorous animal "may gnaw or suck sap from a growing plant, browse on verdant vegetation, gnaw the carcass of..."
imal, eat part of a fungus, end up devour a portion of a p. Thus, such omnivorous might be assigned to the basic one moment, and to the group in another. Pro- the most numerous and the animals of the forest floor, most part are members of the group. The vast majority enter directly into the process of reduction; instead, they feed and are thus instrumenting bacterial populations. Important secondary effect is caused by the floor animals' cease- search for food, their mating and activities, and their endless cease- for food, their mating and activities, and their endless cease-
October 4, 1957, the day that Sputnik I was put into orbit, a frontier opened for mankind. The first time, humanity had not broken free of the close confines of the earth but also had come to an inkling of the great strides red before man attains a better standing of the earth’s total environment.

Since then, observations of the variations of Vanguard I, the grapefruit-sized satellite that probably remain in orbit for 2,000 years, have enabled geocists to refine their impression of the size and shape of the earth. Sputnik I, in turn, disclosed the Van der Waals belts, hitherto unknown regions of radiation lying in space just beyond the earth.

Lunik III, in its epic flight last spring, carried a camera to that part of moon man has never seen. The moon’s surface was photographed while Lunik III was some 220,000 miles from the earth. The exposed film was developed inside the satellite, the pictures scanned electronically and the scanning signal transmitted to earth after the satellite had returned to within 30,000 miles of the earth.

But the exploration of outer space during the past twenty-seven months has not been limited to the use of such super tools. Indeed, while man-made satellites have obtained much important data about the density and temperatures of the upper air, about the concentration of positive and negative ions, and about the shape of our planet, these costly devices are considered by many to be the glamor gadgets of space exploration. Many critics claim—and there is some basis for their contention—that the real workhorses of space research are the solid-fuel rockets—small, efficient devices that carry instruments to moderate altitudes and then fall to earth; rockets such as those that have carried aloft large, radio-reflecting balloons, and that have released voluminous clouds of sodium vapor high in the ionosphere.

During the past few months, also, telescopic photographs of the sun have been made from balloons that reached vantage points ten miles and more high—far above the murky, congested, and shimmering depths of the lower atmosphere. Venus has been the target of the latest such attempt, using a manned telescopic camera carried by balloon to an even higher elevation—over 30,000 feet.

During the flight of Lunik II, a Soviet satellite launched last September, a cloud of sodium vapor was released from the rocket carrier, producing the sight seen on the next page. A fuse was timed to set off the orange-yellow cloud when the satellite was some 90,000 miles from the earth on its moon journey.

The rate at which such clouds disperse is related to the concentration of ionized particles in the area. A series of experiments conducted in the U.S. last fall employed a similar

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**Associate Astronomer on the staff of The American Museum-Hayden Planetarium, Dr. Branley is a regular contributor to these pages.**

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**Group of Moon’s Back, left, was made with 500 mm. in Lunik III. Wave pattern is due to scanning device.**

**Long Shot of Moon, above, was 200 mm. job. Area to right of dotted line in annotated print was previously unobserved.**

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Sodium burst from Lunik II is seen in sequence, above, from top to bottom. Dissipation time, about one minute, is clue to concentration of ions in area.

Lunik III, seen in Soviet sketch, has six aerials, camera hatch at the bottom.

Technique to study the drift of air at altitudes of fifty to a hundred and fifty miles. Rockets, launched from Wallops Island, Virginia, carried loads of sodium a hundred and fifty miles above the earth. The loads then exploded, producing large sodium vapor clouds with long, tapering tails. These test clouds, carried along by the winds, were dispersed by the explosion and interaction with ionized particles that exist at that altitude in the upper air.

Earlier last fall, another and different sort of launching occurred at Wallops Island. A huge metallic-coated balloon was carried aloft by rocket while tightly folded. When altitude was attained, the balloon was automatically inflated. It became a sphere, one hundred feet in diameter, that glowed more brightly than the stars in the twilight sky along the U.S. East Coast—second in brightness only to the moon—and alarmed observers from the Carolinas to Maine (photo, right).

Research into the nature of outer space will increase in tempo as the multitude of projected plans now waiting implementation get off the ground. Metallic balloons, sodium clouds, picture-taking satellites, and half a hundred other ventures are to be undertaken. Amateur observers should be on the alert, for many of these endeavors can be observed by the interested layman, as in the example here illustrated—the brightly glowing balloon, captured on film by Shirley Gale, a talented amateur astronomer.
INTRODUCING THE MICROSCOPE and the science of microscopy to the reader is like taking him into an immense gathering of persons of all races and creeds and trying to acquaint him with each one in turn, including a bit of biography for every individual. For the subject embraces an enormous territory and invades almost all aspects of modern science and industry. Such a broad statement of coverage indicates also the great importance of this instrument, and our own belief, backed by that of many others, is that no one today can afford to be without at least an elementary knowledge of this field.

Among topics to be discussed in future installments of this department—new to readers of NATURAL HISTORY—are the various kinds of microscopes and the uses for which each is designed—some generalized, some specialized; how to buy a microscope—considering such decisions as the purposes for which it is intended, and the price; what a microscope can do for the owner; and the anatomy of the compound microscope, including the functions and upkeep of the various parts, and care of the operator's eyes. We shall also present a program of work for those who already possess a microscope, with suggestions for beginning the manufacture of slide mounts as the nucleus of a collection, and indications as to what sorts of information can be obtained from them.

BEFORE man invented any sort of appliance to augment his vision, he knew nothing at all concerning the microcosm—the world of the finer construction of matter that lies all about us and within us, and of forms of living beings too small to be seen with the unaided eye. There were a few glimmerers, such as the rare insight of Fracastoro of Verona, who, in 1546, postulated small bodies that made up a contagium vivum, floating in the atmosphere—the pathogens that we now call bacteria and viruses. The bacteria were, in fact, discovered in 1676 by the great Dutch amateur microscopist, Anton van Leeuwenhoek, but two centuries were to pass before they were identified by Pasteur in the years 1865-1866 as causal organisms of specific disease. Leeuwenhoek also was the first person to see protozoa, sperm cells, blood corpuscles, and a multitude of other microscopic objects, opening up an entire new vista of the world we habit. Robert Hooke discovered and named the cell, the building block of organic matter, in 1665.

The microscope was a necessary invention before these observations were possible. Discoveries came slowly at first, but grew with an ever-accelerating momentum, leading to our present exhaustive, but by no means complete, information about the invisible portion of our environment. First came a broadening of knowledge in the biological sphere. Many people today think of this science when the microscope is mentioned, but that notion is far from correct, since this clever appliance is an important tool in all of the sciences both pure (as geology or genetics) and applied (as medicine or engineering) and in all of the basic industries. The production of steel and other metals, rubber, textiles, paper, paints, food drugs, cosmetics, and a long list of other manufactured items is based on the microscope as the determining particle size, of purity of the product of correctness of alloying or blending of adulteration, and of many other criteria essential for a proper final product. Competition keeps major firms on their toes, and they pride themselves on their technical laboratories and staff of trained scientists. Indeed, the microscope is the king of instruments.

A pertinent query at this point might be: this is all very well, but what of the average amateur expect to obtain by way of information or education, profit or pleasure, if he takes up microscopy as an avocation? Does he dare embark on a subject as large and advanced as is this one in the mid-twentieth century? The answer is emphatic “Yes.” There is a great deal that one can learn and much that he can do, and our aim in this department...
Corry's one subject with microscope natural glass am colorless, of to are, who hobby, n. le microtomes.

The majority will undoubtedly think they do not like the subject, but have no real realm of interest, and are thus uncertain whether to make a beginning or to go about it.

The advice is to follow this series of articles and try out a sampling of the divisions. We shall be making studies of plants and their parts, of bacteria and diatoms and protozoa, of insects and mites, of textiles and paper, chemical crystals and metals and stones, of sands and soils, rocks, fossils and rocks, and of various animal tissues and organs and blood. Along with these preparations will go a suggestion about the microscope itself and some accessories as illuminants or microtomes.

When the beginner should take the whole field. Only by doing so will he be able later to decide upon a hobby. Having once constructed a collection of slides in every province, it is no point in continuing to generalise, for the experimenter will have been absorbed by the possibilities of one branch, and can go further down one of his choice. Thus, as an example, the owner of a microscope might first be in the area of general botany. From there he may move to botany more specific, then to histology (microscopic my), and, perhaps, wind up in microscopy—the histology of the nervous system. He may pursue these enquiries as a hobby, or he may become a dedicated scientist. By no means all of the important discoveries and advances have been accomplished by professionals; there have been successful amateurs who have made important discoveries and have shared their findings. And by no means are all microscopists men. Indeed, there are many recognized women microscopists—both professional and amateur—at work today.

It is whether one follows microscopy professional end or prefers to combine's efforts solely to learning the things that the microscope reveals. There is a vast amount of literature to be obtained from work of this character. It is fun, it is worthwhile, and it is important, and keeps one abreast of many matters of value in our present complex civilization.

To begin, one would do well to have an introductory book, and I am compelled to recommend one of my own, for there is none other available. There are many fine works on the microscope and others on microtechnique, and we shall have occasion to mention them later but, for a general introduction to the field, I must blusingly cite Exploring With Your Microscope, McGraw-Hill, 1957.

A Project in Engraving Methods

One of the simplest and easiest of subjects with which to inaugurate a slide collection and learn methods is also one of the most interesting. The necessary equipment consists of a few blank microscope slides and cover glasses, a medicine dropper (called a pipette in microtechnique), a bottle of xylene, and one of a mounting medium.

Microslides are thin strips of glass, three inches by one inch, polished and with ground edges. The glass must be of a special quality, perfectly clear and free from bubbles or striations. Seventy-two of these slides are packed in each box. Cover glasses are exceedingly thin squares, circles, or rectangles of glass of the same quality, and are sold in three thicknesses: "0," "1," and "2." "0" is the thinnest and hence the most expensive; circles are more costly than squares; rectangles are employed only in those special cases in which the whole area of the slide must be covered, as in serial sections of embryos. Sizes are specified either by the metric system or in inches. The best cover for all average purposes is a number "1" square, 22 mm.

Xylene is a colorless, oily coal tar derivative that has wide usage in microtechnique as a cleaner. The principle is the same as that used by American pioneers before glass was available. They rubbed pork fat on heavy brown paper to make it translucent and thus served as a window covering that would admit daylight to the interior of a cabin. We shall use xylene in just this fashion, "oiling" our test pieces of paper so that light from the microscope mirror can be transmitted through them and up through the lenses to our eye. Xylene is said to clear the object. It will mix in any proportion with the mountant, as well as with pure alcohol, but it is intolerant of even the slightest trace of water. To see what happens when any water is present in a specimen, take a half-inch square of newspaper, wet it, allow it to dry partially—until it is only damp—then add a drop or two of xylene. A milky, opaque mixture, results to a slide preparation, results.

A mounting medium, or mountant, must combine several qualifications. It

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Van Leeuwenhoek drew bacteria found in the human mouth in 1695, above. Modern photograph, below, shows a spumum scar.
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EYE in four-color photo, above, forms multiple dot pattern under microscope.

NOW select a number of illustrations from newspapers and magazines including at least one of each of the following: a black-and-white newspaper drawing, such as a comic strip; a black-and-white photograph and one from a slick magazine; and, finally, a postage stamp. Affix the postage stamp to the center of a clean slide and allow it to dry thoroughly. Cut a half-inch square from a portion of each of the other samples. Be sure they all show considerable detail. Place them on separate slides.

Add one or two drops of xylene to each specimen and allow the paper fibers to soak up this oily material. Then add one large drop of the mountant. The xylene will evaporate more
than water, and the paper will resume its opaque appearance. The mountant before this happens, place a cover glass on each prep in the following manner: grasp the edges between thumb and forefinger and lower it over the mount on a slant, so that one edge of the cover touches the slide just beyond the square of paper. Then let wing the cover to fall gently into the mountant will flow evenly out all the space beneath the cover, and quantity is correct. Too little will result in air sucking in the cover to make one or more bubbles; too much will cause the mountant to flow out beneath the cover, producing a messy A bit of experience with these specimens will soon acquaint the user with the proper quantity of mountant to use—less for very thin objects, and more for the thicker objects.

The xylene gradually evaporates around the edges of the cover and the mountant solidifies. This may take from one to two weeks if half-an is used, and a shorter time if synthetic mountants are selected. The slide may be used at once, but care must be taken to keep it flat and to remove the spring clips from the microscope stage so that they do not inadvertently contact the edge of the cover and draw out and smear the mountant. When completely hardened, the slide should be polished and labeled. Any excess mountant beyond the cover may be scraped off with a small knife blade—it will flake off readily when dry—but use caution not to touch the edge of the cover; these thin glasses shatter readily. Labeling may be done with a special ink that writes on glass, or by affixing a gummed paper label, applied like a postage stamp.

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First inspect the black-and-white mounts under the low power of the microscope. The fibers of newsprint are much coarser than those of the slick paper of magazines, and the engraving work is correspondingly coarser. These are etchings made from a plate of zinc commonly called a "cut" or a "block." The material to be reproduced is left at the original level of the plate, while that surrounding it is removed, a method known as relief. No screen appears in the magnified view of a line drawing. When a newspaper photograph is examined, however, a screen is seen. The photograph has been broken up into a series of dots—an example of the halftone process. The original picture is photographed upon a sensitized plate through a screen made by fine parallel rulings on glass, the gratings of which are then filled with black. Halftone screens are designated according to number of lines per inch. For coarse newsprint there are 40 lines; for magazine black-and-white, 120 to 150; for superior color work, 150 to 200. A 60-line newspaper halftone will contain 3,600 dots to the square inch, representing the space between the ruled squares. These dots in such squares will be of various shades of light and dark, according to the original subject. When seen by the unaided eye, they run together to reproduce the original picture. The microscope shows such a reproduced photograph to be actually nothing but an optical illusion.

When we turn to the colored illustrations and view them magnified, we see the face of the pretty girl in the magazine cover is just a meaningless series of colored dots. Separate halftones are prepared for those parts of the original that are red, yellow, blue, or green, using filters on the camera. While these are printed, with their appropriate inks, not only are the reds in original rendered by red dots, the yellows by yellow dots, and the blues by blue dots, but when two or more of these are superimposed, other colors are reproduced—that is, red plus yellow makes orange. This is readily apparent under magnification. Those who are this subject of interest should read an article entitled "Photo-etching" in the Encyclopedia Britannica for further information.

In our next installment we shall consider the microtechnical procedure a step further by describing how to prepare mounts of whole insects and their various parts.
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COVER: The anatomical detail presented on the March cover shows the dissected swim bladder of Opsanus tau, the Atlantic toadfish. Grasped in the dissecting forceps is the fine membrane that, when set in motion by the vibrating air contained within the balloon-like swim bladder, acts as a sort of drum in producing this fish’s peculiar grunts and boops. Why the toadfish makes such noises is an open question and one that engaged the attention of an American Museum research associate in animal behavior, Dr. William Tavolga. For an account of his investigations, see p. 33.

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SCIENCE BOOK CLUB, INC.
Wildlife in America, by Peter Matthiessen. Viking, $10.00; 304 pp., illus.
A Natural History of New York City, by John Kieran. Houghton Mifflin, $5.75; 426 pp., illus.

Should mankind succeed in exterminating itself, it will be the first time that a species has caused its own extinction with the awareness of what it is doing. Death on an individual level is something that every animal strives to avoid, but knowledge of the impending death of a species is something that only man has the system of communication and the awareness to predict. Extinction, of course, is a part of evolution, and there are many more kinds of extinct animals than living ones. This fact is readily understandable when one thinks of the many millions of years through which life has evolved and during which experimentation by nature—preyation, cataclysm, disease, and climate—have taken their toll. The animals that exist today are the survivors of evolutionary changes, and man is one of them.

In both life and death every animal leaves its mark on Earth, but as individuals, few creatures exert much pressure on the environment. Certain species, however, because of their large size or huge numbers cause sufficient changes to the ecology of their habitats to be called "ecological dominants." In this regard, man is undoubtedly the dominant species on Earth today.

As an ecological dominant, man is altering environments on a world-wide scale. He cuts trees, plants crops, levels hills and mountains, builds houses and skyscrapers, drains swamps, irrigates deserts, pollutes rivers and air, and desalinates ocean water; he destroys viruses, bacteria, plants, and animals, and he raises livestock. Man alters his environment to suit his needs or whims. Eventually, ecological dominants come into equilibrium with their environment, so that their populations become stabilized within the bounds of the natural resources of the area. Man, however, has become an ecological dominant on a world scale so recently that he has not yet come into the "natural balance" that will be necessary for his survival.

Man's accession to the role of a worldwide dominant has occurred only in the last three or four hundred years. At the middle of the seventeenth century the world population was about 445,000,000, and for the preceding thousands of years it had been increasing only slowly to this point. But then the population erupted, so that in some three hundred years it has increased five-fold and is increasing still. Just what caused this surge in numbers is not known, but it must include a multitude of factors, one of which is surely the advances in communication that not only permitted the exploitation of newly discovered lands, but also allowed the expansion of population in places distant from a source of food. Basically, of course, the increases have resulted from a better survival rate for man as he gradually learned to cope with the ecological factors that previously had held his numbers down.

The large-scale and rapid destruction of so many kinds of animals by man is part of this population explosion. The systematic extermination of certain animals must have started with primitive man's development of agriculture and consequent freedom from the dangers of nomadism involved in following game herds and fruiting seasons. The establishment of permanent homes permitted the raising and storing of crops, and the domestication of animals for food was the beginning of man's ascent to a dominant position in the ecology of earth. Because of the physical protection afforded by villages, man's society structure changed from the family group or groups to larger aggregations. Community co-operation, based on the relatively large supply of manpower available, started the process of extermination of many animals.

The first animals to be attacked systematically were probably the large carnivores, initially because of their inherent danger to man, and then because of their depredations on man's livestock. In addition, the larger game animals in the vicinity of a village soon would be killed off or driven away because of the disturbing presence of man. Although control measures enacted by primitive villagers were important in altering the local ecological picture, they were scientifically restricted and isolated geographically to be of rather minor importance in the over-all ecology of the earth. They are an indication of the future was pressed and man continued urbanizing and increasing in numbers until the population exploded in the seventeenth century.

The effect of this population growth on wildlife is evident from the follow figures on the extinction of mammals given in Francis Harper's Extinct or Vanishing Mammals of the Old World from the time of Christ until 1844. Thirty-three species and subspecies became extinct; in the next one hundred years an equal number of kinds of mammals became extinct, and in the first half of the twentieth century, forty more kinds disappeared from the earth.
that have indirectly but definitely affected the lives of our fauna.

It is a shocking fact that effective legislation to control the mass destruction of American wildlife has been operative for only half a century. By the end of the nineteenth century, legislative acts were being passed that ultimately led to the protection of many kinds of animals, but for others it was too late. The long-cared kit fox, the Newfoundland wolf, Florida wolf, eastern mountain lion, Arizona wapiti, Badlands bighorn, and a number of local forms of grizzly, as well as the passenger pigeon, Eskimo curlew, and Carolina parakeet all disappeared after 1900, but they had been doomed much earlier.

Starting with the outlying islands of North America and the extermination of the great auk, Matthiessen works his way across America by biological regions as they were first explored and later inhabited by Europeans. His documentation of the disappearance of some of the species that have been most diminished in numbers is sketchy, but certainly sufficient to whet one's appetite for the details. Lamentably, the bibliography omits many of the primary accounts (for example, Hornaday's Extermination of the American Bison) that the reader might wish to know of.

Wildlife in America covers a lot of time and territory in a readable and pleasant style. The author is at his best when he recreates the end of a species, as he has done in the opening chapter on the great auk. In it he has grasped the insensible, opportunistic ethos of the men who would destroy the animal, as well as the pathos that mankind should feel at causing the end forever of the product of millions of years of evolution. Least desirable are Matthiessen's unnecessary digressions to explain the finer points of subspeciation, taxonomy, and the differences between splitters and lumpers, and with a sophistication born of hindsight to criticize some of those on whose works he has elsewhere drawn so freely.

Perhaps a history requires no thesis, but one feels a lack of direction as the book progresses, and at the end the reader is offered nothing for the future. It might have been hoped that Matthiessen would use the knowledge gained in research for this book to offer a program or theme for the future of American wildlife, but such is not evident. Nevertheless, for the reader who wants a relatively complete picture of the effect of man on wildlife in North America in a well-written fashion Wildlife in Amer-

Grizzly bear was drawn by early American naturalist John Godman.
ica is highly recommended. The book is attractively illustrated with line drawings by Bob Hines of most of the animals mentioned in the text, contains eight color plates and sixteen pages of photographs, and two appendices that summarize the rare, declining, and extinct vertebrates and a chronology of wildlife legislation, as well as a bibliography.

Many animals are able to persist despite man and his activities may not seem likely in the light of Matthiessen's book, but one has only to turn to John Kieran's A Natural History of New York City to discover an almost unbelievable array of animals and plants that, for the most part undistrubively, inhabit one of the world's greatest urban areas.

Just as Matthiessen's book is more than a narrow compilation of extinct and vanishing animals, Kieran also has written a book of broad scope. In fifteen chapters, he has produced an old-style natural history book. Starting with the history of New York City and running through the geography and geology, he then covers almost every group of animals and plants that can readily be discerned with the naked eye (or perhaps with an assist from a hand lens)—from the single celled protozoa and algae to whales. As he rambles leisurely, but with direction, through fifty years of natural history in New York, Kieran takes the reader on a subway safari, and even the native New York biologist will be surprised to learn what is available in his home territory.

Kieran has written a book that might well be used as a field guide for New York naturalists, and indeed every urban biology teacher should be required to read it. A Natural History of New York City is essentially a biology textbook in non-technical language, which uses as examples the fauna and flora of a city. Kieran not only tells what is present, but he describes it, categorizes it, puts it in its place in nature and New York, and reminiscences over it. And the total is a pleasant reflection of biology that even the most sophisticated urbanite will enjoy and from which he will learn much.

The book is decoratively illustrated with sketches by Henry Bugbee Kane; but while they are attractive, they are often of little help in the identification of species. One might also have hoped that Kieran would have included some references to literature specifically on New York biota rather than the eleven general guides or checklists that he cites. These are two books about man and nature and two different aspects of their relations. If one takes the viewpoint that man is just another animal, then one only need sit back and observe. However, if man is the superbeing that he thinks himself, then he must utilize his abilities to learn his ecological position and to adjust his own life with the life of the flora and fauna around him to a state of equilibrium. At present, man is still unwilling to control his destiny; if and when he does so, he will have achieved a mature civilization. If he continues in his present direction, he may join the myriad of other extinct animals that could not adapt to the ecological situations. Peter Matthiessen has shown what man has done to vertebrates in North America and John Kieran has shown what animals in the presence of man can do with a minimum of encouragement. Both books are welcome additions to the literature of natural history.

SHORTER REVIEWS

In 1956, the Botanical Society of America celebrated its fiftieth anniversary. In honor of this occasion, a number of outstanding authorities in various fields of botanical activity were invited to contribute papers "on the major advances and important developments in botany during the past fifty years, with emphasis on present trends and future problems and on the contribution of plant science to mankind and to his civilization." The forty papers of this volume result from the Society's invitation.

Throughout the jubilee volume, botanists themselves take a very critical view of contemporary botanical teaching and of the role of botanists in modern society. Botany courses fail to draw students, and many have been merged into general biology courses for reasons of economy. The causes for the lack of enthusiasm over botanical courses are manifold, but most of these authors agree that botany courses are oriented to the student preparing for a profession in botany and ignore the great majority of students who take only one botany course during their scholastic career. There is much concentration on minutiae of structure and function, dissection and sketching, almost to the exclusion of a contact with the living plant in greenhouse, garden, or field. Not only botany suffering from the student's lack of interest, but the students themselves are being deprived of information that would enrich their lives, improve their understanding of the environment, and perhaps make direct contributions to their professional advancement.

The most often repeated criticism is the social failing of the botanists: their inability or unwillingness to convey knowledge to his non-professional neighbors. Fortunately, several contributors to this volume are free of these failings. Their papers vary considerably in substance and in the amount of professional jargon, but are marred by unfortunate typographical errors and relatively serious editorial contradiction (for example, on page 57, Leuwenhoek is credited with inventing the microscope in the seventeenth century, while on page 67, another author assigns its invention to Janssen in 1590), but all are of great interest and are well worth reading. Kenneth B. Raper, in "Microbes—Mighty Midgets," outlines progress in the study of microscopic plants, in their utilization in industrial and nutritional fields, and in the development of biotics. "The Fight with Fungi," by James G. Horsfall, is a fascinating survey of the impact of plant disease on human history, of the development of knowledge about the causes of disease and of the research techniques and control measures currently in use. Edward L. Stakman presents an engaging story of the battle against wheat rust. Kenneth Y. Thimmann, in "Growth and Green Hormones in Plants," gives an introduction to the history of the discovery of chemical growth-regulating substances in plants and a survey of research on their nature and action. A. S. Coen presents a summary of our knowledge of chemical weed control, and W. H. Ho points out the need for co-ordinated efforts to find new uses for products of the wild plants of the world in "Plants for Man."

Four papers are of particular importance to the professional botanist. In dealing with the problems of professional botanists, they represent a public confession of failures of botanists and a plea for change. Hiden T. Cox and John Behmke, in a paper with the captivating title "College Botany Could Be Al," analyze the current curricula and orientation of college botany courses and suggest revisions in the courses to meet the needs of (Continued on page 7.)
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To the muskrat, that almost typical member of a North American marsh community, each day is something to live for in itself, whatever may be the season of the year. But since spring is the season we usually associate with biological beginnings, we shall begin here with spring to portray the seasonal fortunes of this wetland animal.

By the calendar, spring sometimes comes when the snow is as deep, the ice as thick and as hard, and the temperature as low as in the severest part of winter. But the tracks of the wide-ranging minks during their late-winter breeding season are laid down in powdery snow or in slush, on wet sand or on frozen mud, or on dry soil. Restless skunks emerge from hibernation long before the weather could tell them to, and great horned owls incubate and brood their young right on through late February and March and April blizzards. As sexual awakening progresses in the muskrat populations, living out of sight of human eyes in their lodges and burrow systems, more and more animals come out and sit on the ice on mild days, until, with the ice gone, the main dispersal away from crowded wintering quarters to easier living sites begins.

Dispersing muskrats travel along marsh and lake edges, along streams and up gullies. They may act like cautious and adaptive explorers, who know what they are doing. Or they may get started in footloose, hazardous wandering and show up on city streets or in farmyards or in any number of out-of-the-way places—if they live long enough. They may travel far or they may not. Living uncertainly or living securely, they hide or fight, doing their best to stay alive—somehow. They face flood, drought, predation, and disease, but between these various crises they may live well. They are not creatures to worry.
Spring dispersal of crowded muskrat colonies may send the animals far afield. They follow lake and stream edges searching for food, and may wander into village streets into farmyards, where they forage for whatever is available.

Late spring floods may cause severe losses to the marsh muskrat population. As the water rises in their burrows, they stay as long as they can and then open up the tops and enlarge the chambers just below the surface of the ground. As the water nears the chamber top or covers the ground, they must come out, to build nests anchored in whatever vegetation there is along the banks or out in the marsh, or to sit in the scrub willows, or to lie quietly, trying somehow to remain in the neighborhood. If there are helpless young in the burrows, the mother may deposit them, one by one, all or only part of the litter, in a drier place outside. Young of swimming size may lie in a pile in the water, in a hole or in a nest, the lower ones withdrawing to climb on the others, until some become too weak to withdraw any more, and their bodies lie, a platform of dead young flesh supporting still-living young flesh. At high flood, all the muskrats of the low bank islands may be gone, the old and the young and their nests and sitting places. Dead and living bodies may float away toward a lake, along flowing channels or off somewhere across the marsh, over the channels and banks and washed-down vegetation.

As spring grades off into summer, nothing much may happen to the muskrats, if they do not become overcrowded and the water levels are favorable to them. The midges hum, new shoots of reed and cattail appear above the water, water lilies float their new pads and flowers, masses of arrowheads take form, and, among the lodges, newly weaned muskrats swim, sit, feed, and dress themselves as if they amounted to something.

Late summer on a north central marsh is ordinarily a season of dry, hot weather. Some degree of drought is normal at this time of year over vast continental regions. It is with extreme drought that the big changes occur. The last inch of water on top of the marsh much seethe with movements—gills, mud backs and tails. A little more expansion and motion ceases over the mud. Some creatures go beneath, become part of a gelatinous film, persist as shells or bony head tails. Here is the down of a duck or the woolly fur spread out from bones of a young muskrat, or perhaps a freshly dead young muskrat, belly slashed by an older one, something with the shrinking shadow of death still moves as carrion below work beneath.

Muskrat movements can be caused by too much, as well as too little, water, as when a series of wet springs may be accompanied by loss of emergent vegetation of marshes. If a marsh, in one season, turns an open-water lake, the evicted dwellers that cannot fly away crowd the shores and adjacent Muskrats, being among the sub
mer, nearly all of the muskrats preyed upon by minks in the Iowa areas are the strife-battered excess males that are forced to wander off and live in risky places because of the intolerance of their better-situated fellow muskrats. In mid- and later summer, most of the mink victims are either surplus young, similarly forced into the dangerous shore zones to keep out of the way of their intolerant elders, or animals placed at overwhelming disadvantage through storm or drought emergencies. Mink victims, therefore, are not just any individual muskrats that minks care to prey upon, but rather those that have fallen into special classes of vulnerability.

Frosts of the Indian summer nights leave thicker and thicker ice on the ponds in the mornings. In shaded, quiet places, the ice may not melt all day. Where a muskrat swims, there may be a swirl of bubbles and pieces of broken ice film, or the animal travels submerged, breaking the ice film only where it surfaces. One evening, icy needles form a crystalline lacework on the lakeside rocks, the water's edge is still and films over, and the lake, also, except where the ducks sit. During the night, the new ice film thickens, cracking now and then, with water oozing from the cracks to freeze in turn. Muskrats sit beside the open holes. New lodges and feed houses appear over the marshes. Faint, muddy prints of both muskrats and minks mark the new ice. Lakeshore ice, in particular, may have a little blood, some bits of vegetation, fish scales, or skin about the rocks and openings where the minks and muskrats feed.

Early winter may bring no great problems for marsh animals adapted to live beneath the ice. The outside temperatures may vary from forty above zero to forty below without making much difference to the life in the water—as long as the essentials for living remain at hand.

With the continued sinking of the frost line, however, the seeming isolation from winter's problems may be transformed into a series of patent emergencies. In the course of a killing

**Dr. Errington's book, Of Men and Marshes, was recently published by The Macmillan Company and received instant acclaim. The marsh muskrat saga is reprinted here by permission.**
freezeout, the last places on a marsh where fishes keep alive include the plunge holes and channels of muskrat burrows and lodges. The water there may be packed with bullheads; almost all other marsh fishes die before this stage. The bullheads gulp air, trying to live, whether the oxygen is all gone from the water or not, whether the water reeks with hydrogen sulfide or not. A few die, or many may, and the living wriggle among masses of floating or partly submerged dead.

The muskrats may or may not feed upon fish, depending principally on whether they have access to an abundance of choice plant foods, to rootstocks or tubers of cattails, bulrushes, reeds, or duck potatoes. When the better plant foods are in short supply, the muskrats may feed upon the fishes almost to the extent that the minks do, either upon their own victims or upon those dragged out and left by the minks. The stomachs of nearly half of one sizable lot of midwinter muskrats from a northern Iowa marsh contained bullhead flesh.

The muskrats, not being as dependant upon the water as the fishes, have more leeway in meeting freezeout crises. But they, too, can winter-kill. As a rule, those living in a food-rich environment with little water get along better than those in food-poor environments with more water. In the shallows that are grown to cattails and bulrushes, the muskrats can still dig out nutritious underparts, even though considerable freezing of the bottom muck occurs.

If the muskrats are forced to come out on the surface to feed in cold weather, some of them may still find something edible in the exposed plant crowns and rootstocks. They gnaw the favored parts right down into the ice and may almost stand on their heads, hindquarters braced above, as they tug and twist. They eat the river bulrush rootstocks sticking here and there from the outside of a lodge. When the entire food supply of the muskrats becomes eneased in ice—as is often true where nothing but cattail and other submerged water plants occur in a foot or two of water, and all of this freezes to the bottom—their situation becomes one of deadly crisis almost in a matter of hours. They cut out through the sides of lodges to travel over the ice, going from one frozen lodge to another. They fight with and eat upon the bodies of their fellow muskrats or leave the marsh to wander over the countryside—tails, eyes, and feet freezing, always vulnerable to whatever predators prey upon muskrats that are trying to live at a hopeless disadvantage.

Here is a beaten group trying to weather a cold snap. They huddle, a half-dozen of them, in the eaten-out and reworked shell of a small lodge. Some openings to the outside are plugged with mud, fragments of water lily rootstocks, and miscellaneous debris—even with the frozen bodies of bullheads. Other openings are partly plugged; others are not plugged at all, and inside the muskrats sit—with upper parts frostling and lower parts wet. The inside ice-glaze has bullhead bodies in it but the muskrats are no longer eating bullheads. They are no longer doing anything except sitting or rearranging themselves. A wet tail tip sticks out of an opening and freezes to the ice outside. I have stroked the backs of such animals with a hatchet handle, and they just turned to look at me, without otherwise moving.

Next morning, the whole top of the lodge shell is open, empty of muskrats, and powdered by a trace of snow. A mink-killed muskrat lies smeared with blood on the ice, and a drag trail represents another victim. A third muskrat lies on the ice without a wound on it but with lungs congested from pneumonia. The trail of a live muskrat can barely be distinguished: after tracking around the wreckage of the lodge, the animal headed for shore, where it worked the rushy and weedy fringes before crawling under a boat. The muskrat tail tip is still frozen to the ice beside the lodge, but the rest of the animal is gone. Fox tracks center about this spot, and they lead off in a straight line toward shore. A crow alights by the mink-killed muskrat; after a little pecking, it walks over to feed on a big bullhead that somehow got on the ice away from the lodge. The mink returns to its remaining victim of the night, but the blood-saturated underfur is now frozen too solidly to the ice for the mink to wrench it free. The mink finally drags away the muskrat with the pneumonic lungs, following the same drag trail it had made earlier.

There are different degrees of security among wintering muskrat populations of glacial marshes, even where practically all individuals are able to survive. Some have to do little else but sit, sleep, swim, feed, and show minimum of wariness toward the ill-disposed of their fellow muskrats and their racial enemies, the intruding minks. Others have to work hard for their lives, as the ice thickens and water recedes under the ice. Some in dry passageways and run along trails between nests and feeding grounds. Thaws cause the flimsier structures to collapse, or the ice or snow to fall, or about the pushed-up plugs of vegetation, mud, stones, and sticks over burrows; and then the occupants face more problems of repairs. Plug of openings may go to extreme when a muskrat continues to push vegetation through a small hole to cold outside, and, with each new
LCEOUS MINK, a constant danger to muskrats during seasons of the year, probably helps control biological wastage by attacking the starving, the roaming, the old, or the ill. Here, a mink burrows through top of flooded lodge.

A patch of vegetation protrudes farther outside until it topples over its own weight.

Cutting through ice, the muskrats are adept if they work from below and they may work well at this. They may gnaw upward through the ice in the middle of a night and then heap up the vegetation around the new hole. I happened to be walking across a marsh center when a muskrat cut through ahead of me. It had its body out, and there it stood ice splinters beside. It then gnaw the ice covering the hole a solidly frozen, abandoned lodge and rehabilitate the lodge in a few hours.

A heavy thaw imposes its own problems upon a muskrat population that got along well in the labyrinths of layered ice and subsurface channels left by receding water during cold weather. The pouring of water from above does not necessarily endanger muskrats through drowning, for only under exceptional conditions are North central muskrats unable to reach air; but they may need to do some quick adjusting when forced out on the surface of dense ice or into the upper parts of previously maintained lodges and burrow systems. At such times, many of the animals are briefly vulnerable to minks and other predators—or to other muskrats if the emergency forces more intimacy than muskrats are disposed to tolerate, particularly as the spring breeding season approaches. If a cold snap follows the thaw while the muskrats are still in process of adjusting to the flood waters, their troubles are compounded. The luckier of the unlucky ones get by with only frozen tails.

The minks are the specialists in seeking out and exploiting dead creatures. They are adept at detecting the scent of the dead as it penetrates to the outside from snowdrift or muskrat lodge or burrow. They are also sufficiently good diggers to break through many frozen surfaces and eat the accessible flesh of coots, ducks, and muskrats partly imbedded in ice.
That the north central marshes really belong to the minks during the winter months is manifested in many ways. Minks may prey upon parts of muskrat populations that become vulnerable with the descent of the frost line. The "sign" shows where a muskrat ventured from an opening in the side of a frozen lodge, to make futile explorations about other frozen lodges. After tracking up new snow with its walking, digging, and gnawing, it began its return trip. Then the walking trail changed to a bounding trail that was joined by the trail of a big mink. The two animals rolled as the mink seized the muskrat by neck or shoulder, grappled with forelegs, and kicked and clawed with hind feet. On the snow is blood and a little fur. A dragging trail leads away across the open spaces, through the cattails and bulrushes and reeds, through marginal weed patches, between and over snow-drifts. Partly blown away in the wind, partly drifted over, the trail leads past one open lodge after another, then into a hole, several hundred yards from the site of the killing. A slightly older drag trail, likewise ending at the hole, backtracks to a place where mink and muskrat wrestled over the snow outside of another lodge. A couple of still older drag trails (but still datable to the same day or to the night before) also lead to the same mink's cache of earlier muskrat victims.

Within a week or so after the onset of a deadly freezeout, the muskrat population of a marsh may be classed as either the dead or the safe—safe, that is, until the frost line reaches another stage or until something else goes wrong for them.

One type of mink predation that can be conspicuous even at times of favorable wintering conditions for the muskrats is centered upon certain individual muskrats that show restlessness with the approach of the spring breeding season. The relatively few individuals of the well-situated population that start coming out on the ice during early winter or midwinter thaws, and persist in doing so for any reason, have limited life expectancies, whether their predatory enemies be minks, foxes, dogs, coyotes, or of prey. These unhappy or restless individuals vary from full-fleshed animals of either sex at their peak physical prowess to the thin chewed-up social misfits of either sex that almost every muskrat population has. They include the senile or mere "kits," the last-born yearling, the last breeding season. They inexplicably, the sick, or member the usual surplus of males. They not fall in any handy classification except that they are muskrats living dangerously while most of the other muskrats are living securely. With these individuals are sooner or later killed off by the opportunistic predators that can do it, or die from wounds inflicted by other muskrats otherwise eliminated. The muskrats of a marsh may again be classed as the dead and the safe—again period of safety for the safe party. The muskrat population may extend past the spring breakup and the dispersal from wintering to breeding quarters, the presence of muskrats hungry, enemy minks notwithstanding.
Red algae lie exposed at low tide along the seashore in Japan, where these plants have an important place both as food and in industry (they provide a source of gelatagar-agar, used by bacteriologists in culture media).

Complex Primitives

Red algae are among the lowest plant forms; but their intricate...

By I. Mackenzie Lamb

Some time very early in the story of life on this planet, primitive plants evolved that possessed a green pigment-complex we call chlorophyll. By means of this, they were able to trap the energy radiated by the sun and use this energy to build needed foodstuffs from the simplest organic elements in the air and water. These first green plants were the beginning of a group that has persisted throughout many millions of years between time and the present—almost the...
are classed primarily according to pigmentation and into three main groups: green, brown, and red. Red and brown algae, like the green, contain chlorophyll, but it is masked by other pigments that give these types their color.

**The Red Alga Group**

Mode of reproduction indicates a long evolutionary development.

Present-day red alga, *Heterosiphonia*, resembles fossil *Waputikia*, suggesting a close relationship between two plants despite wide time-gap separating them.
were assuredly of a simple and barely differentiated structure—probably one-celled organisms floating on or near the surface in the warm, sunlit waters of those times' ancient seas.

But evolution proceeds from the simple toward the more complex, incessantly tending toward a closer integration with the environment and a better utilization of available resources. Thus, among the algae, these primitive, one-celled plants developed specialized offshoots and lineages of more refined, efficient, and complex structure. Chief among these forms of specialization was what we call "colonial organization," in which a number of individuals pool their resources by remaining permanently attached to each other, with an increasing tendency toward the modification of certain cells to perform particular functions for the benefit of the composite whole—functions, for instance, of protection, of assimilating foodstuffs, of locomotion, and of reproduction.

The extent to which this evolutionary specialization proceeded among the algae is obvious when we consider such an example as the seaweed brown kelp, in which the vegetative body (or thallus) reaches a length of several yards and is differentiated first into a basal, rootlike attachment that holds the plant fast, then a stalk, and finally a broad, characteristically leaflike frond for the assimilation of food. All three structures closely mimic the root, stem, and leaf structure of higher plants, and arose—by the process known as convergent evolution—in response to comparable biological and environmental factors.

It is obvious that the algae, in an early period in the history of evolution, before any of them had attained any great degree of specialization, came to a parting of the ways. The original pigment common to all, known as Chlorophyll A, became blended, in some offshoots, with different chemical compositions and became masked to a greater or lesser extent by other, accessory pigments, the carotenones and xanthophylls. These changes were to influence profoundly both the appearance and the functional biology of the newly formed stocks among the algae.

Indeed, we now know that pigmentation is a very fundamental characteristic in the algae as a whole, and no classification of this group of plants is first systematically expounded. The Irish botanist Harvey, some time over a century ago—rests primarily on this single feature.

The seaweeds of our rocky coasts fall into three broad natural groups, all based on qualities of pigmentation: the green algae (Chlorophyceae), brown algae (Phaeophyceae), and red algae (Rhodophyceae).
group of algae that forms our subject. Very few one-celled red algae exist—by far the greater number have a more complex structure, consisting of cells joined together to form threads or filaments. Indeed, this filamentous structure is the basic form in almost the whole group, an underlying structural theme upon which many, often highly complex, variations are played. In the more advanced forms, belonging to the subgroup known as Florideae, curious thickenings (called pit connections) exist in the walls between adjacent cells. These may form both “primary” connections (between cells of the same filament) and “secondary” ones (between the cells of one filament and those of its neighbor).

In this way a branch, composed of a number of cell filaments laid together in parallel arrangement, can acquire definite form and stabilized structure, much as a loose handful of wooden beads can be made rigid by driving nails or pegs between them. In addition, the cell chains are securely held in position relative to each other by a transparent, tenacious, gelatinous substance secreted by the outer part of the cell walls.

Whether the pit connections of the Florideae serve any other purpose than this mechanical function is not known with certainty; it is tempting, however, to speculate on the possibility that they also allow the transport of foodstuffs in solution from one cell to another.

The interlocking of simple cell chains in this way, together with their inclusion in a gelatinous matrix, allows a surprisingly large number of

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Chainlike alga, Battrachospermum, is composed of a central strand with tufts of filaments branching from it. Dark dots at right hold reproductive bodies.
shapes and structural types to develop. This is especially evident when the cells themselves are modified in form according to their position and function, as is the case among the more highly developed red algae. A cylindrical or threadlike thallus can be built up by the attachment of an outer layer of radiating filaments to a central core composed of one or several longitudinal strands. This is the "insulated cable," or "feather boa" type of red algae structure. By joining many filaments side by side in a single plane, in turn, a flat, leaflike thallus can be produced—approximately the "rush mat" type. Whenever these vegetative bodies are more than just a few cell layers in thickness, we find that only the outer cells are equipped with the pigment-bearing bodies (plastids), which enable them to assimilate food-stuffs by photosynthesis.

None of the red algae reaches the colossal dimensions of the great brown kelps, but quite a few attain a respectable size, with fronds well over a foot in length. Even in quite large ones, however, often there is only a single, central cell filament present—running the entire length of the frond and usually protruding as a growing point at the extreme tip. This central filament may be immersed in a thick mass of surrounding filaments or peripheral cells, the number of the latter in some red algae, such as in the genus Polysiphonia, being constant for each species. Other types have many parallel central filaments, so that the growing tip, seen under the microscope, shows many apical threads fanning out in a fountain-like organization.

Most red algae possess a highly specialized type of sexual reproduction that involves the bringing together of two types of cell nuclei, usually regarded as "male" and "female," to form a fusion nucleus combining the hereditary traits of the two parents. These genetic characteristics are borne on the chromosomes—small, sausage-shaped portions of the nucleus—and the number of chromosomes in each comparable nucleus is constant for any given species. When the two nuclei fuse, the resultant double (or diploid) nucleus naturally contains double the normal number of chromosomes. For the plant to return to the number of chromosomes normal in a single (or haploid) nucleus, the latter must be halved. This is accomplished, in all organisms having sexual reproduction, by a special type of nuclear division—called reduction division, or meiosis.

Bearing these facts in mind, let us look at one of the red algae in which sexual reproduction takes place in the simplest manner.

Batrachospermum is peculiar among the red algae in being a freshwater type. It grows on stones in cold, swiftly flowing, inland streams, in such situations as under rocks or bridges, and may be found in almost all parts of the United States where such situations occur. The field naturalist usually looks for small, soft and slimy tufts of fronds in the form of a gray, pale-green, blue-green, or violet color—paradoxically not the color we should expect in this genus the red phycoerythrin pigment is, according to the literature, either absent or else overlaid by a related pigment of a blue color, phycocyanin.

When taken from the waters, the fronds collapse into a gelatinous mass like frog spawn (hence its ancient name—from the Greek batrachos, frog, + sperma, seed). When floated out in a shallow dish and examined with a hand lens, the alga shows a quite...
beaded, filamentous structure. A real surprise, however, comes when a small piece is mounted in gum on a glass slide and examined under the microscope. At this magnification, the slime mass is transformed into a beautiful little plant. From a central strand of longitudinally parallel colorless threads, there arise at intervals rounded tufts of branching filaments that contain the photosynthetic pigments and which remind one of beads on a string (photo, p. 19).

MARINE genus of the same order is Nemalion, which grows in slimy tufts on rocks in the tidal zone in the form of reddish-brown, wormlike, gelatinous strings several inches in length. Its structure, it follows the same plan as Batrachospermum, with a central strand of colorless threads running lengthwise and an outer layer of branching filaments terminating in tufts of hairs radiating in all directions. Here, however, the photosynthetic filaments are not clumped in tufts or beads, but are densely packed along the entire length of the plant, which therefore does not have the necklace-like structure we have seen to be characteristic of Batrachospermum.

Nemalion or Batrachospermum is collected in midsummer, a low-power microscope or even a strong hand lens reveals numerous dense, rounded clumps of cells borne among the photosynthetic filaments. These are masses of sporangia—cells that liberate spores for the propagation of the species. Such sporangia (or carpogonia, as they are called in this case) are formed as the result of sexual reproduction. For these algae produce both male and female organs, usually close together on the same plant. The male bodies (known as spermatia) are minute, round cells produced in large numbers from the ends of certain of the filaments. Set free in the water in enormous numbers, they drift in the current until, by pure chance, some of them come into contact with the receptive female organ that they are designed to fertilize. In all red algae, the male cells are of this same, round type, lacking the whip-like cilia usually present in the male cells of other algae. So, their dissemination is a passive process, depending on the movement of the water in which they are liberated.

Meanwhile, the female organs have been elaborated on other filaments to await the arrival of the male sperm cells. Each consists of a short chain of unpigmented cells called the carpogonium, whose end cell is surmounted by an elongated, sticky, hair-like outgrowth (the trichogynge) especially adapted to receive the male cells.

Sooner or later, one or more of the male sperm cells will drift against the sticky trichogyne, and adhere to it. From this point onward, it would be difficult to understand the course of events without some inside knowledge of what takes place within the cytoplasm of the cell. Thus, for a moment, we will revert to our earlier discussion of nuclei and chromosomes.

Every cell of the plant body of Batrachospermum and Nemalion, including the reproductive cells, contains one nucleus with the single (haploid) number of chromosomes—this number being eight in Nemalion. When a spermatium fuses with the female reproductive organ, it empties its tiny nucleus into the receptive trichogyne: only its case, the empty cell wall, remains attached to the surface.

The nucleus of the spermatium, containing in its chromosomes all of the hereditary information about the parent from which it came, travels inside the trichogyne to the first cell of the chain, which it enters. This is the egg cell and, of course, it also contains one nucleus with the same, single,
or haploid, number of chromosomes.

Now an event takes place that occurs but once in the life cycle of any organism—the fusion of male and female nuclei to form a single large nucleus, which, having the double number of chromosomes, is called diploid, as we have seen. The life span of the haploid generation has terminated for the time being, and the fertilized egg cell represents a second phase of existence, in which chromosomes in the cell nucleus are paired up in duplicate.

In *Batrachospermum* and *Nemalion*, this second, diploid, generation is of the shortest possible duration. It is confined to the fertilized egg cell alone, for as soon as this fertilized egg undergoes its first partition, meiosis—the special type of chromosome-reducing nuclear division we mentioned—takes place. The duplicated chromosomes are torn asunder, and only one of each kind is bestowed upon each of the daughter nuclei.

The clumps of minute carposporangia, which have already been described as dense specks found among the plant's photosynthetic filaments, are produced as the terminal cells of a number of short, compact, and crowded filaments formed by the divisions of the fertilized egg cell. Since reduction of chromosomes took place at the first division of the fusion nucleus, it follows that these carposporangial filaments, and the spores that they produce in their terminal, carposporangial cells, are haploid like the rest of the vegetative plant. The spores, on being liberated and settling on a suitable substratum, germinate to give rise to new *Batrachospermum* or *Nemalion* plants.

This condition, in which the diploid phase of the life cycle is represented only by the fertilized egg cell and which terminates on the latter's first division, is a primitive one in the red algae. On this account, *Batrachospermum* and *Nemalion* are rated as primitive forms. We know for sure that any plant of these two genera that we pick out of the water belongs to the haploid generation. But in other, more highly evolved types of red algae, this is not the case—these have an alternation of two generations, haploid and diploid, growing as separate plants and usually indistinguishable from each other as regards their reproductive characteristics.

Such complications in the life cycle arise, basically, from the postponement of meiosis to a later stage in the organism's development. Not only do the fertilized egg diploid, but also the carposporangial filaments and the spores to which the egg gives rise, have diploid nuclei. Furthermore, when these spores germinate, they give rise to diploid plants, of the same appearance as the haploid ones, so that less reproductive structures are present, it is impossible—short of counting the chromosomes under a microscope—to tell whether the particular plant that we have gathered is of the haploid or the diploid generation. This phenomenon is known to botanists as the alternation of generations. It is widespread in the plant kingdom, though often rather difficult to notice on account of the extreme reduction in size of the two alternating generations. In most instances the haploid.

As an example of red algae in which this more complicated pattern of life cycle occurs, we may cite the genus, *Dasya*, a stringy form...
The nucleus of one of them migrates downward into the egg cell to fuse with its nucleus.

Now, two things happen almost simultaneously. The supporting cell at the bottom of the carpogonial chain proliferates a second, rather large cell called, for reasons that will become clear presently, the auxiliary cell (figure 3). At the same time, the egg cell, itself, buds off a small, connecting cell that bridges the open space between it and the auxiliary cell in the curve we have mentioned (figure 4). With this auxiliary cell, the budded connecting cell fuses, so that the whole complex now takes on the form of a closed ring.

The diploid fusion nucleus of the egg cell now migrates, via the small connecting cell, into the auxiliary cell. The haploid nucleus of this auxiliary cell is pushed to one side and takes no part in the subsequent proceedings. Now, from the auxiliary cell, a chain of a few new cells buds out, each of which receives a diploid nucleus from repeated divisions—but not reduction divisions—of the original fusion nucleus. These latter cells now give off a number of smaller cell chains that terminate in carposporangia similar in appearance to those of Nemalion (figure 5); but they all contain not haploid, but diploid nuclei, because no meiosis of the original fusion nucleus or its descendants has yet occurred.

While all this has been going on, a spherical envelope of cells from the sterile cell tissue at the base of the carpogonium has grown up around the developing spore cluster. By the time the spores are ripe, this protective capsule (the cystocarp) encloses them completely. They are liberated, a few at a time, through an opening at its apex.

This migration of the fusion nucleus out of the fertilized egg cell into another, auxiliary cell (which performs a nutritive function) is found in no other group of plants but the red algae. The spores of Dasya finally settle on the sea floor, and those that encounter favorable conditions germinate and grow into typical-looking Dasya plants. These diploid plants are genetically different from their precursors. We might expect this profound genetic difference to be reflected...
in the size or appearance of the plant, but this is not so in Dasya or in the majority of red algae exhibiting a generation of generations. As we have already said, unless reproductive structures are present, it is quite possible, on ordinary inspection, to determine whether a given individual plant is haploid or diploid.

But by their fruits shall ye know them: the diploid Dasya of the second generation produce no sporogenous organs but, instead, bear as their reproductive organs another type of sporangium (called a tetrasporangium: the Greek _tetra_, four—since it is divided at maturity into four cells, each of which produces a single spore). In _Dasya_ and many other red algae with the same type of life cycle—the four cells of the tetrasporangium are clustered together in a ball, with three of the cells visible in surface view and the fourth underneath. The formation of these tetrasporangia is connected with the second event in _Dasya_’s reproductive cycle, the corollary of nuclear fusion—by nuclear reduction. The splitting of the double nuclei to bring about the division of the single (haploid) chromosome number has to take place at some or another in the life cycle. As we saw in _Nemalion_ and other primitive red algae, this took place immediately after fusion, at the nuclear division. With _Dasya_, it is during two nuclear divisions in which four cells of the tetrasporangium are formed that meiosis—and halving of the diploid chromosome number—finally takes place. Therefore, each of the four tetraspores is isolated and germinates, it contains one haploid nucleus, and grows into a haploid plant of the type with which we started our study. A fresh generation of generations has set in, and we are back at the beginning, with the life history of this advanced red alga repeating itself anew.

Many red algae have evolved the capacity to extract lime from sea water, and to deposit it in their tissues, either in the form of granules or spicules, or as a solid casing of calcium and magnesium carbonate. Calciumified red algae vary from lichen-like crusts on the rocks of the genera _Lithophyllum_ and _Cirrhipathia_—to upright, branched articulated structures resembling...
als. One of our common coastal algal species, to be found firmly attached to rocks at or just below the lowest ebb tide level, is of this latter type. Its 
rigid, calcareous stems are rough to the touch and divided with geometrical precision into jointed segments. It was named *Coralina officinalis* by Linnaeus on account of its markedly coral-like appearance.

The lime-encrusted red algae of this type readily leave their characteristic <br>prints in rock formations, to be petrified intact for millions of years to 
time—*Corallina* and *Coccolithus*, for example. Representatives of calcareous 
and coralline red algae, very similar to living forms, are found in rock deposits dating back to the Cretaceous period. This group, dating back about 140 million years ago. However, 
the red algae are non-calcareous types of red algae that do not survive in quite high evolutionary specia
tion. These appear to go back much further than this—possibly to the Cenozoic era, at the start of the Paleozoic era. Thus, the group as a whole can be considered to have evolved gradually, having already evolved, 400 million or more years ago, to forms closely parallel to those of today.

Each fossil found as this must stimu<br>late our curiosity as to how the 
red algae, as a natural group, origi
nated in those remote epochs, when 
they had comparatively recently made 
a sudden appearance and was still confined to our planet’s ancient seas.

Certain of the most primitive exist<br>ing red algae seem to show a remote <br>relationship with another very ancient group of algae, the blue-green algae 
(*Chlorella* or *Monophyceae*). The <br>ancestry of the same pigments— <br>coccyanin and phycocyanin—in 
these members of both these groups, 
nowhere else in the plant kingdom, 
seems to be substantially. Yet, 
the blue-green algae, propagation <br>is entirely vegetative and sexual reproduction is unknown. Although it seems logical to <br>assume that, at one time or another, 
interbreeding links between the two <br>groups must have existed, these links <br>have probably been lost, or simply <br>become extinct. 

One of the fundamental principles <br>of natural selection in all living <br>organisms, as deduced from the ob<br>serve history of forms well repre<br>seed in the fossil record, is that struc<br>tural innovations in structure or func<br>tion are never derived from highly <br>specialized, lower groups—often of <br>great genetic plasticity—which have <br>descended relatively unchanged along<br>side of the more complicated forms. This helps explain why, in some ex<br>emply, primitive red algae, we find <br>radical departures from normal standar<l<s for example, occurrence of <br>creeping, amoeboid carpospores—bare <br>cytoplasm, with no cell walls—in *Por<br>phyra*. when all other red algae have <br>strictly non-motile reproductive bodies. It would seem that in *Porphyra*, the emergence of an entirely new evolutionary trend in the group. The same may well be true of the red algae like *Batrachosporium*, which inhabit fresh-water streams. Significantly enough, almost all the fresh-water red algae belong to primitive, unspecialized families.

Hence, we may reasonably draw 
the conclusion that red algae rep<br>resent one of the most ancient forms of plant life existing at the present day, 
that they have always inhabited the sea, and that the migration of a few families into fresh water is a relatively recent evolutionary trend. The elabor<br>ate reproductive processes that the red algae show are in themselves a sign of antiquity: more recently evolved groups of plants, once they have adapted to their environment, tend to undergo simplification in this respect.

In point of fact, there is something <br>rigidly geometrical and conservative <br>in the anatomical structure of the red <br>algae, which we do not find in presumably more modern groups of plants, <br>like the higher fungi. We find the same <br>sort of difference, in general terms, <br>between the geometrically constant <br>growth-form of the cone-bearing trees <br>(gymnosperms) and the irregular, <br>adaptable, more opportunist type of <br>growth and branching in the more <br>recently evolved flowering trees (angio<br>spers). Was some concept of this kind <br>in the mind of the Chinese sage who first invented the ideograph for <br>algae (illustration at right) one of <br>whose symbols stands for regularly <br>arranged segments or cells? Whether <br>or not the exceedingly regular and <br>beautiful structure of these ancient <br>plants was thus appreciated in those <br>far-off days, it is certain that for us, <br>today—with the aid of a low-power <br>microscope or hand lens—the red al<br>gae afford as fascinating a subject for <br>study as will be found anywhere in <br>the wide domain of natural history.
LONG BEFORE MAN MASTERED THE AIR at Kitty Hawk, he had marveled at the wondrous spectacle of birds in flight. In spite of today’s technological progress in the design and control of “flying machines” and the imminence of man’s travel through outer space, birds remain the peer in the realm of true flight. We ask ourselves, being intellectually curious and perhaps a little vain, why this should be so. How, in fact, does a bird fly?

Flight is the most characteristic attribute of birds, and has played a dominant role in their origin and evolution. The primitive ancestral bird probably rose from a generalized type of reptile, during an era when highly specialized groups like the pterosaurs, or flying reptiles, were among the dominant animals. The development of flight was necessarily dependent upon adaptations to meet the seemingly conflicting demands of economy of weight and the rigidity and strength of structure, and we can but speculate on its origin. Some scientists look to arboreal reptiles as the ancestors of birds, and suggest that flight began with a primitive gliding motion. Others have postulated that flight originated among bipedal reptiles that “flapped their forelimbs” as they ran. In time, the scales of the forelimb enlarged and flattened into feather-like structures that increased the efficiency of the “wings.”

Although none of the flying reptiles survived to present time, less successful types of flight or simulated flight were developed independently among other animal groups. Certain fishes, for example, “fly” by spreading their fins and gliding on air currents above the water. But they receive their propelling force from vigorous movements of the tail, rather than from the outstretched fins. Flying squirrels are able to glide, by spreading folds of skin spread laterally from the body, having achieved true flight, through the use of members stretched between their limbs, but they lack many of the advantageous adaptations that have been evolved by birds.

Certainly the development of feathers and their coat is one of the secrets of the success of birds. An engineering masterpiece, the feather combines the desired attributes of lightness, flexibility, and durability. The feather coat provides an efficient, smooth, and virtually airtight body surface. The bones of birds are remarkable—often hollow or porous—but adequate to furnish the support necessary for the stresses of flight. Some have become fused together, thereby increasing rigidity and compactness. The air sacs that penetrate many parts of the body...
Approaching perch, wings and tail act as brakes to retard flight velocity.
Within eight inches of target, chickadee, still checking its speed, begins to lower its legs.
As legs fully extended, bird ready to make contact with perch.

Contact is made—feet grip twig as wings work to maintain balance.

Momentum now carries bird forward.

Recovery from forward motion will achieve normal perching stance.
the body, including some bones, probably increase flight efficiency. The bulk of the musculature, particularly those parts controlling the wings and feet, is located nearer to the center of gravity than the extremities as in many animals. No teeth, the abbreviation of internal organ systems, and the rapid elimination of body wastes are additional adaptations for weight economy.

The many kinds of birds differ in the way they fly: each species has evolved a wing that is best suited for its particular way of life. Within this range of variability, however, all have adhered to certain basic features. The streamlined body contours are essential for reduction of air friction and turbulence. The wing of a bird, when viewed in cross section, is thickest at the leading edge, and gradually tapers to a thin, trailing edge. This same efficient design is exemplified in each of the longer wing feathers, or primaries, as well, wherein the thickened shaft is located closer to the leading edge of the feather. The upper surface of the wing is invariably curved convexly, whereas the lower surface is straight or concave. This arrangement of the “airfoil” results in a reduction of air pressure above and an increased upward pressure or lifting force below. Birds are capable of increasing the amount of lift by tilting the wing. Too much tilt, however, destroys this lift, and results in a stall. The stream of air no longer follows the airfoil of the wing; the difference in air pressure on the two wing surfaces changes to a backward pressure, or drag.

A bird’s wing serves in a dual capacity, performing the functions of both the wing and the propeller of an airplane. The inner half, or “arm,” bearing the secondary and tertiary wing feathers, corresponds to the wing of the airplane. It supplies the greater share of the lift necessary to keep the bird aloft. The outer half, or “hand,” bearing the primary wing feathers, corresponds to the propeller, and accounts for the forward motion. The longer, outer primaries are a vital part of a bird’s flying equipment—their loss seriously impairs flight.

For many years a popular misconception of the mechanism of bird flight was the belief that as the wing beat down the bird was lifted up and forward. Our high-speed photographs today suggest that the process is not nearly so simple. In normal flight, the outer half of the wing moves in a semicircle. On the downstroke, the wing tip moves downward and forward, with the tips of the primaries twisted in such a manner as to drive the bird forward with a propeller-like action. The inner half of the wing moves comparatively little, yet supplies the necessary lifting force at all times, regardless of the flapping action of the outer portion. On the upstroke, the wing tip moves upward and backward, pressing against the air and hence continuing to push the bird along. A figure eight is thus described by the wing tip in the course of these two components of flapping flight. In the smaller, faster birds, the air pressure on the upper surface is often reduced by partial folding of the wing, in which case the upward—backward stroke is used primarily for a rapid recovery of the wings to the raised position without producing a significant forward thrust.

When an airplane reduces its speed, flaps along the trailing edge of the wing are lowered so as to increase lift. Birds may accomplish a similar effect by rotating the entire wing and by using the tail as a flap. These devices for increasing lift at lowered speeds are especially important upon landing, where forward speed must be retarded to insure against injury. Additional means for preventing stalling are the apertures, or “slots,” between the tips of the outermost primary feathers. This increase lift by making the air flow fast and evenly over the upper surface of the wing. In some species the outermost primaries are notched to create more efficient slots. Maneuvering, turning, and twisting is accomplished chiefly by adjusting the relative pressure against each wing.

In addition to the normal, flapping flight described above, there is a second general type of flight—soar or gliding. Soaring birds take advantage of currents—air—called thermals—and rise or sink, depending upon the power of the rising air and the advantage the bird takes of it. Air currents that are deflected upward above mountain ridges or shore lines are the reason for a number of soaring birds commonly observed over such topographic features. Soaring birds have comparatively light wing loads. While the tiny chickadee shown has which weighs less than half an ounce, may have a weight of 0.3 pounds per square foot. The five-pound structure may have a wing load of only 1.1 pound per square foot. The chickadee, with so small a wing area in relation to body weight, must flap its wings rapidly—up to four times per second. By contrast, the herring gull, which has long, narrow wings, need only flap its wings two to three times per second. In general, the smaller the wing in relation to body weight, the faster it must beat to provide sufficient lift.

Soaring birds usually have wings that are long in relation to their width—engineers say that they have high “aspect ratio.” Birds vary tremendously with respect to the aspect ratios of their wings, depending upon the types of flight patterns required for their particular way of life. Most songbirds, for example, have an elliptical wing of low aspect ratio that permits them to maneuver more efficiently in close quarters. Swallows and falcons have wings adapted for high speeds, with a moderate high aspect ratio and wing tips that are tapered with a lack slots. The albatross and other oceanic soaring birds have wings of extremely high aspect ratios, with the wing tip slots absent or poorly developed. The slotted soaring wing, as evolved by certain birds of prey, combines moderate aspect ratio with pronounced slotting at the wing tip, thus insuring excellent lift.

Attempts to better understand the flight of birds have been plagued by the multiplicity of variable factors involved. Consequently, the experimental analysis of bird flight has thus far been impossible. High-speed photography has been a promising approach, however, and is largely to this technique that we owe our present knowledge of how birds fly. The interpretation of what the camera sees is based upon principles of aerodynamics. Comparisons made between man’s “flying machines” and the way in which birds demonstrate these principles have been most enlightening. Among other things, scientists quickly discovered that the wing of an airplane is far less complex than a bird’s flexible, jointed, magnificent wing.
Inched by spring action of legs, 
is guided along new flight path by tail.
Johnny isn't watching the last of the evening news.
The shadows that shiver and shake on the TV screen are shivering and shaking in nobody else's living room tonight. Johnny has discovered something new. He's traded the fleeting, flickering "thrills" of the 24 inch screen for the ceaseless excitement and majesty of the night sky.
He's traded the nervous rattle of the private eye's gun for a ringside seat at stupendous nightly fireworks in the heavens.
He has, in short, discovered astronomy.
Nothing better could happen than what happened to Johnny. And it happened simply cause someone took the trouble to awaken, nourish and satisfy a lifetime of curiosity Johnny by making him the gift of a fine telescope.
Someone, not so long ago, gave Johnny a Unitron.
Little Climates

By E. Laurence Palmer

THERE MAJOR ASPECTS of what we shall call "little climates" will challenge the interest of all of us in the coming year. As this is written, only one of these aspects has had firsthand experience; the others have been killed by the second aspect and many other factors. It is probable (but we hope not probable) that most of us experience this second aspect unexpectedly in our future. As to the third aspect, it is certain that all of us have had and will experience the influence of it that has yet been developed.

It is the interest of mastering outer space, we have said a little monkey—protected by an elaborate lattice—far from the surface of the earth. If any of us go to the moon in the future, we will be protected by a little climate more elaborate than any that has yet been developed.

Could a nuclear war break out, those of us who have had to know how to find a spot where our needs may be met until the danger has passed. This possibility we elect to avoid considering.

Instead, we hope to help you understand the universal and the more important "little climates" that are as close as you can read this—climates about which you can do something and the understanding of which may well make you healthier, wealthier, safer, and it may be hoped, happier.

Through the operation of an air-conditioning and a gas furnace, the thermometer beside my window reads approximately 70°F. throughout the day, or near it. I enjoy looking through this window to another that is at right angles to it, only a few feet away in my room. Between these two windows is an open space in which the temperature may be as high as nearly 100°F or as low as 50°F. I do not enjoy these extremes of temperature. If I look from the house through one of these windows across the open space to the other I see that in the daytime the window nearest me is dark and the one opposite is dark.

In the spring, the temperature outside my house gets to about 50°F, I frequently notice sluggish cluster flies on the outside woodwork. They appear when the temperature drops much below 50°F.

I may be seen crowding against the outside of those walls that are dark from the outside. If they manage to get inside, they find that the temperature there is 50°F and they then try to get through the window more—this time from the bright side. Knowing do that when the temperature is below 50°F they are darkness and contact and when it is above 50°F seek light and avoid contact, I can do something about their management.

When it is bright and warm and the flies swarm against my sunniest windows, trying to get out, I open the windows and let them go. When it is cool and they wish to get back in again, I close the windows—and that is that. If we can control light, heat, moisture, and the other factors mentioned in the following chart section of this article, we can control a surprisingly large number of things. Some of these must be controlled if we, ourselves, are to survive.

If we wish, we may recognize three types of climate on the basis of size. More commonly, writers distinguish between the climates of areas on the basis of only two sizes. They say, for example, that the climate of parts of a garden are "microclimates," while those of greater areas are "macroclimates" or just "climates." Here, we elect to consider only the climates of areas under a cubic inch in size as being microclimates and those of areas from a cubic inch to a thousand cubic feet as being "little climates." We can control conditions in a climate of a single cubic inch rather completely. We can do much about a climate a thousand cubic feet in size. But individual areas larger than that need the pooled efforts such as do not concern us here.

In this study, we have selected eighteen factors that may influence any climate—large or small. In our chart, we have indicated some of the more important aspects of each. Since any of you can surely control the physical conditions in an area of a few cubic inches, you might try to learn the effect of the factors we will consider by simply changing conditions in such an area and observing what happens. For example, shut off the light, change the temperature or the pressure of air, water, or soil on a given spot and see what happens. Do this for a short time or for a long time to see if this factor of time has significance. Then investigate the possibility suggested by other proposals.

A serious competition seems to be developing between the agriculture of the U. S. and of other lands. Why, for example, can we plan our food production so that twelve per cent of our population can produce not only enough to feed us all but to accumulate embarrassing surpluses, while the U.S.S.R. uses fifty per cent of its population to produce an inferior return? Our success lies mostly in our ability to recognize significant little things in our environment. We know that, with the proper use of fertilizers, irrigation, cultivation, and labor, one farmer in good situations can produce a bushel of corn for every three minutes of human labor. We know that the land can produce corn with little rotation of crops with the help of fertilizers that industry produces in part from the atmosphere. We know that chickens provide a superior means of producing useful protein from corn but that they...
do not use effectively the non-fruiting parts of the plant. We know that hogs and cattle can use this non-fruiting part effectively in their diet. By little climate management, we can control insects and fungi, and produce hybrid seed, making this whole cycle possible.

It is doubtful if any readers will object to considering light, temperature, or pressure as factors of the little climates. Obviously little climates can be most effectively understood if we know about states of matter and the physical and chemical nature of matter to be found in our little climates. Most important changes in little climates involve the physiology of plants and animals, which, in turn, involve chemical and physical changes that must be appreciated.

We elected to include sound as a factor in little climates not because it is as fundamental as chemical and physical changes but because it may have more significance than we might at first think. Offhand, we speak of a neighborhood as being "nice and quiet" or "noisy" and values attach to these differences. We go to great expense to install mufflers and to use wall coverings that are sound-absorbent, yet we rely on sound for much of our communications and a good deal of our enjoyment. By mechanical representations of natural sounds we can call animals to their death so effectively that we have laws limiting this use of sound. We use sound waves in surgery, in psychology, and in other ways. Mechanically, we can magnify the sound of a moth chewing wool to the point where it is audible to us. If necessary, we could similarly magnify many other sounds of nature that we cannot hear.

To a considerable extent, the time element figures in the success of a little climate. Most of us can dive safely into a lake, remain submerged for a time and then come to the surface and renew our normal breathing. Plants and animals of little climates vary greatly as to the length of time during which they can suspend breathing: survival may hinge on ability in this field. The nature of such threats to an organism's survival is important, of course: a man or a louse might survive a few minutes under water, where either could survive only a few seconds in a blast of flame. Organisms vary, too, in their ability to survive if a portion of their bodies is subjected to a severe influence while the remaining portion is not exposed. This happens particularly in plants, in which—as in the common marsh fires, for example—the underground parts may have the protection of the earth while the tops burn away. Sometimes destruction of a part of an organism may be advantageous and sometimes—as in the case of some pine cones—exposure to a fire may be necessary if the seeds are to be freed. Then, a little climate—protecting a cubic inch or so of a plant or animal—may be all that is necessary to perpetuate a species in a given locality.

Short periods of time in which protection is available are also frequently important in connection with the breeding cycle. Eggs or helpless young may need abnormal luck to come through the crises they experience early in life. Frequently these critical periods seem to be synchronized with the times when nature provides a maximum of protection. If alternate food for an enemy is available in abundance for just a short time, the individual's chances for survival improve.

O f course there are other material factors that can be considered in understanding little climates, concepts of time and of the mechanical and physical nature of matter, of light, sound, and pressure; but these are less important—but not so objectively evident as air, water, and soil. Rarely in nature do you find air without vapor or mineral dust in it. It is almost as unwise to find water without minerals dissolved in it or out air present in it. Our study then concerns things not as entities but as mixtures of different proportions. Little climates will vary remarkably owing to these differences in proportion.

If we look at almost any organism carefully, we will probably find it tremendously influenced by either air or soil. Some of the readers of these pages found some interest in our previous mention of the kudzu crown vetch. We may be concerned about how and persistently kudzu grows. We can see it in length a foot a day and find that it penetrates the soil to depth of over a dozen feet. A single acre may grow as much as a hundred feet in a year. The plant may yield three and one-half tons of hay an acre a year, but this may be insignificant compared to the fact that a cover of kudzu can keep the soil temperature down to 5° below what it is in an adjacent field, and that the lower temperature means a reduction in the loss of moisture—a factor that could be the greatest importance. Most legumes establish a relationship with nitrogen-fixing bacteria. These bacteria, fixing nitrogen from the air so we have available that can penetrate the soil deeply, can use nitrogen in the air, can keep the temperature down and reduce the loss of soil moisture. Air, water, and soil are all necessary to their existence and they bring the three together to perform useful functions. They make our own little climates once they can become established and these, if suitable to our needs, can be of great benefit.

The interrelationships between air, water, and soil are remarkably close so far as concerns almost all the little climate factors here considered. Light was considered here as being available. But the light falling on the soil, may raise its temperature—causing rapid evaporation of water in the soil to form vapor in the air. If materials in the air, in the form of dust, may be involved in causing precipitation or may shut the sun off from the soil and cause a variety of changes. It is thus easier to think of combined action of air, water, and soil than it is to find any one of these in a pure, independent state. So important are these three that we now have great numbers of persons organizing together to guarantee that these three may be available for a given area. We have shed commissions, antipollution organizations, smog-control groups—all of them concerned with problems that may seem remote from little climates but each of their concerns is merely a magnification of the same little units, which you may learn to understand by experimenting in your home, your own yard, or in a few cubic inches of your garden. A drop of water on unprotected garden soil may start a cycle that, multiplied sufficiently and given adequate time, could wipe out a continent or revamp our something quite different from its original state. Just can and do dictate what that little drop will
can practically dictate the future of a country. It may not be evident, but position is of great impor-
tance in understanding a little climate. National interest may demand elbowroom and a place in the sun as the use of increasing populations or decreasing stra-
ge resources. We go to war over such matters and a study of how this expansion requirement can be
without destructive changes is of great importance.

Our little climates this reaching out horizontally the necessities of life is often conspicuous. Birds
mammals establish "territories" of their own, which defend at the risk of their lives. This is often asso-
ciated with the starting of a new generation and the necessity of getting food for the young near the nest.

Men have more or less solved the transportation-problems so that every city dweller does not need
own cow barn and orchard to survive. Now if we increase the productivity of every little climate we reduce our worries about a safe future.

The human population in a large city may be pho-
cenal if considered in terms of an acre of the earth's face. We now put many in a room in a tenement
make our tenements many stories high. In doing we change our demands for space on a horizontal
and look to the vertical arrangement.

The vertical arrangement of little climates is common
ature, particularly where extremes are found. A
art may be too hot to support many forms of life on its surface. But, a few inches or feet underground, situations may be comfortable so far as temperature, humidity, and other factors are concerned. Conse-

quently, much of the desert animal life goes under-
ground during the heat of the day. Ants may build their dens underground with separate layers at different
hs so that young can be carried to suitable regions.

ven outside, we find that there are temperature dif-

ferences at different elevations, which are most impor-
A very few feet up a mountainside may mean a lowering of the temperature.

We speak of the values of "cover" in reference to the aggregation of loose material, which is usually
mon on the earth's surface, and which forms a

dary between solid earth and air. We recognize a
series of strata in a forest, from the canopy down
ugh underbrush and ground cover to topsoil, subsoil, bedrock. Each of these strata has its own little
ate or series of little climates and for the most part
we appropriate populations of plants and animals.

When demands for space on horizontal and cal axes is a combination of these, which we call
alexical axis or a slope, which is neither hori-
vertical alone but a combination of these. Often
graphic distribution of little climates solves many
ems and often it creates many. Think of the im-
ance of slope in your neighborhood and you will surprised at what comes to mind. Erosion and depo-
sition soil. The importance of steepness of slope and the nature of the surface of a slope, all figure in
standing little climates.

Position is of further importance if we consider its
utation to different things—most frequently to the
Living things find different problems if they live a north-facing slope than if they live on a south-

tacing one. Their day may be reversed in some respects if they live on an east-facing or a west-facing slope. Even the length of the seasons may vary due to this matter of orientation to the sun. Life in a little climate may reach its peak of daily activity in the morning or in the afternoon, depending on the exposure.
<table>
<thead>
<tr>
<th>Topographic Position</th>
<th>Air</th>
<th>Water</th>
<th>Sound</th>
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<tbody>
<tr>
<td><strong>CHARACTER</strong></td>
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<tr>
<td>The nature of a little climate may be profoundly influenced by its topographic position, that is, its position in relation to the slope of the solid surface. This may be true on land or under water. This may be more important than position on a horizontal plane or on a vertical axis because slope affects stability considerably. The disturbances owing to the differences caused by slope may be a handicap or may be an asset.</td>
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<tr>
<td>Air is a factor that determines survival of living things in most large and small climates. Air has no definite chemical composition and may include many gases, liquids, and solids, any one of which may affect the character of the air and the associated climate. Air is not essential to the survival of such plants as the anemobic bacteria, and the multiplication of these of course cannot be controlled by shutting off the air.</td>
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<tr>
<td>Water is essential to most little climates and its management may provide most wanted controls. While water has a definite chemical composition it is an excellent solvent and may be affected by many substances taken into solution. The quantity of water necessary for the survival of plants and animals varies tremendously according to environment and we can get their water supply in association with the digestion of their foods.</td>
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<tr>
<td><strong>DIFFERENCES</strong></td>
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<td>Slope is generally expressed in percentages. If there is a drop of one foot in every ten feet of horizontal space, then the slope is referred to as a ten per cent slope. A slope of one per cent may be of major importance in managing farm land under some conditions. Ability to master the task of going up a slope and to resist the pull of going down a slope are important. We can easily walk up a slope prohibitive to a railroad train.</td>
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<td>Hazes, smogs, fogs are caused by particles of liquids or solids or both held in suspension in the air. They may, by shutting off sunlight, greatly affect the nature of climates large and small, particularly where survival conditions are critical. Combustion may remove oxygen from the air and free into it great quantities of carbon dioxide. Smelter wastes discharged into the air, volcanic action, and other phenomena greatly affect its composition.</td>
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<td>The particular substances like lime, salt, acids, which may enter into solution in water, may determine the particular values of that water to living things, both in large and in small. Water may be of little use to living things than water with some substances in solution. Pollution of water is a problem of utmost importance, as it is coming to be for air, and many communities have to use and re-use their water supply.</td>
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<td><strong>ADJUSTMENTS</strong></td>
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<td>Any substance like a liquid that does not have a fixed shape will, if placed on a slope, tend to change its shape and move downhill. The steepness of the slope will determine the speed of the downward movement and the ability of the moving substance to carry other substances with it. When the movement is stopped, the load is dropped. Erosion and deposition result from this situation, whether the moving force is water, moving soil, or moving air.</td>
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<td>Air in motion changes the nature of climates, large or small. Motion may be necessary and certainly is useful in mixing airs of different composition. Since organisms cannot exist if dependent on their own wastes, such changes as those caused by motion are important. Many animals provide by breathing the necessary motion to change the gases. Some plants and animals store useful air. Others reach it by special periscope-like devices.</td>
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<td>Water in motion both solves and prevents the development of problems. From time immemorial streams have been used to flush wastes from congested populations. Violent wave action may upset little climates that may have reached a comfortable equilibrium and eroding streams provide by nature and problems of a spot completely. Management permits useful changes in the position of underground water and may sustain agriculture thereby.</td>
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<td><strong>EXAMPLES</strong></td>
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<tr>
<td>While valuable topsoil may be lost by the erosion caused by moving water, air, or soil, and values may decrease correspondingly, we know that by management of plant cover and animals topsoil may be built back from subsoil at the rate of nearly one-half inch a year. So the management of changes that take place on slopes is not only of academic value in understanding little climates, but of strategic value to the wealth of the land.</td>
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<td>Air conditioning has become a household word for controlling the climate of a small area in which we can live in comfort. This usually involves both the temperature and the humidity of the air. By management, a degree of control can be effected for many small areas. Tree- and grass-planting, circulation of air and water, the diverting of wind paths on minor or minor scales may be a part of the management of air and little climate control.</td>
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<td>Distribution of fishes is often definitely governed by the temperature and associated climatic conditions. In deep bodies of water there may be three zones placed one above the other, with the middle zone or thermocline bounded above by a layer high in temperature and salt and below by a lower lake poorly populated, often stagnant in summer, and with little circulation.</td>
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<td>It may appear as if the sound is carried as an element in the atmosphere but it is not. Ground and water, the medium in which the man's experience of the sound world is considerably limited, is a very inefficient medium for sound. The sounds that are not significantly modified by organisms. We are aware that the earth produces a number of sounds that are completely within our reach, but we recognize their existence.</td>
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<td>Unlike heat and sound, waves and sound waves require an elastic medium for transmission. Hence the structures for the reception. This is a factor of sensitivity to sound, the wave motion on their medium is highly limited in animals and some of the organisms are more or less commonly in a wave or a wave area. Sound waves may produce pleasant sensation, such as each has its role in associated animal behavior.</td>
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<td>Sounds serve effective in bringing organization together to satisfy and reproduction and to effect motion of large numbers of a kind of organism. They also serve to protect the organism, as many animals have defenses, of source of danger in the physical world, and to attract the opposite sex. Such sounds are often a reason for the existence of a species. They effect a therapeutical efficiency of times.</td>
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<td>There is every reason to expect that the management of the sound environment of small creatures will increase the knowledge of man. Sounds can be photographed and recorded from the photo to the specific details that can be preserved. We may learn into this study by understanding what our own hearing range may be. The sounds of singing birds, other birds, and other origins and products</td>
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heat and its absence, may be di-
certed, controlled, and
d as tools of major portance in manage-
ment of large or small
matic units. Of par-
tial importance is the
ility of visible light to
in photosynthesis,
t which takes place in
t plants and forms
basic food for all
ants and animals.
ning at 186,000
seconds per second its ef-
is practically instan-
taneous.

Heat is a determining
factor in the nature of
any climate, large or
small. Fortunately, heat
waves may be directed,
created, absorbed, re-
lected, refracted, and
rejected in varying de-
grees and, so, may be
controlled and used to
the advantage of al-
most any environment.

Temperatures even of
large areas may be af-
fected by the manage-
ment of adjacent areas. Heat
may come from the sun or be
generated.

There is a close associ-
between light and heat and
there may be some associa-
tion between sound and heat.

Important in the under-
standing and use of heat
are the facts that it may be
conducted, imitated against,
reflected, refracted, and
may be accompanied by the
loss of heat, that heat may be
associated with the exp-
ansion and contraction of
materials and affect
the volume and weight
per unit of volume of
substances.

Changes in pressure may
be expected in changes in
temperature, expo-
sure to sunlight, composi-
tion, position, chemi-
cal and physical condi-
tion, condition of asso-
ciated areas, mechanical
means and impact.

While many plants and
animals may become
affected by large or
small climates is highly
sensitive to pressure dif-
ferences. For these dif-
ferences special ma-
chines, such as barome-
ters, hydrometers, and
other devices, have been
developed and are in
constant use.

If supporting and con-
suming agents in a hori-
zontal position in a little
climate can change posi-
tion they may be able to
survive. This change
may be only minor if
food and other necessi-
ties are abundant and
within reach. A bird in a
nest may be able to
reach out and get a meal
without moving from
the nest but a nation
may feel called upon to
go to war with a neigh-
bor if sufficient elbow-
room is not available.

Most organisms have
critically high and low
temperatures beyond
which they cannot sur-
vive and these may be
used in control or in
protection. Temperature
is often significant in the
feeding, reproduction,
growth, and matur-
ity of some organisms
and its control may be
important in the man-
agement of the organ.
ism and its control may be
be of para-
tial importance in
termining its prosper-
or survival in larger
atic units.

Horizontal room re-
quirements vary with the
ability of an organism to
move about by
stretching, crawling,
walking, hopping, swim-
ing, or some other
means of locomotion.

Organisms frequently
have structural devices appro-
riate to adjustments to
changing pressure, as,
with the air bladders in
fishes, special struc-
tures in whales, and even
some in plants.

Changes in vertical po-
tion not only bring re-
wards through changes in
temperature, but they
dislose useful differ-
ce, in water abun-
dance, food abundance,
and freedom from dis-
turbance of dangerous
neighbors. As was the
case in mastery of hori-
zontal space, so, many
organisms attain desired
climates by the extension
of parts of their bodies
to nearby suitable sur-
roundings.

Vertical Space
and Position

The populations of areas
are commonly stratified
in accordance with vari-
tiations in pressure and
these are particularly
evident in air and in
water. Each stratum is
in a way a little climate
within the larger and
the characteristics and
properties of appropri-
ate populations. Organ-
isms frequently have
structural devices appro-
riate to adjustments to
changing pressure, as,
with the air bladders in
fishes, special struc-
tures in whales, and even
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Horizontal room re-
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Organisms frequently
have structural devices appro-
riate to adjustments to
changing pressure, as,
with the air bladders in
fishes, special struc-
tures in whales, and even
some in plants.

Look at almost any
horizontal space and
notice how in nature it
varies and how suitable
organisms occupy app-
oriate space and how
successful societies are
composed of the var-
ious elements needed for
survival. Any large or small
map shows places where
specific things may be
found. Horizontal planning
must be made as popula-
tions increase and available
horizontal space van-
ses.

While many plants and
animals may become
part of great horizontal
seasonal migrations,
other organisms find
their equal success by being
able to move vertically
underground, not only
in different seasons, but
also from day to
day. This is particularly
evident in deserts where
great populations of ani-
mae live underground
either during the heat of
the day, but above ground
in the cool of the night.

Horizontal Position
is sometimes of major
portance in determining
the success of a little
climate. Among the im-
portant factors is the
distance to food, dis-
tance to safety, ability
to master horizontal space,
distance to peaceful ex-
istence, distance to free-
dom, distance to water,
room for expansion in
competition with own
and associated species.

Many organisms can make
minor necessary adjust-
ments.

Heat, in the air, the
water, or on the ground,
underground, the pressure
an environment
exerts on the or-
ganism living in it is
both a determining fac-
tor in their survival and
a means of controlling
them at times. Air,
water, and earth mater-
ials have weight, which
may be exerted with
telling effects on con-
tact organisms. Many
organisms can make
minor necessary adjust-
ments.

The practice of map-
ing an environ-
ment and its smaller
parts by the use of ther-
ometers to recognize the
effect of temperature on
populations, on
humidity, on hardness.

Estimation of organisms
in thermometer-contain-
ing bottles to see what,
any, differences in
behavior may be associ-
ated with temperature.

Note the effect of tem-
perature on the growth
of plants and the causes of
varying temperatures.

Notice how freezing
causes roads, lawns, and
other areas to heave,
possibly rupturing
plants in the process and
killing deep-rooted
forms unless their parts
are pushed back to
destroy the spring rolling of
the surface. Notice how
plants vary in the ability
of their young spring
growth to resist freezing
and how some insects
apparently are not af-
fected by the freezing
pressures, which so ob-
viously affect others.

Where suitable climates
of small or large size
can be placed serially
above each other, the
demand for horizontal
elbowroom decreases.

Skyscrapers in our big
cities are supreme ex-
amples of this principle.

There is an analogy in
park cars one above the
other to save the neces-
sity of using horizontal
space. Ants and wasps
in nests build tiers of
living quarters.
Although we recognize the major importance of compass-dictated position, we here elect to include the relationship of little climatic to special influences—such as bodies of water, valley winds, and special situations caused by unusual vistas, gorges, parks, and so on. Position in relation to a body of water or periodic wind path may be more important than position in relationship to the sun in determining the nature of a little climate.

Two different worlds exist above and below the ground surface but each may affect the other. Locomotion for plants and animals is relatively limited below ground. Circulation of air and water is not necessarily free. Commonly, there are distinct strata with the humus-laden topsoil being the most important to agriculture and the less important to mining and associated geological fields.

The prevailing state of matter in an environment determines in part the large and small climates found there, particularly as animals and plants are forced from one to the other under varying conditions. Ability of an organism to exist as a solid, as a colloid, or as a liquid at different stages of its life cycle makes it possible for such an organism to exist in deep areas most important to mining and associated geological fields. They also have significant existence in parts of the physical environment.

Since organisms make up much of the content of little climates, areas and since organisms have specific chemical needs, the chemical nature of an environment may dictate the nature of the little climate. The role of the senses be significant if although they are not used, even though critical differences may be recognized by these methods. Changes in the role of chemistry in affairs have been related even in little climates.

Conspicuous biological differences based on chemical differences are marshes, alkali desert, and the salines. Reasonably informed amateur may recognize plants and animals as differences in sulfur, and other chemicals. So significant are some of these associations that explorers even have terminate by tracing mineral veins through observations where pertinent plants have developed.

Of course the use of chemicals in modifying a little climate is wide spread. Lime, fertilizers, and the like carry with their use dangers that are both direct and indirect. While fungicides and insecticides destroy some of agriculture, some and natural enemies exist that may have the long run cause useful areas to become useless.

The study of the effects of chemicals on little climates is widespread and probable experimentation even by the amateur. Some observations have been made only on accident. Gasoline spill on a lawn, salt dropping from a roof, and from various management-of-soil practices have grave effects.
Stability

As in the physical and biologic fields, it is also safe to say that true independence of little climates does not exist. However independent an animal seems to be it is dependent on other animals or on plants for food; the plants are dependent on solar energy, water, and other essentials. Similarly, a little climate is dependent on associated climates for its survival. It may take air, water, mineral nutrients and it may take the associate losses.

Changes in position may be effected by the influence of outside forces, as the moon affects the tides, while various motions that determine many of the problems of survival of influenced organisms. Similarly, to the great extent, the moving animals and plants must be considered. The little climates of a game trail may vary greatly from those of an adjacent territory, and the ability of plants and animals to survive impact on a specific terrain. Hence, a lawn may be important.

If we recognize as elements of climate or weather the units mentioned, we must recognize how closely any one is associated with another. Change in temperature causes change in the number of organisms that remain exposed without their destruction, and for how long? Values exist and can be recognized in the establishment of habits of eating, resting, and working that may influence the success of a variety of organisms in little climates.

The sensitivity of organisms and of parts of organisms to harmful or helpful influences for short periods of time can be highly important. Under what conditions, for example, can the rock squirrel continue to live in a part that remains exposed without their destruction, and for how long? Values exist and can be recognized in the establishment of habits of eating, resting, and working that may influence the success of a variety of organisms in little climates.

Ability to react quickly to changing conditions is rewarded promptly by victory in athletic events and through practice may be improved. Many organisms that cannot react promptly to new situations find themselves destroyed. Much effort is spent in training organisms to perform under these conditions in a minimum of time to the end that maintenance costs are reduced and profits forthcoming.

Planning a program of breeding for livestock or organisms over a period of time longer than a day, a season, or a year does much to assure desired improvements and may be as important as the development of superior structures associated with building. Specific rewards have come from understandings that have led to hastening the maturity of domestic plants and animals through environment management and, subsequently, extending the life span of man.

Some of the long-time span areas in which we have made progress, but can make much more, are the time necessary to establish the productivity of soils to productive capacity, the time required and the food needed to develop individual animals to maximum usefulness, the time necessary to restore to production burned-over areas, and the time required to bring a flock of hens, an orchard, or a fish pond to produce at maximum.

Increased knowledge of genetics has provided a method of help in improving our mastery of long-time problems of plants and animals. We have changed the breeding period of plants and animals. We have learned how to produce them so that they will grow in what may have been unsuitable soil, how to be sure that the offspring will arrive when they may be most efficiently brought through critical times of the year, and be disease-resistant.

Try to interpret in the nature of different little climates the appropriateness of the movement of animals, of plants, or their parts. A flower turns toward the sun, a part of an apple trails may be changed by different conditions different for adjacent parts and permitting improved prosperity to the plant as a whole and to its owner. The ramifications of this whole situation should be sufficiently challenging for a long-sustained exploration.

In terms of their effect on little climates, consider the everyday things we do in which the immediate and most important thing done is to control the climatic condition in the immediate environment of a living being. Notice how agriculture, medicine, dentistry, and even industry are dependent on little climates that are associated with them.

Biologists recognize symbiotic relationships in which two or more organisms are mutually dependent with no relation to either; parasitism in which one organism lives solely on the loss of the other; saprophytic relationships where any organism exists on the dead bodies or wastes of another, and commensalism in which organisms may be dependent on one or more others without destruction of the host. Similar relations may occur between little climates.

Some specific, significant short-time sequences might involve the following: respirations, the respiration of an organism without it, the length of time an organism can survive intense heat, great physical shocks, prolonged drought, and low barometric pressure such as are to be found at high altitudes. Important also is the percentage of an organism's body that may be adversely affected without critical results. Ability to survive desiccation is important.

H. Bailey in his verse "Mother Mud" alludes to the importance of the situation when he says, "And ev'ry bird that hops on the lawn is quietly and sacred in proclaiming the king of the mud."
nature IN THE SCHOOL

This study of little climates should be useful in school for the phenomena with which it is concerned may be created in any schoolroom at any time with the simplest of equipment. Yet these simple experiments point out principles that are involved in the whole field of study concerning organisms in relation to their environment. We can do little about the climate of Africa, of Patagonia, or of Arkansas. We can, however, create in a couple of fruit jars conditions of temperature, light, humidity, and the like that simulate conditions to be found almost anywhere in the world at any time of the year. We can with a simple twist of a bottle turn night into day, winter into summer, wet weather to dry. We can put animals and plants into these little climates and observe how they respond. Through these activities we may well gain a better understanding of large and small climates than we could through the reading of many books or attendance at many lectures. Here's how.

Take two metal-topped jars. Remove the tops and place the tops back to back. With a strong knife or tinsnips, cut a cross in one of the tops (illustration). Using this cross as a guide, mark an identical cross in the other top. Cut this cross, also, and place the two tops so that the free portions of the cross coincide. Push two opposite angles of the cross one way and the other two angles in the opposite direction so that the two tops are locked firmly together back to back. Put the bottles back on the locked tops. This equipment is all that is really needed to do the basic work of climate study.

If you cover one of the bottles with a piece of black cloth, you have one bottle in which night conditions are simulated. The other may have conditions of the day. Put some free fruit flies or cluster flies in either one of these bottles to see if they prefer conditions of light or of darkness. Can you, by controlling the light, control the behavior of the flies? If you can control the behavior of the flies in the bottles, what can you do to influence their behavior outside? Knowing what these flies do in response to light, figure out how you can use light to move the flies from one room to another. Try out your ideas to see if they work. If they do not, then try again with some changes that may occur to you. Read the column on "Light" in the chart section (see p. 37), and you may get a suggestion.

If you wish to see what effect temperature may have on the behavior of flies in your little climate, then raise the temperature in one bottle and lower it in the other. An easy way to raise temperature is to fill a hot water bottle with warm water and place it on one bottle. By putting cold water in another hot water bottle and putting this on the other bottle you can get a cold climate. Now fool with these climates and the flies to learn what you can from what you see. You might try placing a hot bottle on top of your experimental bottle and a cold one beneath it to see if the flies show any preference. Using light and temperature—or either—can you get all of the flies to move into one bottle?

It may be worth your while to see between which temperatures your flies are active. Certainly, you can make it too cold or too hot for them. After you have decided—through your bottle experiments—what temperatures your flies prefer, keep watch outside the bottle to see if the flies behave the same way outside as they did inside. You may wish to try any of the insects you can find on a schoolroom window to see what temperature ranges they prefer. Try wasps, cluster flies, large bluebottle flies, or ordinary houseflies. You will sure notice some differences in the responses of these insects.

If you wish to use your bottles to experiment with humidity, put a small wad of wet tissue paper in one of the bottles. Beneath it, one the outside, place a half water bottle filled with hot water. Over the top place a hot water bottle filled with cold water. After a while, you will notice that a cloud of vapor forms inside the bottle. Is this vapor near the source of cold or near the source of heat? Reverse the positions of the hot water bottle to see if you can make the vapor form on the lower or on the upper side of the experimental bottle. Then try to explain what you see.

Having learned a bit about experimenting with living animals—such as flies—try your luck with other animals. A wood frog may change its color within an hour if it is put in darkness. Put one of these frogs in a darkened bottle and another in a lighted bottle and leave the two for an hour. When they are put side by side what color differences can you notice? You might like trying to cover just the eyes of your frog—to see if the color change is due to the light which the eyes are exposed. What do you conclude?

If a fly hangs around the bald head of a person in a lighted room in the evening, why do you suppose it seeks the head rather than a dark part of the room? If you wish to sweat the fly why not illuminate some light area like a refrigerator door to which the fly may go, using a flashlight to pinpoint the spot? You may be surprised to find that the fly obligingly goes to the place where you want it. It may then be controlled by whatever means you prefer. The best part of it is that you have done this by learning how to control the behavior of a living thing.

These simple experiments, and those that they may inspire, will help you learn much about living things and little climates. The experimental materials need not cost you little. The animals for the most part come to you whether you want them or not. You need neither kill nor harm your experimental animals. Yet what you learn can be useful in many ways.
spontaneous transformation of nitrogen N13 and oxygen O15 into the more stable carbon C13 and nitrogen N15, respectively. It may be noted from the diagram that the carbon cycle has the same net result as the proton-proton reaction. Carbon C12 acts only as a catalyst in the nuclear transformation; it emerges in its original form at the end of the cycle and may serve again and again in the same catalytic capacity.

The carbon cycle requires higher temperatures than the proton-proton reaction. The generation of energy within a given star will therefore depend on the prevailing temperature conditions. Our own sun, however, constitutes a borderline case, where both these processes are present.

The transformation of hydrogen into helium occurs at an extremely slow rate. For example, it is estimated that our sun has consumed thus far only five per cent of its hydrogen supply. On the other hand, it is evident that aging stars will tend to become poor in hydrogen (but rich in helium!). Yet such stars still shine brilliantly. One must assume that they derive their energy from some other "fuel."

In 1954, the British astrophysicist Fred Hoyle suggested that helium nuclei themselves might serve as building blocks for heavier elements, with the attendant generation of

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**Sky Reporter**

by Simone Daro Gossner

Nuclear furnaces are old hat in the universe. If light and heat were rated in the stars by ordinary combustion, there would not be enough material in these bodies to keep the fire going for very long. The heat reactions to which stars owe their energy are similar to those in a hydrogen bomb, the only important difference being that, in stars, the reactions occur at a much slower rate, with explosion. The fundamental principle involved in all this is the transformation of matter into energy, according to Einstein's most famous equation ($E = mc^2$). Conditions of temperature and pressure prevailing in each star determine in general manner in which the release of energy is accomplished. Two such processes are thought to be prevalent: simple proton-proton reaction and more complex carbon cycle.

In the first step of a proton-proton reaction, the nuclei of two hydrogen ions (protons) collide to form a proton (H2). This fusion is accompanied by the release of one positron and one neutrino. The positron eventually annihilates a free electron to produce a quantum of energy. The neutrino escapes into space and is lost to the star. The second step sees the deuteron combining with another proton to form an isotope of helium (He3). Gamma radiation is emitted at this point. Finally, the fusion of two such nuclei produces one nucleus of normal helium (He4) and two protons, which are available for a repetition of the whole process. The net result of the reaction is the transformation of four protons and two electrons into one normal helium nucleus, two quanta of energy, two neutrinos, and gamma radiation.

The carbon cycle is a similar chain of reactions involving the fusion of protons with the nuclei of heavier elements of carbon, nitrogen, and oxygen (diagram, right). The successful completion of the cycle assumes the

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Low-temperature furnace is outlined, above. Cycle starts and ends, center.

High-temperature furnace involves a catalyst, C12, in a complex sequence, but net result is same: transformation of the lost mass into radiant energy.
energy. According to Hoyle’s theory, three He4 nuclei would combine to form carbon C12, with emission of gamma radiation. Similarly, the fusion of this carbon with another nucleus of helium would produce oxygen O16 with gamma radiation, and so forth. Until recently, Hoyle’s theories were considered with skepticism because the helium reactions could not be produced in the laboratory. In 1959, however, D. E. Alburger, of the Brookhaven National Laboratory, attacked the problem anew with special equipment, designed by himself, and with the powerful Van de Graaf accelerator at Oak Ridge. Not only did he succeed in fusing helium into carbon, but precise measurements of the quantity of energy released in the reaction agreed exactly with the amount predicted by Hoyle’s theory of helium nucleus building blocks.

THE SKY IN MARCH

From the Almanac:

Moon at first quarter: March 5, 6:06 A.M., EST
Full Moon: March 13, 3:26 A.M., EST
Moon at last quarter: March 20, 1:41 A.M., EST
New Moon: March 27, 2:38 A.M., EST

The sun will be at the vernal equinox on March 20, at 9:43 A.M., Eastern Standard Time. This will mark the beginning of spring in the Northern Hemisphere.

For the visual observer:

With the exception of Mercury (March 1 to 10), all planets will be found in the morning sky.

On March 1, Mercury will set in the west about ninety minutes after sunset. It will be in inferior conjunction on March 10, entering the morning sky on that date. By the end of March, it will rise about an hour before the sun and will be low over the eastern horizon at sunrise.

Venus (magnitude -3.3) will rise in the morning twilight, about an hour and a quarter before sunrise on March 1, an hour before sunrise on March 15, and forty-five minutes before sunrise on March 31. It will be low in the east at dawn.

Mars (magnitude +1.4) will rise approximately ninety minutes before the sun throughout the month of March. It will appear low in the southeastern sky at sunrise.

Jupiter (magnitude -1.7) will be located in Sagittarius. It will rise at about 2:45 A.M., local time, on March 1; 1:45 A.M. on March 15, and 12:45 A.M. on March 31.

Saturn (magnitude +0.3) also will be found in Sagittarius, trailing behind Jupiter by approximately an hour and a quarter. Thus it will rise at about 4 A.M. on March 1, 3 A.M. on March 15, and 2 A.M. on March 31.

Eclipses

A total lunar eclipse will occur during the night of March 12-13. The entire phenomenon will be visible from the United States, beginning at 1:30 A.M., EST and ending at 5:18 A.M., EST. The total phase will last from 2:41 to 4:16 A.M., EST with mid-totality at 3:29 A.M., EST.

There will be a partial eclipse of the sun on March 27, but the phenomenon will be limited to parts of Antarctica, southern Australia, and the south Pacific Ocean.

The former Astronomy Editor for Nature Magazine, Mrs. Cossner, continues in that role for Natural History.
Foghorn sounds beneath the sea

The toadfish's noise is heard from Maine to the Gulf. Why?

BY WILLIAM N. TAVOLGA
Hydrophone — special microphone used in the author's research—is lowered over rowboat's side as a recording of toadfish sounds begins.

The toadfish, of course, is not the only noisemaker in the sea—it just happens to be one of the loudest and most distinctive. The concept of the "silent deep," as we have discovered in the past decades, is a false one. Even a skin diver with no special listening equipment will hear a constant background noise—crackling, grunting, scraping, and thumping—as he travels underwater. The commonest marine noisemakers are species of small, edible shrimp. These animals, which hide inside empty shells, in crevices, or under rocks, possess a claw with a special snapping joint. The cumulative impact of thousands of these little claws at work is a steady din, like the crackle of static. Both crustaceans and fishes who feed upon the organisms that encrust rocks and pilings add to the submarine bedlam as they scrape and pick at their prey with claws or teeth. Rapid movements and changes of direction among large predatory fishes, such as barracuda, produce a sound like that of a dropped bowling ball. During the spawning season, schools of drum or weakfish will sound like an orchestra of bongos, while a large aggregation of sea catfish will bubble like some Brobdingnagian coffee percolator.

Shallow coastal waters are usually noisier than the deeps, and this is probably a function of a larger number of secretive species that hide and stake out territories among rocks and other shelters. The deeper regions tend to be quieter, but there is less known of the benthonic sound-makers there. Dr. Donald R. Griffin, of Harvard University, recorded some mysterious echoing wails at a depth of over 2,500 fathoms, but he was not able to identify the source of the sound.

Despite this tumult, adequate detection of underwater sounds is no simple matter. Any ordinary microphone can be waterproofed, but most still require a cushion of air around the pressure-sensitive element and this buffer stage makes the rendition of water-borne sounds inaccurate. Special, submersible microphones—called hydrophones—must be used, together with amplifying equipment that matches the electronic characteristics of both the hydrophone and the recorder that receives the signal. Since World War II, equipment has been developed to the point where underwater sounds of biological origin can be studied adequately.

Following the invention of sonar, an underwater sound system that can be used to locate submerged objects much the way radar is used above water, the U.S. Navy has been concerned with the problem of the noise produced by the whole range of marine animals. To the biologist, however, these sounds are not noise in the sense of interference. Rather, the study of such sounds gives us an insight into
many hitherto unknown facets of animal behavior. We now know that the sense of hearing and the production of sounds may be just as important in the lives of aquatic animals as are the senses of vision and smell.

In the case of the porpoise, and probably other cetaceans as well, for example, W. N. Kellogg of Florida State University, at Tallahassee, has demonstrated that echolocation is almost essential to orientation and the location of food. For many fishes, sound production is known to be related to spawning activity: this is true for the drum, the croakers, and others, particularly the goby (see Natural History, March, 1958). The male goby, for example, emits soft, low-pitched grunts in the course of its elaborate courtship. In the majority of cases in which sound production has been detected, however, little is known of the exact conditions under which sounds are made and of the possible role of these sounds in the normal behavior pattern of the species.

The loud, distinctive calls of the toadfish make this species a potentially fruitful one for study. Two questions immediately present themselves: how does the toadfish make these sounds, and why?

Before we answer the first question, we must describe the sounds of the toadfish in some detail. Two distinct kinds can be detected: the pow-erful, foghorn "boops," mentioned earlier, and short "grunts," sometimes accompanied by a long, deep-throated "growl." To describe sounds as boops, grunts, or growls is, of course, to be both subjective and inaccurate. Each reader will form his own impression of what these words represent. Recording the sounds is obviously the best descriptive method.

Records of many animal sounds, especially bird songs, are available but little has been done to use actual illustrations of sounds to accompany a text in a manner analogous to diagrams. Yet we can analyze sounds and illustrate the results of our analysis in objective terms by use of an instrument known as the sound spectro-photograph. Use of this device in connection with the mating calls of frogs and toads should be familiar to the readers of these pages (see Natural History, April, 1958). The machine does to sound what a spectroscope does to light: it breaks up a complex combination of vibrations into its various component frequencies.

In sound, pitch is a function of the frequency of vibration: thus middle C has a frequency of 262 cycles per second, the A above is 440 c.p.s., and so forth. Most natural sounds are composed of many frequencies—that is, harmonics— at regular intervals above the fundamental, or lowest, frequency. Various combinations of frequencies are what are primarily responsible for differences in quality, or timbre—for example, the evident contrast between a violin, a human voice, a trumpet, or a frog’s croak.

The sound spectrograph separates a given sound into these component frequencies and automatically makes a written record that plots the harmonics horizontally (see illustration left and right, above). The height of each trace above the base line is a measure of its frequency in c.p.s.; the length of each trace is a measure of the sound’s duration in time. In a second type of record possible with the sound spectrograph, the relative loudness of all the component frequencies can be measured. The instrument, furthermore, detects and presents in a graphic manner properties of sound that cannot be heard or measured by the human ear. In many ways, therefore, a spectrogram is even more useful for descriptive purposes than is a recording.

A spectrogram of a toadfish’s typical boop shows that the major portion of this sound consists of dark stripe at the level of 140 c.p.s. or almost D below middle C, above. Additional stripes above the fundamental represent harmonics. These are distributed at 140 c.p.s. intervals up to almost 2000 c.p.s.—a note well above high C on the musical scale. The length of each trace in the lower portions of the illustrations, above, represents a time interval of slightly less than six-tenths of a second.
Coast toadfish’s “foghorn” is a sound, with its fundamental up around 350 c.p.s., harmonics up nearly to 4,000 cycles, bulk of energy higher.

emits a double boop, the second one shorter than the first. Each of the boops is preceded by a short grunt and the entire performance is preluded by a longer grunt, as if it were a warmup. Verbally, we might represent the sound sequence as: “grunt, bu-boooop, bu-boop.”

The boop of the Gulf Coast toadfish also differs from that of its Atlantic relative in additional ways. O. beta’s fundamental frequency is 350 c.p.s., or more than an octave higher. Harmonics are present, at 350 c.p.s. intervals, up to 3,850 c.p.s. The relative amplitudes of these harmonics are also characteristic. Usually the harmonic at 1,050 c.p.s. is strongest with the one just below, at 700 c.p.s., almost equivalent. The top harmonic, at 3,850 c.p.s., is usually weak and sometimes absent. Even without measuring the specific frequencies involved, a comparison of spectrograms of the sounds of the two species shows the differences clearly, as the illustrations above indicate. To the ear, the two sounds are also easily separable.

How does the toadfish make these sounds? Lacking a set of lungs and vocal cords, what sort of mechanism does he use? Basically, the sound-producer is its air bladder, an organ present in most fishes as a stabilizer that permits the animal to maintain its position at various depths. The content of a fish’s air bladder can be varied, by most species, either through a connecting tube opening into the esophagus or by the alternate secretion or absorption of air by surrounding blood vessels. In the latter case, there are usually found complex interwoven masses of capillaries—known as “red glands”—which possess the necessary large surface area for rapid gaseous exchange between blood and air bladder.

In the majority of fishes capable of sound production, it is the air bladder that is used—in the manner of a drum. The air within the bladder is set in vibration by pounding upon it or moving the bladder’s surface in some other way. In the case of the toadfishes, however, the air bladder, in itself, is a complete, self-contained sound-producing system.

The toadfish air bladder is large, heart-shaped, and loosely attached to the dorsal part of the abdominal wall. Along its sides lie a pair of broad, flat muscles. Vibration of these muscles sets the enclosed air in motion. Within, the bladder is divided in two chambers by a thin, membranous partition. There is no connection to the esophagus: some small “red glands” lie along the ventral margin of the partition membrane. This membrane has a tiny hole in its center, with a circle of muscles around it. Stimulation of the nerves leading to a toadfish bladder that has been completely removed from the body will result in...
Abdominal cavity open, the swim bladder—"voice" organ of the toadfish—is now visible beneath tangle of viscera.

Exposed swim bladder, a heart-shaped organ, is literal a balloon of thin tissue, puffed up by the air it contains.
Bladder's surface, shown in close-up, carries a band of muscle along outer curve. Vibration of these muscles is what sets the contained air in motion.

Production of grumlike sounds, complete hoop sound complex has been elicited by this procedure.

The precise mechanism of sound production is not known. It has theorized that the hole in the formation is a valve that is normally closed and that the muscle-in- vibration of air in the two chambers sets the partition in motion. Size of the chambers and the tension of the partition would determine fundamental pitch of the sound. Shapes of the chambers, in turn, would determine the sound's timbre, harmonic content.

One might logically ask: can the fish hear the sounds of other fish or, indeed, can he hear any- at all? Actually, fishes in genera have excellent hearing. Many species have shown an auditory activity greater than humans'. Discrimination is remarkable in some species. The common goldfish,
for example, can be taught to discriminate between half tones and can remember a scale containing as many as eight different notes.  

Fish with air bladders have better hearing than those without. This means that the air bladder in some way enhances the auditory sense. Since a fish lives in water, its body fluids and protoplasmic contents are actually only slightly different in density from its surrounding medium. In a sense, a fish is "transparent" to water-borne sound, and the presence of an air bladder serves as an acoustical discontinuity within which sounds can be reverberated and amplified. In some fishes—the cat-fishes, for example—there is a series of small bones connecting the air bladder to the inner ear. This apparatus in a manner analogous to the bones of the human middle ear in transmitting the sounds to the vibration-sensitive nerve endings through the fluids of the inner ear. Although the toadfish has not been specifically tested for its hearing acuteness, from the evidence on many other species of teleost fishes, it must be presumed that the toadfish can at least hear and discriminate among its own kind, and probably can also hear and discriminate among most of the other undersea noises.

Our next question is why the toadfish makes the sounds he does. A better way to state this question would be to ask: under what circumstances are sounds produced, and in what way are the sounds related to the animal's normal behavior pattern? As to the first of these points, a toadfish in its natural environment can be made to grunt by approaching it with one's hand or a foreign object. In captivity, the toadfish will answer any sort of irritating stimulus—prodding, pushing, rapid movements, or electric shock—with a grunt. In an aquarium containing several toadfish and other species, I have heard one animal grunting at another that brushed by or approached the first too closely.

Often, the grunt induced by probing is accompanied by a characteristic, spread-out posture of the fins and gill covers and a wide gaping of the huge mouth. If the offending probe is not quickly removed, the grunts continue and are followed by vigorous snaps and bites. The grunting sounds, then, can be interpreted as a defensive mechanism. Such behavior is to be expected from a species whose normal behavior pattern is fundamentally "antisocial." Toadfish do not school, or aggregate in any fashion; they normally spend most of their time concealed in such unlikely hiding places as empty cans, discarded boots, or bottomless bottles; they are territorial in habit and encourage the approach of other fishes, including members of their own species. Pairing of male and female takes place for a short time only: just long enough for the female to deposit a mass of eggs in whatever shelter the male has chosen. Unlike most marine fishes, newly hatched toadfish do not drift away to join the other planktonic larvae; instead, they remain within the shelter for some time and eventually migrate away along the bottom. They may not move more than a mile or so from their birthplace before settling down to a life of misanthropic grunting in their various hiding places.

If the toadfish's grunt is a defense mechanism and a warning to intruders, what about the boop? It is often suggested that the boop sound has some relationship to spawning behavior, but this is not easy to prove. Toadfish in captivity rarely, if ever, produce the sound. Data from the field must be collected by recording the sounds in habitats where, usually, the water is turbid and the bottom muddy, so that simultaneous visual observations are difficult or impossible. It is even difficult to track down the specific individual that is being recorded. In the few cases in which this has been accomplished, the "booper" has always proven to be a large, mature male. Females, however, have exactly the same air bladder mechanism as males, and the ability to grunt is demonstrably quite as good as the males.

While at a marine station in Florida, I had the good fortune both to hear and see a single toadfish over a period of several weeks. Herma (as he was named) lived under the station dock in about five feet of water. From time to time, his boop could be heard by anyone standing out on the dock. At night, he became more active and the blasts more frequent—sometimes as often as two or three a minute. When observed with the aid of the dock light or a submarine lantern, he would sporadically move about on the bottom, foraging for food. He had a dozen different hiding places; tin cans, sunk boots, and other trash. I watched and listened to Herman during the months of July and August, 1944, and eventually I caught him on a baited hook. He proved to be a member of the Gulf Coast species, and the gonads were in an exhausted state, which showed he had spawned some time earlier, probably in the spring.

It is clear, then, that Herma's boop was not functioning in connection with sexual behavior. This does not mean that the toadfish has no function to aid mating during the spawning season; but it does, with certainty that such is not his exclusive purpose. Thus our answer on the function of the boop may be tentative for the present, as we must hedge with qualifications. The sounds may serve as part of the territorial, "antisocial" behavior of this species, by serving to delimit an area and discourage intruders. What function, if any, these sounds have in the spawning behavior we cannot yet say. If some captive environment could be devised for a toadfish wherein their sound production is not inhibited, we should then be able, with controlled conditions of observation and experiment, to give a specific answer to this question.
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Typical landscape of the Namib is shown above. Barren soil and rock predominate, even during region's rainy years. Red dunes like those below blanket a large portion of the Namib, reaching entire length of the desert's coastal side.
A Year of the Namib
Desert stresses are relentless

By Henno Martin

The Hottentot word for desert is "namib." The Namib Desert, itself, stretches the entire length of the thousand-mile coast line of South West Africa. Here, the great breakers of the South Atlantic pound an utterly desolate shore, cold ocean currents meeting a warm land under the burning skies of the Tropic of Capricorn. Cool mist banks may be blown inland almost nightly, but these never fall as rain. Thus, near the coast, the desert is absolute. The passing seasons bring little change and only a few specially adapted plants and animals live here.

Farther inland, the winds of summer occasionally bring enough moist air across the African continent to produce a few violent thunderstorms. Where these occur, they change the Namib from absolute desert into semidesert, producing vegetation to support large herds of game. Depending on this uncertain rainfall, the boundary between full desert and semidesert changes from year to year.

The year's so-called "rainy season" ends in April. If it has been average, parts of the Namib's vast plains will have received two to three inches of rain and will be thinly veiled by soft, nourishing, silver-fronded grass. In the less lucky areas, the sun burns down on barren, stony rubble...
Squat Moringa, the tree from which oil of ben is extracted, can survive droughts by means of moisture stored in trunk.
ELABRA ALOES and cactus euphorbia in foreground are a few of numerous desert plants protected from animals by a poisonous sap. Across the valley, Great Escarpment may be seen in distance, separating desert from the African plateau.

Coarse, glistening, granite sand. In the months that follow, the earth rotates through an endless succession of hot, cloudless days and cold, star-glittering nights.

The winds of the Namib are regulated by the temperature balance between continent and ocean. During the day, the land cools more than the sea; therefore, during crepuscular, the cold air flows down to the sea over the cooled desert plains. In the afternoon, when barren sand rock surface, hillsides, canyon walls, and the big red rocks have been heated, the warm air rises and sucks a cool column of oceanic air into the desert. East winds and west winde with clockwork regularity, and the game herds contentedly, moving eastward in the morning and westward in the afternoon, always against the wind.

This pattern of grazing greatly reduces the danger of an ambush by leopard, lion, or human hunters. Springbok Lily, along with other large flowers, may occasionally be found in sand round Namib's water courses after heavy rain.
Promise of rain reaches the desert, above, as thunder is heard in east. New grass may be half-inch high the next day.

(Antidorcas euchore), oryx (Oryx beatrix), and zebra (Hartmannae)—all the animals that graze on the open plains follow this pattern. But not the ostriches, which rely on their fantastic eyesight to detect danger, and not the klipspringers (Oreotragus), which live in the precipices of the canyon walls where the wind is always irregular.

Under the scorching sun and the dry winds, the grass soon loses its moisture and turns the golden yellow of ripe grain. But, even in this state, it provides sufficient moisture to supply the needs of the ruminating antelopes. They do not visit the fast-disappearing pools of water in the dry river beds during these months, and only seldom do they come for a little salt to one of the Namib’s small salt springs. Not so the zebras. Each night, they descend

A German geologist who spent over two years in the Namib, Dr. Martin has written a book describing his life in that region—The Sheltering Desert, published by Thomas Nelson.
Stagnating pool is all that remains in river's bed a week after a storm. Even in season, rain comes only once a month.
Springbok, among fastest of all Namib animals, bound across parched grass plain. As in other grazing animals, springbok precipitous paths into the deep, wild gorges to slake their thirst. All the larger carnivores too—the leopards, hyenas, wild dogs (*Lycaon pictus*), and jackals need a drink every other day. So, every game path that shows the mixed tracks of zebra and carnivore leads to a water hole.

About an hour after sunrise, flocks of Namaqua sand grouse alight with melodious calls, close their ranks and walk to the pool with the freshest water, take a few sips and depart again into the blue sky. All day long there is a continuous coming and going of animals. The half-hour of dusk is usually quiet—but then, just before dusk changes to darkness, by the hundreds, grouse will again fall down on the sky. Soon afterwards, the first jackal howl will proclaim the beginning of the desert night.

The zebras are the water engineers of the Namib. They smell out the small reservoirs hidden below the sand and gravel of the dry river beds and dig holes two to three feet deep with their hard hooves. This wins water for them and makes it available to other animals as well. The zebras have, in thousands of years, trodden innumerable paths through the labyrinthine gorges and ridges that fringe

*Zebras, above, and oryx antelope, below, migrate westward into desert after heavy rain. Of the two animals, oryx are better adapted to the Namib.*
canyons of the Namib. Many paths connect the grazing areas of the plains; others lead to potential holes. Migrating game, not yet well acquainted with them, can smell out which among the various game paths ones used by animals going to drink. The character of the urine (most animals relieve themselves after grazing), and salt smell of a water hole clings to the land and can be picked up on a game path at a distance of forty miles and more from the drinking place.

In September and October, the days become longer and the sun climbs higher and higher. Then, one day toward noon, the first cumulus clouds lift their white heads over the blue wall of the Great Escarpment which separates the Namib from the high African Plateau. In the afternoon, the wind from the sea pushes these clouds back again.

Next day, the cumulus towers rise earlier and higher on the eastern horizon. The first cloud shadows may travel over the Namib’s parched plains and oven-hot gorges and, in the evening, the first distant lightning may play over the east like a beautiful promise. On the third or fourth day, one or another thunderstorm may penetrate the desert and bring short bursts of rain. The herds of oryx, which have withstood drought, subsisting on residual moisture of dry grass until August, when they begin to seek out the springs.
into the Namib—shedding half an inch of rain on a few square miles of stony plain and hillside. From this storm center, the cool air flows radially away in wild gusts, spreading the refreshing smell of rain and wet earth. Thirty, fifty, eighty miles away, the animals grazing the old, tinder-dry stubble lift their heads, suck the wind with extended nostrils, and begin to walk slowly and steadily over the plains and hills and through the gorges toward the patch of newly wet earth. The ones that arrive on the next day will find the fresh young grass already half an inch high. On that day, not a single antelope will appear at a water hole. Soon hundreds, sometimes thousands, of these beautiful animals will be concentrated on the fresh grazing.

The young grass grows fast but hungry mouths work even faster. Furthermore, the moisture, which has penetrated the desert soil only to a depth of four or five inches, evaporates quickly under the hot, high sun. After a week or ten days, the great assemblage of game disappears over the horizon in search of another lucky, rain-blessed region.

In most years, November and December bring only a few similar, quite local showers. Then the noon hours, under a sun burning down from the zenith, will be almost unbearably hot. The fine sand of the river beds can blister naked feet and a man with a full water bag can die between the red, oven-like dunes. The game will seek the sparse shadow of the rare camel-thorn trees or the better protection of overhanging rocks. Fortunately, just as these days reach their worst, the rising hot air ushers in cool breezes from the sea, giving all the desert creatures a refreshing

Ostriches are among few Namib animals that do not rely on scent to detect danger when they feed or drink, depending...
The oryx is an excellent animal; during dry periods they can travel for miles, only drinking when they find water. Adult oryx can go up to a week without water. The dehydration of their blood and their big muscles make them hard to see at a distance.

But these temporary supplies are exhausted all too soon. Now even oryx and springbok descend the precipitous zebra paths into the deep gorges in search of the all-important water. They walk many hours, often whole nights, to get there and they wait patiently for further hours at water holes yielding only a mouthful every few minutes.

Leopards and hyenas wax fat now, but the tests of endurance for the other animals are relentlessly stepped up from month to month. Not only their powers of endurance are being tried, but their power of self-command too. No one who has witnessed the struggle between thirst and prudence at a water hole taints by a dangerous smell—a struggle that may last for an hour or more—can doubt that some animals possess this quality to a considerable degree.

In July and August, the oryx calves are born. The mothers have to hide their babies under rock ledges or leafless shrubs, concealed from the vultures, while the adults descend into the gorges for a drink. The danger from prowling carnivores is small because these hunters sleep away the hot days. But, despite precautions, few of the young will survive; the milk of their mothers dries up before there is any fresh grazing to restore their lactation.

Most of the game can still find enough old grass to subsist. But the superdry food and the lack of vitamins cause constipation, and the affected animals are soon so weakened that, after a last visit to a water hole, they will remain there, to wait in the insignificant shade of a gray tamarisk bush for the night, the hyenas, and the inevitable.

Some clever old oryx bulls know how to avoid this danger. They go westward, where there is no water but where a few patches of hardly touched old grazing still exist and, on the salty soil of some of the depressions, a species of tiny, juicy Mesembryanthemum grows. Their juice, it is true, is very salty but, after a moist night, the little leaves are swollen with water absorbed from the air and sometimes even glisten with dew. The oryx will fill a good part of its stomach with this wet, green food before the sun gets hot and will then proceed to the old grass.

During February and March that the fate of the next or nine months is decided. If the rains remain scarce, with time intervals of as much as three to four between showers, the migrating game will eat everything that comes up, and there will not be enough moisture retained growth. Then no new grass will be available for at least half a year.

The grazing animals have to fall back on the year-old, cut stubble, already cropped down almost to the roots. Moisture content of this old grass is so low that even antelopes must visit the few water holes and springs regularly from the end of April onward.

Springbok kid lies in the shade. Predators take a smaller toll of kids than does the mothers' loss of milk during drought.
Now the Namib appears truly deserted: sun and wind seem to play over a dead landscape. Yet most of the smaller animals survive, because they avoid the heat of the day in their burrows. In the night, the geckos come out of their holes, the big tarantulas begin to prowl and, in the dunes, the beetles rise out of the loose sand. The little Namib hares look for small succulent plants, and the rock rabbits venture from their fissures, marked by white sinter-like deposits of urine, which is concentrated in a special, large, double appendix, enabling them to use the low moisture content of their food to the utmost. The rock rabbits never need any water, even in the driest years.

Such a drought cycle may last several years. Then, one day in December or February, after the east wind has been blowing stronger than is usual, a phalanx of white again appears over the eastern escarpment. The cumulus towers grow to enormous size until, one afternoon, the thunder rolls, cloudbursts drench the plains, and rivers in spate roar through the canyons. More rain during the next days and weeks penetrates the soil down to bedrock. Green grass begins to wave from horizon to horizon; flowers lift their gay heads everywhere. The game returns, and soon new springbok kids and zebra foals gambol around their mothers. The herds of game move west, as far into the desert as possible, because the shortest grass is the most nourishing. When at last they move east again, the plains of the Namib are golden with mature grass extending as far into the distance as the eye can see.

Such a rainy season assures a plentiful food supply for the desert grazers for as long as the next two years. But this abundant rainfall comes only about once in every eight years. It will therefore not be long until the bitter struggle for survival in the Namib desert commences once again.

**Tarantula, like insects and lizards, survives in the hottest season with relative ease, leaving its burrow only at night.**
game is mobile and is readily killed only by swift s or packs of wild dogs. In the hot season, when game routes lead to few permanent water holes, exhausted zebras or antelopes fall easy prey to leopards and waiting hyenas.
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By Paul Mason Tild

Scattered here and there over the North American continent—and about the other continents as well—are forests from which no logs are ever taken to the mill. No birds sing among these branches, or drum on bark in quest of insect prey. The small animals that once roamed the litter of forest floors in search of nut and cone are vanished; hole, bark, log and branch as silent as stone. Indeed, they are stones, for these are the petrified forests.

Colorful fossil logs that weather out of the Chinle sediments, below, in north-eastern Arizona are believed to be remains of stream-carried forest debris. Many...
though a fortuitous combination of natural circumstances, the wood of old life has been preserved in Minnesota, usually by one of the varieties of opal—such as jasper, chalcedony, or even opal—by some organisms. Although, now and then, the original wood has been replaced by such substances as pyrites, gypsum, native copper, or even radioactives like torbernite, autunite, or uraninite.

One of the better-publicized localities of petrified wood in the United States are in the arid West, a cirque that has been preserved as national monument. Such a cowboy-petified forest association is a unique one; it is as accurate.

It is true that the West affords some remarkable and colorful occurrences. The renowned "rainbow forest," near Winslow, Arizona, the choicest part of which has been preserved as national forest in

National trees were distant relatives of modern pines as araucarias.

A few years ago life for Chung San Kim was hopeless. He had no home in war-ravaged Seoul, Korea. His mother died during the communist invasion. Even the chance to go to school was denied him. His invalided father could not earn enough for Chung San's food and school supplies.

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Through correspondence, Mrs. Sonia Busch became more than a name to Chung San Kim . . . more than a sponsor. He called her, "Sister whom I only can see in dream."

Poignantly he wrote:

"Autumn has stolen away, and now it is early winter here in Korea. The skeletonized trees without reddened leaves are standing lonely . . . Praying for the happiness of my sister."

At the end of every letter he drew a picture to illustrate his thoughts.

With drawings and words touched by poetry, Mrs. Busch in Millbrook, N. Y. knew that in Chung San Kim's eyes, she is a beautiful American.

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STANDING SILICIFIED TRUNK IN YELLOWSTONE PARK ATTIC TO VULCANISM AT TIMES P
In the Petrified Forest National Park, Utah, here, certainly, is a great expanse of brightly colored logs, threatened years with destruction by souvenir and mineral collectors, but by the activities of an enterprising firm bent on converting the heritage into commercial grits. One of the petrified logs possesses another petrified log, one composed of primitive clubbed cycads, the supposed ancestors of our modern flowering plants—also preserved in the sands of South Dakota for the public. The Petrified Forest National Monument, one of the specimens in the exhibit, is actually the development of fruit and the young crown in sunning, as they did in life hundreds of millions of years ago. Here are the great fossil forest trees of the Yellowstone, the specimens circle Cliffs, Petrified Forest in the wild back country of southeastern Utah, and many other such notable localities in Oregon, California, Nevada, Washington and other western and southwestern states.

Fanciers of the "biggest" and the "longest" among petrified trees may point to an area near the village of Leadville, Colorado, north of the Black Rock Desert, where stands a fossil stump some fifteen feet high and forty-six feet in diameter. In the same state, near the town of Coalville, a trunk measures nearly 300 feet in length. Both of these giants of the world of fossil wood belong to the genus Metasequoia, closely related to the so-called "living fossil" species of tree still extant in China.

The eastern half of the North American continent has, by no means, been devoid of such relics of ancient forest life. From the Maritime Provinces of Canada, south along the Atlantic seaboard and along the coast of the Gulf States, there are many localities where petrified wood may be found in some abundance—less colorful, perhaps, than that of the West, and less obvious to inquisitive eyes because of the nature of soil and vegetation. If the East cannot boast the most colorful, it can at least lay claim to what is probably the most ancient of the fossil forests yet discovered in North America. At Gilboa, not many miles southwest of Albany, New York, construction work for a reservoir revealed the fossil stumps of a forest that flourished during middle-Mississippian time, some three hundred million years ago. Relics of forest life that antedate the old forest of Gilboa are not common anywhere in the world.

Collectors sometimes wonder whether any of the animal life must have been intimately associated with the ancient trees is ever found, or in them. The answer is "yes, but not often." Occasional pieces of petrified wood exhibit the scrollwork of bark beetles and the nibblings of other wood-eaters, but few of the animals themselves seem to have obligingly stayed with the petrifact-to-be.

At Joggins, Nova Scotia, not far from the narrow neck of land that connects that province with New Brunswick, there is a series of petrified forests, piled atop the other like the layers of a cake. In life, these woodlands occupied a great marshy area that was undergoing a geological sinking movement and seems to have been a catch-basin for accumulating sediments that later became solid rock. Here, during late Palaeozoic time, there flourished rich stands of the primitive plants known as scale-trees, each successive forest growing up over its dead predecessor, to eventually leave its remains in great profusion in the forms of sandstone "casts."

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![Image of a tree's soft inner tissue buried by sandstone, forming cast.]
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Within the sandstone-filled, hollowed-out stumps of these early trees, one may find the remains of such amphibians as newts and frogs. On the surface of the ground, the shells of snails may be seen, which have been produced by the resident snails.

From one of the Oregon petrified wood localities come fragments of fossil wood that exhibit small holes made by some species of termite; in another locality in the same state also come petrified logs that exhibit not only the ravages of teredo worms but, in some cases, the fossilized worms themselves.

In the ordinary course of events, the forest tree—ancient or modern—loses its life, dies, and slowly returns the soil by way of organic decay and attack of animal and plant life. The occurrence of petrified wood in an area seems to indicate that something out of the ordinary, geologically speaking, must have happened to preserve the original timber.

The trees of the multi-layered forests of Nova Scotia, for example, apparently flourished in marshlands that were periodically flooded with water and its accompanying rush of silt, while a local downward movement of the earth’s crust assisted in the progress of burial of forest debris, logs, and stumps. In this case, the downward movement was not nearly equal in effect to the upward accumulation of peat and sediment deposit, keeping the whole process on an even keel, so to speak, and eventually resulting in a succession of buried forest “horizons.”

In contrast to this slow process of burial was the sudden and violent invasion of standing forests like those that are now flourished on the Yellowstone plateau of Wyoming. In Yellowstone National Park, on the flanks of Amethyst Mountain, a vertical section of mountain ranges is more than two thousand feet of fossil forest exposed. There, to borrow a phrase from an early observer, “rows of right trunks stand out on the ledges, the columns of a ruined temple.” At least eight separate forests are veiled, piled one on the other, overwhelmed in turn by widely spaced eruptions of volcanic ash.

Still a third and somewhat more suggestive method of tree burial is involved in the preservation of petrified logs like those of the cold “rainbow forest” of northern Arizona. Most of the trunks that weather in the brightly colored sedimentary rocks of the Petrified Forest National Mon-
in spate. It may be imagined that at the headwaters of this wild ride to geology came as the floodwaters submerged the logs were stranded here, to be covered and later buried by the rushing waves of silt and sand.

A sliver of wood—or a forest of slivers—has been safely preserved in sediments, away from free oxygen. The attack of living scavengers may ensue by way of a subtle process, one whose exact mechanism is still a matter for study.

The process by which the substance of one mineral is replaced by that of another is known as metasomatism—literally, the exchange of bodies. Percolating water, carrying with it dissolved minerals, exchanges its molecules by atom by atom with the substance of the wood. Upon completion of the exchange, the wood is said to be petrified, whether it has finally become part of one of the minerals of the family or another.

The substance of the wood has been transformed by a quartz mineral—precious as a gemstone. This is said to be sili-

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NEWS (Continued from page 6)  
ical student. Harry J. Fuller, "Theodor of Botany," reinforces the study and suggestions of Cox and in "Botany for Living." C. J. Nettles evaluates the role of botany in our citizens of the future. He believes that botanists should be ready to help. Information and assistance to citizens as more of them enjoy life outdoors, take more frequent stunts into state and national parks will be needed and are allowed a time in their retirement years. II of an increase in longevity, unless Peetie, in a paper "On-Arization of Botany," writes of stunts in nature as a popular pastime and of personal barbs he has received in his work.

Jack McCormick  
THE AMERICAN MUSEUM OF NATURAL HISTORY

A FIELD GUIDE TO AMERICAN WILDLIFE: EAST, CENTRAL, AND NORTH by Hill Collins, Jr. Harper, $6.95 (edition 87.95); 200 figs., 48 plates, 776 maps, 683 pp. Ilus. by Francis Peterson, Nina L. Wil- liam Cameron Yrizarry, is a book ambitiously designed to provide the field identification of "all the birds, mammals, reptiles, amphibians, fish, food and game fishes, sea mammels and principal marine invertebrates occurring in the north-eastern portion of North America and the north-west portion of Canada."

The text includes descriptions of ornithology, ecology, behavior, distribution; these are most detailed in the classification. Range maps are provided for the vertebrates.

Previous limitation of the Complete Bird Guide is the illustration of the birds and mammals. These fall far below the standards set by the excellent guides currently available for these groups, and will be of limited value in field identification. The decision to include illustrations of bird eggs was unfortunate, for they add nothing. By way of contrast, Yrizarry's plates of reptiles and amphibians are well done, hand- some to look at, and useful in the field.

In view of the pretentious scope of this volume, readers may be amazed at the amount of space devoted to irrelevant material and features of questionable value in a field guide. The geologic age is given for many groups; the genus of the box turtle, for example, "goes back to the Miocene." Poetry is quoted freely, as with the six lines from T.C.P. Wilson's "Magpies in Picardy" about magpies in Picardy. There is an original bit of prose about the raccoon: "Coonskin hats, coonskin coats, and coons in general are part of pioneer America, recent America, and outdoor America. And all the while old Ringtail sits in his hollow tree, or drums his Ginny dinner, and somebody pulls through into the Space Age." Yrizarry is warned that if one watches the courtship of the Brewer's blackbird one may see "the rufftuft, male pre-coital display, female pre-coital display, male elevated tail display, head-up display, walking together, mutual display, the dart, and the chase.

The desire to relieve the burden of the field student of nature by creating one guide to do the job of four or five is commendable. Perhaps it is even possible. To accomplish this feat, however, without sacrificing quality and standards, will require a fusion of talents for editing and illustrating that has not yet been achieved.

WESLEY E. LANYON  
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The Wolf of the Sea

A visitor to Antarctica gets a unique close-up of a killer whale

By Joseph Curtis Moore

Ominous dorsal fin cutting the water, killer whale surfaces, perhaps to look for food, at edge of the Antarctic ice shelf.

Powerful, swift, and rapacious, the killer whale may be losing something of its fascination (and fearfulness) for the man who, from the solid deck of a factory ship, may now view the beast with less concern than did earlier generations of whalers. Even when man at sea on a small modern vessel encounters killer whales, he may feel no emotion greater than the thrill of actually witnessing a band of these bold, black-and-white “wolves of the sea.” Their contrasting colors and the towering dorsal fins of the old males provide a spectacle to remember, as a school of the twenty-foot-long killers breach the surface to breathe at intervals. Then they pass beyond ken, in obedience to the unknown drives that steer their apparently purposeful course.

For one more intimately involved with the forces of the sea, such as an Eskimo in his frail kayak or a fisherman in an open boat, close exposure to these voracious predators can test all of a man’s courage.

In the Antarctic, one of the more precarious conditions under which a man may encounter killer whales is when walking on the sea ice near open water. If normal prey—seals or penguins—is not easily available, it is thought that killer whales, seeing men on the shore, may batter and break the ice sheet from beneath and spill the unwary into the water to their death. Killers have also been reported to attack the greater whalebone whales, and may even kill an adult one occasionally. The glistening, black and white head of the Antarctic killer, elevated so that the small, black eye may view what is on top of the ice, as Morton Beebe has captured it here on film, may well indicate that this whale was considering the photographer as a potential victim.

Shortly before the picture was taken, Mr. Beebe notes, the shore line came alive—as penguins and seals threshed out of the water in wild alarm and scurried across the ice in search of safety. Realizing that killer whales were in the vicinity, Mr. Beebe and his companions deliberately tried to attract them by jumping up and down on the ice, which they judged to be a reasonably safe eight feet thickness. The whales did rise a pound the ice underneath them, Mr. Beebe says, and when cracks developed, the amateur experimenters fled.

Bits of new information about killer whales become available occasionally. In 1945, a school of twenty were stranded on the Paciﬁc coast of Vancouver Island. A local scientist measured and compared the individuals of this one pack. Its adult females may substantially exceed fifteen feet in length. The small of thirteen beached females was immature fifteen feet, four inches; largest—nineteen feet, five inches. Potentially important source of new information is a small whaleery in Japan that takes about six killer whales a year. A report of six years’ activity shows, for instance, that killer whales are born about four feet long, and that adult males grow to reach an extreme length as much as thirty-one feet.

Murderous head is silhouetted against icy wastes, right, as killer shoves water and balefully eyes the camera.
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SCULPTURED ANIMALS Photographs by Lee Bolton
FIRST MARITIME TRADE IN HISTORY Lionel Casson
FLIGHT OF THE ALBATROSS William Jameson

DEPARTMENTS

THE ROLE OF THE HISTORY OF SCIENCE Christopher Gerald
THE MARSH E. Laurence Palmer
SKY REPORTER Simone Daro Gossner
NATURE AND THE CAMERA David Linton

COVER: In its course between Northern and Southern Rhodesia, the Zambezi River is broken by the great Kariba Dam, whose beginnings in 1956 are shown here. The structure will be dedicated by the Queen Mother next month, and 1962 will create an artificial lake with four times the capacity of the Colora Lake Mead, bringing cheap power to Rhodesia. This has meant resettlement of the 50,000 Valley Tonga people, whose move has transformed part of Rhodesia into a vast laboratory, affording a unique chance to study the effects of an environment on a given culture. For this study in human geography, see page 272.

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Reviews

The Function of the History of Science

By Christopher Gerou

In a recent and much-discussed lecture, the English physicist–novelist C. P. Snow expressed a concern that has been growing in other quarters as well. His argument, in brief, ran that there is an increasingly wide split between what he calls "the two cultures"; on the one hand, the classic academic culture based on the humanities and the arts; on the other, the scientific culture based on exact observation and experiment and on the rigorous logic of mathematics.

As a result of increasing specialization and, particularly in the years since World War II, as a result of the hot forcing of scientific talent in colleges and universities—usually with a heavy weighting of government subsidy—there is ever-widening cleavage among school and thinking people in general. They may be "cultured" in one of two senses but seldom or never in both. As a result, Snow feels, there is a dangerous growth of misunderstanding between men who typically, regard either an appreciation of Renaissance painting or an appreciation of Vesalius' treatise on anatomy (1543) carried this study of a skeleton.

Dictionary of the American Indian

by John L. Stoutenburgh, Jr.

formerly of the American Museum of Natural History

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George Sarton, first professor of the history of science at Harvard and the founder of two scholarly journals in the field, brought his studies a tremendous classical background as well as the necessary scientific one, plus a conviction that the history of science was part and parcel of history as a whole, not some sort of separate and parallel development. As a result, his monumental History of Science is unfamiliar but very rewarding ground to the scientist who digs into it for the first time. It bristles with references and all the painstaking textual detail of careful classical scholarship. At the same time, it traces connections not only between the scientist and his predecessor but also between the scientist and non-scientific contemporaries who often influenced him as much or more.

A pocket-sized sample of Sarton, and a good one, is his Ancient Science and Modern Civilization (Harper Torchbooks, 95¢). In this series of three lectures delivered in 1954, he covers the flowering and decline of science in the Hellenistic age from 300 B.C. to about A.D. 400. In essays on “Euclid and His Time,” “Ptolemy and His Time,” and “The End of Greek Science and Culture,” he epitomizes a period in the history of science that continues to be one of its greatest periods.

One-volume histories of science suffer from almost as great an impediment as the one-volume encyclopedia. Among them, Charles Singer's A Short History of Scientific Ideas to 1900 (Oxford, $8.00) is the latest and quite probably the best. Dr. Singer—chief editor of the monumental, five-volume History of Technology, recently completed and not likely to be superseded—writes with distinction as well as with the clarity so necessary in a work of this length. The Short History could well serve as an introduction to science-as-a-whole to any member of Snow's non-scientific culture. From it he could, if he wished, possess himself of a wider scientific background than is owned by many scientists. The illustrations are many and good; but the index, unfortunately, lists only names.

Allowed more space, Singer spreads himself to even better advantage in the essays collected in the volume From Magic to Science (Dover, $2.00). One of the essays is a full-scale treatment of science under the Roman Empire. The Romans, he points out, were at their best in nature study and at their worst in pure mathematics, and perhaps too concerned with rhetoric to be notable in any field of science. In his second study, the author traces the submergence—and survival among—of ancient scientific learning during Europe's Dark Ages and shows how these classic works were recovered, again to become vital forces in the science.

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Environment and a Culture

Thayer Tonga resettlement is a case study in human geography

By Thayer Scudder

IN NORTHWESTERN RHODESIA, the great Zambezi river literally cuts its way through the Central African high plateau. Two thousand feet above the Indian Ocean, some 1,300 miles long, its middle reaches—which form the boundary between Northern and Southern Rhodesia—the vast Kariba area has been recently completed. By 1962, an artificial Lake (Lake Mead), now the world’s largest artificial reservoir, Cheap power, flowing from its generators, will be sent directly to the Northern Rhodesian “Copper Belt” and to the larger Southern African urban centers, where it will play a critical role in the developing economy of the political entity known as the Central African Federation.

Over 2,000 feet below the Central African Plateau, home of practically the entire European and Asian (and of most Africans), the area of this upper portion of the Middle Zambezi Valley is visited annually by only a few whites—government officials.

The region is inhabited, however, by over 50,000 Africans, who settled in the banks of the Zambezi and its major tributaries centuries ago, when Bushman bands probably still roamed through the area. Perhaps the Valley Tonga first inhabited this region as a refuge area from the more warlike peoples that periodically have swept through southern Rhodesia, destroying cereal crops and plundering villages. Today, however, even the most remote areas in Africa are being inundated by the Kariba Lake, this once isolated area has ceased to be a refuge, and its inhabitants have been resettled inland from the waters of Lake Kariba.

With such a large area soon to be inundated and lost to science completely, a study program of the pro-

resettlement areas for Valley Tonga after new lake has flooded. Zambezi Valley are shown in gray on the map, above.
A Harvard geographer, Mr. Scudder studied the Valley Tonga for the Rhodes-Livingstone Institute in 1956-57. He plans soon to investigate the effects of the resettlement.

Officer of the Rhodes-Livingstone Institute in Lusaka. My task was to study the human geography of the Valley Tonga over a twelve-month period under the supervision of Dr. Elizabeth Colson, an anthropologist and Senior Research Officer of the Institute. While she studied the structure of Valley Tonga society, I concentrated on their subsistence economy and its adaptation to the environment in which this isolated people made their home.

This region has been considered a famine area ever since it came under the jurisdiction of the British South Africa Company over fifty years ago. Why had it been necessary for Government to send grain into the area practically every other year? In our discussion of the food economy of the people prior to their resettlement, this problem will be frequently mentioned. But, first, a brief description of the physical environment of the region.

Some two hundred miles upriver from the dam site in the Kariba Gorge, the Zambezi Valley is again constricted at the exit of the spectacular Batoka Gorge, which, fifty miles further upriver, funnels off the Zambezi at the base of Victoria Falls. Between these two gorges lies the home of practically all the Valley Tonga. In cross section, the geologist H. S. Gair describes this area as a vast, asymmetrical syncline, with an abrupt margin on the Northern Rhodesian side. Structurally, the Valley is composed primarily of Karroo sandstones, occasionally capped with basalt, which, when they lie close to the river's edge,

THE SEASON'S PERILS

Causes of famine are diagrammed here. Above, untimely drought during the rainy season may kill or stunt all crops except those on the recent deposits of alluvium at tributary deltas. A severe early flood, below, inundates all alluvial flats before plants can be harvested, sparing only those on upland fields. Karroo sandstones underlie alluvial garden...
hem is being built so owners can protect the field. Tonga continue agriculture throughout the year, in rainy season and also in dry, when planting follows the water level as it drops and newer alluvia become available for use.

ASON HAZARDS are illustrated here. If a river fails in spring because of a lack of rain, there will not be enough ground moisture to grow crops in areas back from the water during dry season, above. If, on the other hand, river rises prematurely, below, crops planted low on banks at end of the dry season may be flooded while still unripe.
Valley Tonga, despite hard lives, are a cheerful people: group above, dressed in best clothes, are on way to a dance.

are overlaid with Zambezi alluvia that vary in their a

On the Northern Rhodesian side, which carries appro
mately two-thirds of the population, Gair divides the Va
into three zones of greatly varying width. The first, clos
to the river, is quite flat—with occasional isolated hils
and varies in width from under one mile to over ten. Th
approximately coincides with the area to be flooded a
is the only zone we shall consider in detail. Inland, this zo
abuts upon an undulating region of rugged, bush-cover

Harvested cucumbers, above, are valued for their seeds,
which, pressed and roasted, are often used in Tonga recipes.
The hills—generally running parallel to the river and, in places, coming down practically to the water's edge—are spectacular at times. These hills may rise several hundred feet above the Valley floor, cutting off the riverine zone on a third zone of flat, low-lying country at the base of the Plateau. Through this third zone, tributaries of the river meander, running parallel to the main river until, after having rounded almost 90°, they break through the hills to flow out onto the flatlands adjacent to the river.

Together, these metal zones vary in width from over twenty-five miles to less than two, so that—taken as a whole—this portion of the Zambezi Valley, from one side of the Plateau to the other, ranges from nearly seventy miles wide to only a fraction of that. Isolation, until recent times, was fostered by the nature of the Plateau margin. Rather than descending abrupt escarpments, the invader must traverse ten or more miles of deeply dissected, broken country before reaching the Valley floor.

Newborn baby provides focus of attention for the Valley Tonga family seen, above, relaxing in dry season by garden.

Cattle, left, are scarce in the Zambezi Valley because of disease. Their chief use is not for milk, but in plowing.
Kaffir corn is harvested after end of the rainy season in April or May. Grown both in bush gardens and near rivers, kaffir corn is, with millet and maize, one of Valley Tonga's three principal crops. Platform is used for drying the grain.

The Valley Tonga are [this present tense refers to 1956-57] subsistence cultivators, living close to the Zambezi and its major tributaries in permanent villages. Their principal crops are bulrush millet (Pennisetum typhoides), kaffir corn (Sorghum vulgare), and maize. Population density appears to be determined by the amount of alluvium found along river banks and in the delta areas of certain tributaries. As the amount of alluvium varies considerably because of underlying structure and other factors, population density and village size also vary both along the length of the Zambezi, and on the opposing banks, for large alluvial flats at the mouth of major tributaries are found only on the Northern Rhodesian side. On the basis of age, Dr. Geoffrey Bond has divided the more extensive alluvia into two classes: Alluvium II and Alluvium III. Alluvium III soils are the younger. Where they have been laid down in extensive deposits in tributary deltas, they are the most important agricultural soils along the Zambezi. Adjacent Alluvium II soils vary in fertility. In some localities, they are not suitable for agricultural purposes, supporting little vegetation other than mopane scrub (Colophospermum mopane), which is cleared here and there to provide Valley Tonga village sites.

Permanently farming the more fertile alluvia wherever they are annually inundated, the Valley Tonga are able to cultivate two crops per year—one in the rainy season (November-March) and the other during the dry. As the Zambezi begins to drop after its annual flood (April-May), the people follow the receding waters and plant their crops in the alluvium as soon as it becomes sufficiently dry. Throughout the rest of the dry season, the Zambezi continues to drop in its channel, so that—by the following November, when the rains again are due—the staggered nature of the dry-season plantings is obvious to anyone boating on the river. Near the water's edge, maize seedlings are but a few inches high—in contrast to tasseling plants halfway up the bank. The crops planted near the top of the bank, or on the alluvium back from the Zambezi's channel, or in tributary delta areas, have already been harvested. With the rains, a second crop will be planted in these recently harvested fields, to be harvested when it reaches ripeness the following March.

Given such an agricultural setup, why did periodic famines occur, especially when the population was smaller than it is now? While drought during the rainy season is the major cause of famine, a less obvious cause is tied up with the annual regime of the Zambezi. Although river flow fluctuates during any twelve-month period according to a definite pattern, the water level can vary tremendously from year to year during certain critical months. For example, in March, 1943, Zambezi flow recorded at Livingstone was 147,100 cubic feet per second. The following March it was only 29,300 c.f.s. So far as the Valley Tonga are concerned, such variation can mean the difference between a good harvest and virtually no harvest at all. If the river floods in early March—instead of in April or May—it will inundate the delta areas and alluvial flats inland from the main channel before most of the rainy season maize can be harvested. Up to eight per cent of the crop can be taken by the water in this way. If this unseasonal flooding happens in two successive years...
Grain is being spread on platform to dry, *above*, will be stored in village granary. Abundance of crops may vary sharply from village to village; before the British rule, food-rich villages were often attacked by hungry ones.
the Valley Tonga find themselves in a serious position. On the other hand, if the river fails to rise appreciably in March, April, and May—because of insufficient local and upriver rains—there will not be sufficient ground moisture to grow dry-season maize in the alluvial areas back from the river or even along the top of its primary channel. A similar predicament can occur if, after the flood season, the river drops too rapidly, leaving dry-season crops high and dry (the mean maximum annual temperature throughout the Valley is close to 90°F). Finally, if the river begins to rise appreciably in December—rather than in January-February—because of heavy early rains, crops planted low on the banks during the latter portion of the dry season may be flooded before they can be harvested. In any twelve-month period, up to three of these four possibilities can occur—which means a bad year indeed.

Thus the fertility of Zambezi alluvia and the river's annual pattern enables the Valley Tonga to plant two crops a year, although an extreme variation in river flow during the same months in different years may keep the people from harvesting either or both of these crops.

In some years, the crops may be under three feet of water at harvest time; in others, they may scorch because of insufficient moisture. Although the seasonal fluctuation of the Zambezi is the basis for the type of agricultural economy the Valley Tonga practice, at the same time its variability imposes severe limitations upon this economy.

As an escape valve, the people also practice a form of shifting cultivation in the bush during the rainy season. In the past, this has been largely limited to a narrow band of land along the main watercourses (including the Zambezi) just back from the alluvial zone. Within the past fifteen years, however, the villagers have begun to cultivate sizable gardens (called matemwa) well back in the bush often a mile or more from the villages and running water. Harvests of bulrush millet here appear to be good even during years of low rainfall, so long as the sandy loams of Karroo origin—have not been exhausted. Granted this one wonders why the people did not grow more millet in the bush as a famine check in the past, especially since aerial photographs reveal sizable areas of suitable land. Although no people utilize all natural resources within their environment, people with subsistence economies, in general, are acutely aware of those aspects of their habitat that relate to their main occupations—whether gathering, hunting, fishing, pastoralism, or agriculture. If, as in the case of Valley Tonga agriculture, large tracts of land are unused at certain points in time, there are probably excellent reasons, both environmental and cultural, for this.
Much of the low-lying bush area back from the Zambezi is mopane woodland, which constitutes perhaps the best browse for big game in low veld areas. Although, today, much of the game has been shot off or driven out of the mopane into isolated thicket areas, elephants still periodically devastate Tonga gardens. In the past—when the population was smaller (it appears to have doubled in the past half-century), and guns rare—matemwa gardens would have been very vulnerable. Moreover, in many suitable areas, if little rain falls in February or March, lack of drinking water can be a hardship to bush cultivators.

Irregular rainfall, however, has implications of even greater importance. Since total rainfall varies between adjacent areas within the Middle Zambezi Valley not only in any one year, but also in the same month and on the same day, rainy season harvests—which are dependent on rainfall rather than on ground moisture from major waterways—may be excellent in one area, but insufficient in another area only twenty miles away.

This factor alone may have had much to do with the pattern of raiding within the Valley. Prior to Pax Britannica, clusters of villages were drawn together into geographical units—called chisi—which in the past formed a basis for certain political activities. When famine affected the villages of one chisi, for example, its male inhabitants might raid villages in another chisi where a good harvest was stored away. If people had cultivated isolated gardens out in the bush in those days, they would have been far more vulnerable to raids than in their regular gardens, which lay comfortably close to the rivers and villages.

Of course, raiding ceased in the Valley after the turn of the century, so that this factor would no longer be a deterrent to bush cultivation. In those early days of British administration, however, families—and even whole villages—were still accustomed to move up to the Northern Rhodesian Plateau when famine conditions became un-
SPARKING the tremendous development of *matemwa* gardens on the Northern Rhodesia side of the Valley in the last ten years was a Government grain tax placed on bulrush millet, which obligated each family to deliver a fixed quantity to special granaries in chiefs' villages. As a famine relief measure, this was most successful as it practically forced families to supplement their usual gardens with new ones in the bush. While the tax was only imposed for a few years, it speeded a process that had just begun to develop (aerial photographs indicate that enterprising individuals had begun to cultivate *matemwa* gardens even before the grain tax was introduced).

Today, over large areas, bulrush millet has actually become a more important crop than maize or kaffir corn—which are best grown close to the rivers in alluvial soils. As millet harvests have increased, less acreage of other crops is being planted in the poorer alluvia back from the rivers, although—because of the *matemwa*—the total of all crops per family appears to be greater during the five-year period 1951-56 than ever before. Even with a larger population, the need for famine relief was lessened during these years. Of course many other factors enter into this picture but the development of *matemwa* gardens appears to be the most important.

Unfortunately for the Valley Tonga, time cannot be stopped. Already some *matemwa* gardens have been continually cultivated for nearly ten years. While harvests are still remarkably good, it is doubtful that soil fertility will last much longer. Sooner, rather than later, the people would have to clear new *matemwa* and allow old gardens to regenerate—a process probably requiring at least twenty years. After ten years of bush clearing, however, little suitable land is left today for future gardens. In fact, some young men—returning from several years' labor in the urban centers on the Plateau—must now clear gardens in areas cut off from their villages during the rainy season by major watercourses in flood.

As for those alluvial soils finally being rested because of increased millet production, their fallowing was long overdue. While the food shortages that reappeared in certain areas along the Zambezi during 1957-58 were primarily correlated with record March floods during two successive years (*matemwa* gardens, alone, cannot support the existing population), those conditions also reflected the exhaustion of sizable areas of alluvium, coupled with insufficient land for *matemwa* gardens. The implications here are that even without the Kariba Dam Project, Government would have been forced to resettle many of the Valley Tonga within the next fifteen to twenty years—primarily because of the exhaustion of the soil.

Viewed within the context of their limited technology, the current Valley Tonga agricultural practices are, in general, well adapted to their environment, although, from the European viewpoint, many profitable innovations could be introduced. While some of these would involve technological improvements that the Africans are as yet in no position to receive, others do not.

Perhaps the most glaring of these inadequacies in the Valley Tonga system of agriculture is the complete absence of food crop irrigation. Although the people occasionally water tobacco seedlings, food crops are allowed to burn up high on the banks of the Zambezi while thousands of acre-feet flow by within a hundred paces. Even with present

Wild grasses are harvested during February at the height of rainy season, are a major food source during famine years.
River gardens could be watered by using the waters with which the people carry cooking and drinking to the village. There is no sufficient explanation for this situation; it is just one of the imponderables that are found in any study of human populations.

Yet unexploited possibilities within the knowledge of the people at least lend themselves to tentative solutions. Although no systematic crop rotation or crop rotation is practiced, these are techniques possibly with advantage to cultivators of alluvial soils. By one generation, soil exhaustion would be so severe to make the development of specific remedies to restore fertility apparently pointless.

However, if the Zambezi sticks to its annual pattern without marked fluctuations, alluvial crops often will be sufficient, while no amount of fertilization (whose benefits the people recognize), for example, would help crops that are inundated. Bush gardens, of course, would benefit from such techniques, but agricultural practices among the Valley Tonga are practically the same, regardless of soil type. The pattern developed for riverside cultivation is transferred intact to the bush, where sandy loams are cultivated as if they were alluvia. Perhaps the most important point here is that while the people do not carry out some practices that they ought to (and that they could, given Tonga technology), most of their actual techniques are quite well adjusted to local conditions. (The second half of Mr. Seudder’s case study in human geography will appear in the May, 1960, issue of NATURAL HISTORY).
Foundation of hornets' social organization is the female, above. Brood-rearing and food-gathering are her principal activities. Here a female *Vespa crabro* menaces an insect ready to attack in defense of the comb on which she
Brood-rearing involves two-way exchange

By FRITZ SCHREMMER

Brood-rearing and its concomitant food-gathering present some of the most remarkable aspects of a hornet—in this case, Vespa crabro—community’s activities.

In rearing the brood, for instance, a constant nest temperature is maintained. The larvae seem to thrive best at about 36°F, and experiments indicate that this temperature changes by no more than two to four degrees during the entire summer brood-time, although outside temperatures may vary by as much as 20°F. In cold weather, hornets produce heat by burning their bodies’ nutritive substances.

The number of winged inhabitants in a hornet’s nest may often exceed 1,000 individuals. In addition, the colony may contain more than 200 larvae. The latter stay neatly arranged in their hexagonal cells, their heads all pointing toward the center of the comb—a convenient arrangement for the food-supplying adults.

As soon as a larva is fully grown, it begins to close its cell with a convex covering that consists of secreted threads that assume a feltylike texture. Within this closed cell, the larva casts off its skin and changes into a white pupa, in which can be recognized the embryonic limbs and body segments of the adult hornet. After a period of fourteen to eighteen days, the pupal skin is also cast, but the insect remains in the cell for one or two more days, as an imago, preparing to hatch. It then eats slowly through the cell covering, and the adult hornet emerges, prepared to begin contributing food to other residents of the nest—a highly intricate, co-operative process.

Flies, caterpillars, and many other insects are a hornet’s normal prey. These are carefully chewed; the fluids are swallowed and stored in the hornet’s crop for distribution to the community, while the finely ground flesh is formed into a ball and carried home between the mandibles.

On arrival back at the nest, the working hornet—a female, as are all
Workers—is immediately surrounded by her sisters, who beg for food. The collector bends sideways, opens her mandibles, and regurgitates the contents of her crop, which ooze from her broad, slightly protruding crop, and is quickly licked up by others. The collector-hornet only the barest minimum of food herself. If there are many insects in the nest, the collector-hornet is emptied, and she soon search for food. If her crop is emptied slowly, or if it remains filled, she stays in the nest until the food is consumed.

The sisters who were fed by the collector-hornet withdraw into the interior of the nest, where they in turn pass on the food they have received. Thus, each “beggar” becomes a donor. No wonder the crop of social insects that exhibit this behavior has been termed the “social stomach.”

Newly hatched larvae are fed nutritious glandular secretions from worker-hornets’ bodies, while the somewhat older larvae are fed primarily with insect flesh. A collector-hornet bends down into a cell containing a larva, which lifts its head, opens its mandibles wide, and emits a drop of water-clear saliva that smears the food pellet, making it moist and slippery, and thus easy to swallow.

Surprisingly, even when the collector does not offer food, the larva reacts in the same manner. In this case, however, the saliva is imbibed by the adult.
Horn-shaped antennae identify male hornet, above. Males, which appear at the summer's end, are not workers, but have only single function—procreation.

Hornet. If the larva does not secrete, it is urged to do so in an unequivocal manner: the adult seizes the larva's head between her mandibles, draws it slightly toward herself, then pushes it violently back into its cell until the larva produces the saliva.

The fact that adult animals are fed by larval saliva, and that they eagerly demand it, is one of the strangest phenomena in the social life of the hymenoptera. W. M. Wheeler, the late Harvard entomologist, called this kind of reciprocal feeding "trophalaxis," and hypothesized that it is one of the bases of the life of these insects, actually preventing disintegration of the social organization. Larval saliva is both nutritive and stimulating, and induces the workers to nurse the brood.

Another aspect of reciprocal feeding can be found in the licking phenomenon. Sometimes female hornets have been seen licking each other with such vigor, mandibles agape, that they appear to be fighting. The areas most licked are the neck and the dorsal side of the abdomen.

This licking has little or nothing to do with any social "cleaning" drive. Rather, it serves to obtain a stimulating substance secreted by the skin. Research concerning the nature of this material is still being conducted, and the only positive statement that can now be made is that mutual licking plays a vital role in regulating the social life of the hornet.

The male hornet is not a worker: immediately after copulation, the utilized female pursues the male, and stinging him. In one observation a male fell motionless to the ground shortly after being stung between the abdominal segments. One of his antennae was bitten off, and the right wing broken at the root. After twenty minutes, only the terminal segments of his legs showed weak and convulsive movements; his death occurred two hours later (see photo, right).

Such maltreatment of a male is unique. Males have been found in study cages, with their heads severed from their bodies. Others had been so nibbled upon that pieces of tissue or the thorax were missing. It is obvious that these victims had contributed to the nourishment of an equally ill-fated brother's offspring.
INFORMATION OF HORNETS is rarely observed. Male's curved horns are at upper left, above, female's at lower left. Dying male, below, is paralyzed by sting of fertilized female, who also bit off left antenna and broke right wing.
Egyptian snake, carved from granite some two thousand years ago, rests head above inscription.
Sculptured Animals

Beasts, birds, mythical creatures have been immortalized in art

Photographs by Lee Boltin

The contemporary American, accustomed to seeing his animals curled by the hearth or peering demurely on a calendar on the wall, sometimes forgets that animals played a role in other cultures important enough to immortalized in major and often exquisite works of art. Adored for their flesh—their skins, teeth, and hair used for clothing and other essentials of life—animals were so necessary a part of early and primitive societies that they were worshiped as deities, and sometimes even considered reincarnations of human ancestor spirits.

The sculpture on these pages, from the collection assembled by Jay Leff and recently exhibited at the Carnegie Institute in Pittsburgh, gives an indication not only of the importance of animals in a wide variety of societies but of the wealth of styles and materials in which they were rep-resented. People as diverse as the ancient Chinese and the mound-builders portrayed them naturalistically, in bold sculptural forms. In contrast, the Bambara, a group of tribes still living in the Western Sudan, carve their tjirara, or antelope headpieces, in a stylized fashion in which the empty spaces are as important to the sculpture as the carving itself. Stone, wood, metal, and such animal products as horn, bone, ivory, and shell have been employed. Birds, snakes, horses, lions, and every other beast known to man—including some fanciful hybrids produced by the artist’s fertile imagination—all have been fair game.

To carve a beautiful object for beauty’s sake alone was a concept almost unknown to artists of these cultures. As a result, most of the bowls, boxes, horns, rattle bikes, masks, and figures shown here were either used as ceremonial objects or as household utensils. But disparate though these objects and the ideas that produced them may be, there is one unifying factor. Each creation is the work of a skilled artist whose standard of beauty was extraordinarily high.
Bronze tiger, incised with gold, was given a belligerent pose by its Chinese sculptor, during the Han Dynasty.

Less than naturalistic horse supports a Dogon rider of the French Sudan, carved in eighteenth century.

Heavily inlaid flute of steatite, precontact work of California's Chumash tribe, may mimic bird's head.
Perching bird forms bowl of this stemless pipe, typical of Ohio’s Hopewell culture (c. 500 B.C. to c. A.D. 1).

Headdress, in form of abstract antelope, is an example of modern work by Bambara of the French Sudan.
Stylized lizard, boldly carved from stone, was made during the first millennium B.C. in Mexico's Guerrero area.

Realistic horns top this antelope headdress of nineteenth-century date, another example of Bambara woodwork.
Olmec plate, above, from Mexico, has fish's shape.

Northwest Coast rattle shows bird's and bear's heads.
Egyptian ibis, a sacred bird, was wrought of bronze and wood in the third century B.C. Eye is inset of obsidian.

Horn vessel from Northwest Coast carries the distorted figure of prone human with head of an animal.

Heavy-antlered ungulate, from Caspian Sea area, was cast in bronze over three millennia ago.
Head of horned animal, modeled in terra cotta, comes from Africa's Guinea Coast. Reproductions are by permission of Jay Leff.
This is the 106th of Nature Magazine's special educational inserts.
THE MARSH
A Pageant of Natural History

By E. Laurence Palmer

Where land meets water, as in a marsh, the aquatic and the terrestrial patterns of life must be reconciled by those that make such areas their homes. Ecologists—those specialists in the interrelationships between living things and their environments—write about this great compromise in a language that is sometimes difficult for the non-professional to understand. But since it is the ecologists who are most familiar with the basic conflicts of marsh life, let us see if we cannot profit by some of their conclusions.

Here, we elect to recognize that, in a marsh, the predominant plant life is herbaceous, while that of a swamp is dominated by the woody plants. We cautiously reject bogs from consideration here, because in bogs there is but little decay of plant material; while in marshes the decay rate is high, with a corresponding abundance of animals that participate in reducing dead tissues to simpler forms—a function that provides material for the development of abundant new living tissue. Much as the gunner finds his best hunting along the borders where woodlands meet grasslands, or where dry lands meet wet lands, we should expect to find such areas good hunting for those whose interest lies in the study of living natural history.

The English poet Shelley made use of a marsh to depict the ultimate in ruin when he wrote: "...when London shall be a habitation of bitterns, when St. Paul and Westminster Abbey shall stand shapeless and nameless ruins in the midst of an unpeopled marsh..." Apparently Shelley had never been in a boat or a blind and watched a busy marsh day begin or end, for certainly the average marsh is a populous area, zoologically speaking.

After you have finished reading this article, you may be able to see in a marsh not only beauty, but a great pageant of natural history displayed in its lands, waters, plants, and animals. You will better appreciate the serious human health problems associated with the draining of rivers like the Nile, and the serious conservation problems that may follow the promiscuous drainage of farm marshlands, as in our own Midwest.

A marsh is likely to be a difficult place in which to live, either for plant or animal life. In the heat of summer, humans seek the shade. During a windstorm they seek shelter. From uncontrolled fire they seek safe refuge. During floods they seek dry lands; and during drought, moisture. A marsh can be the playground of all such extreme conditions. How, then, does the life of the marsh meet high winds, fire, flood, and parched drought? As an example consider the cattail.

Notice how the cattails of the marsh yield to the winds, instead of resisting and being broken. What happens to the wind do to a plant like the cattail? When the sun is shining brightly, hold your hand, palm downward, in the sunshine. Is the back or the palm of your hand the warmer in this circumstance? Now turn your hand on edge, so that the sun strikes an edge rather than a flat side. How does this new position affect the amount of heat supplied to your hand? Remember that, in morning and evening, the sun does not strike the earth as directly as it does at midday. Return, then, to your
attail, and consider how this plant is so made that, through the lighted part of the day, it gets more heat when the sun is low, and less when it is high. Thus does the cattail escape the sun’s most withering rays.

In spring or fall, fires may sometimes sweep the marshlands, particularly the cattail marshes. At such times the most valuable part of the cattail plant is likely to be buried under an inch or so of water or soggy trash. Can you imagine a safer place for the precious starch that is stored in this plant? If wind, fire, and burning sunlight cannot kill the cattail plant, what about drought? It takes long drought to dry the blanket established by a mass of cattails, and even then there are roots that reach a level where moisture may still be found. A cattail marsh is a rather stable institution after it has become firmly established; and, once established, animal life depends on it for both food and shelter. Muskrats can hide in the wamps, and be certain of ample food under stands of cattail leaves that tower over beds of starch-laden underground structures. They are not only protected from hostile neighbors, but from fire as well—they have underground burrows in which to hide until danger has passed.

Perhaps the greatest tragedies for marsh-dwelling animals occur when late spring fires sweep their habitat. Marsh birds may have begun nesting activities, only to find that all is lost in a few minutes. There is probably no perfect place for any organism; if there were, that form of life well might overrun the earth.

Marshes may vary because of the chemical nature of their waters. There are salt marshes near the sea and near salt springs, alkali marshes near alkali exposures, and marshes whose waters are nearly pure—or at least relatively free from both salt and alkali. Where animal life remains in a marsh, we assume that it has adjusted to the chemical conditions prevailing in a given locality.

One of the most interesting phenomena connected with marshes is their tendency to build land. If you have the occasion to handle marsh plants, you may be impressed by the fact that many of them feel “slimy,” and seem covered with a gelatinous coating. Such a coating may well be of plant origin, and may be composed of algae. The jelly-like covering tends to collect silt from the water, the silt eventually settling to the bottom to build more land. This may represent a substantial land-building contribution over the years, and may substantially reduce the area of open water in a marsh-surrounded pond or lake.

More effective in land building than the algae, perhaps, is the development by many marsh plants of horizontal underwater structures from which the erect parts of the plant arise. Cattails and bulrushes are particularly effective in this respect. They may build structures that resemble floating platforms on both edges of a waterway. Commonly, such platforms are thick enough and strong enough to support the weight of a man, so that in many extensive marshes one can walk all day in water up to the knees and never go deeper, unless an open stream should be encountered.

As far as humans are concerned, land-building may have its drawbacks, especially in the maintenance of open passages for boats. Such land-building accounts, however, for the relatively deep water to be found just off the channels that may penetrate marshes where streams enter them. Eventually, land development in marshes may become sufficiently advanced to allow human agricultural activities.
The dictionary tells us that a marsh is "a tract of wet or periodically inundated treeless land, usually characterized by grasses, cattails, or other monocotyledons." In our accompanying chart section there are nine representative plants of such an area. Of the two thallophytes, or plants that are not differentiated as to stems, leaves and roots, one is an alga and one is a fungus. A relatively common liverwort, and a moss that may or may not be considered a marsh plant—depending on your definition of the word "marsh"—represent the bryophytes. One pteridophyte, or representative of the fern division of plants, is listed. For the flowering plants, the cattail and the bulrush are suggested as being representative of plants of vertical pattern, while pond weed and cow lily are representative of the plants of horizontal plan. Only one of these four is a dicotyledon; so, in general, we recognize the dictionary's emphasis on the importance of monocotyledons.

While the cattails and bulrushes of a swamp are likely to be conspicuous, there may be other plants present that are of equal importance. The seasonal variation in the abundance of primitive marsh plants is great. At some times of the year, the alga *Nostoc* may become so abundant that it forces its attention on the most casual observer. This alga usually appears as masses of jelly that soon become silt-covered, and which look like semifloating mud balls. Other algae abound, and are conspicuous in their own ways as bright green, slimy threads like *Spirogyra*; delicate nets like *Hydrodictyon*; coarse-branching, somewhat slimy threads as in *Vaucheria*; or as the delicate, branching threads that are characteristic of *Cladophora*.

Many of these plants have been considered in detail in Number 69 of this series, or may be found figured and discussed in biology textbooks. Some of them seem to flourish best in polluted water, and are of some value in superficially indicating the presence of pollution. However, it is not always easy to determine whether the algae are responsible for the pollution, or the pollution responsible for the algae. Anyone who has explored a marsh has probably seen one or more dead fish floating in the water, and almost invariably such fish will seem covered with a fuzz, which is usually the fungus *Saprolegnia*, often known as "water mold."

The bryophytes, which include the liverworts and mosses, are rarely as conspicuous in marshlands as are the other groups. Forms like *Ricciocarpus* may be seen floating, closely crowded, on the water's surface; and the adjacent wet muds may support colonies of *Marchantia*, which may make an almost continuous green carpet close to the soil. The mosses do not ordinarily form a conspicuous portion of the marsh flora, although they may sometimes crowd the tops of floating logs. *Sphagnum* moss, although included here, is more typically a bog plant.

Among the pteridophytes—the division of plants that includes the ferns and their allies—there are marsh representatives in abundance. Our Number 104 dealt, for the most part, with this group. To that treatment we are adding the water-clover fern *Marsilea*. The peculiar sporocarps of this plant, which look like fruits but really are not, are frequently eaten by ducks. These plants play an important role in anchoring soft soil at the water edge, and in helping to build land.

As representatives of the flowering plants, or spermatophytes, we present the ubiquitous cattail, the historic bulrush, and the sometimes conspicuous, diminutive, duckweed. From time immemorial, flowering plants of marshes have supplied men with food, fuel, clothing, and shelter. In some parts of the world, the major means of transportation may be by boats made largely of cattails bound together and waterproofed. Many parts of the Old World, home-roofing is still thatching, secured from the reed *Phragmites*. This same reed grows in abundance in many American marshes.

Marshes have supplied men with food in the form of wild rice, and flour from cattail tops, collected season by beating the bent plant-tops, which release the contents into the bottom of a canoe. The arrowhead group, so common about marsh edges, supplies man with underground parts known as Indian onion and duck potato. The closely associated bur reed provides a superior food for muskrats and deer. Sweet flag, which closely related to the duckweed discussed in the previous section, has pungent, aromatic rootstocks that are gathered, dried, and sold in drugstores, either ground or in their natural condition. It is used as a flavoring for food and candy, as a perfume in oils of various sorts, and sometimes even in soaps.

We must also consider the role of flowering plants making marshes places of beauty. Some of these plants, like the calla lily and several orchids, are monocotyledons; while others, like the water lily, are dicotyledons. Of American lotus, of the water lily family, is a thing of beauty, and in the South may be sufficiently abundant to provide a food source. Unfortunately, it has been found that the margins of its leaves provide excellent protection for transforming mosquitoes that may be future carriers of malaria. In China and in Egypt the lotus is grown extensively for food, and most of the lotus produce beautiful flowers, acorn-sized seeds that taste like chestnuts, and tubers that, when properly prepared and baked, taste like sweet potatoes.

The animals of marshlands are of great importance in our picture of the marsh, and nine are listed in the chart section of this insert, each representing a major group. We have included the mallard duck as representative of the birds of such areas, and the muskrat as typical of the mammals; but of even greater interest might be representatives of the lower orders, like the protozoans that swarm unseen. Let us briefly review the role that marsh animals play in the health, comfort, and happiness of mankind.

It has long been recognized that there is a relationship between marshes and human health. Explorers have found that waterways are convenient highways into unknown territories, and early settlements have often been near such avenues of travel. However, men early recognized that there was an association between such waterways and human diseases, like malaria, which is each...
Herbaceous plants, like the wild rice being harvested in the illustration, *above*, distinguish the flora of marshes.

Typical swamp, *below*, is dominated by the woody plants. The soil is saturated, but not wholly covered, with water.
Sphagnum moss, *Sphagnum sp.*

Sweet flag, *Acorus calamus*

*Marsilea, Marsilea quadrifolia*

A liverwort, *Marchantia polymorpha*
by insects that are part of a cycle depending on marshy conditions. At present, it is particularly important that we have some understanding of this relationship. All over the world we are damming streams to provide power, to irrigate deserts, to increase navigable waters, and to secure water for human consumption. In doing these things, however, we may be creating conditions that we cannot afford to ignore.

If the building of a dam on the Nile River increases marshy areas where human population is high, complications may arise. Such marshes are likely to support pond snails. In turn, the snails may be hosts to organisms that may infect men who wade in such marshes with schistosomiasis, a disease that not only deforms but makes it impossible for an infected person to live a productive life. The building of such dams thus may actually help to increase illness, poverty and misery, although intended, of course, to be of benefit to man.

The shallow waters of marshlands may support mosquitoes and pond snails that can be disease carriers; but they may also support fishes that feed on such snails and insects. We must remember to protect some of these natural controls that are ordinarily present in a marsh.

Marshes are natural breeding grounds for many kinds of amphibians. Even the larvae of the tree toads that live much of their lives in treetops start life in marshy places. Swarms of salamanders invade the marshlands in spring to lay their eggs. A single spotted salamander may lay some two hundred eggs, the young from which may then spend up to three months in the marsh, feeding, in part, on smaller animals that may be undesirable from the human viewpoint. An individual bullfrog, on the other hand, may lay as many as 20,000 eggs, each of which can develop into a polliwog that will feed largely on the oozes and slimes of the marsh.

Marshes provide a favorable environment for many reptiles, too. Some of these, like snapping and painted turtles, spend much of their lives in such areas. They may destroy useful animal life like ducks, frogs, and fishes; but it is not commonly realized that more than fifty per cent of the turtle’s food may be waterweeds, and that its appetite for carrion helps speed the destruction of dead animals whose bodies might otherwise be a potential source of danger to human health.

Bird life of the marshes, is, of course, most plentiful; ducks, in particular, provide “sport” and food for many gunners, as well as satisfaction to bird watchers. Few birds of the marshes are undesirable from the human viewpoint, although marsh-inhabiting blackbirds may occasionally be charged with invading man’s grain fields in great numbers.

It is doubtful if one could find a marshland that is not the home or range of birds, mammals, reptiles, amphibians, fish, and invertebrates of many kinds. The majority of this animal life is able to survive because of the shelter provided by marsh plants, and practically all of it is dependent on marsh plants as food, either directly or by way of the animals on which the individuals themselves feed. Basic, of course, is the fact that a marsh supplies exactly the right amount of water and soil and sunshine to keep this whole involved society—a pageant of natural history—functioning normally.
<table>
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<th><strong>THE SETTING</strong></th>
<th><strong>DESCRIPTION</strong></th>
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| Pond Scum **Spirogyra sp.** | Warm, shallow, stagnant waters form
the habitat of many of the fresh-water
algae. Of the blue-green group, both
*Oscillatoria* and *Nostoc* thrive in
the waters of marshlands. Here we con-
sider the green alga *Spirogyra*, of the
Family *Zygmenaceae*, and Order *Zyg-
nematales*, Class *Phycymycetes*. |
| **Water Mold** **Saprolegnia sp.** | Water molds are often conspicuous
in the polluted waters of marshes,
particularly near centers of human popula-
tion. A dead animal like a fish or cat
may support the gray fuzz that gener-
ally characterizes this plant. Family
*Saprolegniaeae*, Order *Saprolegniae*,
Class *Phycymycetes*. |
| **Ricciocarpus** **Ricciocarpus natans** | In marshes, conditions may be ideal for
liverworts. Some, like *Marchantia*, are
best known as earth plants; others, like
*Ricciocarpus*, may float on the water.
As representative of the liverworts, we
name *Ricciocarpus*, Family *Ricciaceae*,
Order *Marchantiatales*, Class *Hepaticae*. |
| **Sphagnum Moss** **Sphagnum sp.** | Relatively few mosses are to be found
in typical marshes. However, sphag-
num mosses grow in abundance in and
near areas that might be considered
marshes, and we elect to consider the
moss *Sphagnum*, of the Family *Sphag-
naceae*, the Order *Sphagnumatales*, and
the Class *Musci*. |
| **Marshes, or Pepperwort** **Marsilea quadrifolia** | Marshlands support a number of ferns
and fern allies. Horsetails, for example,
may be abundant in some marshes. Here,
however, we consider marsilea,
sometimes called “waterclove fern,”
of the Family *Marsileaceae*, the Order *Fil-
icales*, and the Division *Pteridophyta*. |
| **Cattail** **Typha latifolia** | Strong winds that blow across marshes
can do little damage to flexible, ribbon-
like leaves of the cattail, and fires that
spread through marshes cannot kill parts
burned under mud and water. This plant is
of the Family *Typhaceae*, the Order *Pan-
danales*, and Class *Monocotyledoneae*. |
| **Bulrush** **Scirpus validus** | Bulrushes meet the conditions of
marshlands much as do the cattails,
but pioneer farther into the water,
sometimes being largely submerged
without being destroyed. Bulrush is a
sedge rather than a rush. It is of the
Family *Cyperaceae*, Order *Graminales*,
Class *Monocotyledoneae*. |
| **Duckweed** **Spirodela polyrhiza** | In late summer marsh waters may be
covered by floating duckweeds. Related
plants include duckmeat, lesser duck-
weed and watermeal, all floating on
water's surface. Duckweed has several
rootlets; duckmeat and lesser duck-
weed, one. Family *Lemnaceae*, Order *Araceae*,
Class *Monocotyledoneae*.

Siprodela is widely distributed in the
Old World, and into the tropics in
America. The plant is an oval, floating
body, bearing two or more rootless
beneath. It is to ½ inch long, dark
green above and purple beneath. Four
to fifteen nerves appear on the upper
surface of the frond. |
| **Spatterdock, or Cow Lily** **Nuphar advena** | Representing the dicotyledons in this
discussion of the marshes is the spat-
terdock, or yellow water lily. As a
rule, the monocots nearly monopolize
marshlands. The spatterdock, cow lily,
or yellow water lily is of the Family
*Nymphaceae*, Order *Ranunculales*,
Class *Dicotyledoneae*. |

Found in waters and marshes and along
slow streams from Labrador west to
the Rocky Mountains, and south to
Florida, Texas and Utah. Members of
this family are widely distributed. Leaves
to 12-inch blades on petioles that may
be more than a foot long. Rootstock
may be 4 inches through. |
**Spiregyra** manufactures its own food by using light, water and carbon dioxide, the water and carbon dioxide entering into the composition of the ultimate products—sugars and starches. Oxygen is freed, and the entangled bubbles found in masses of **Spiregyra** may actually be free oxygen.

Water mold gets its food wholly from other plants and from animals, the threads penetrating the tissues of the host and extracting the needed nourishment. Some members of the genus are serious enemies to crops, often attacking the growing roots and finally destroying the plant. **Spiregyra** may be a serious pollutant of fresh water in marshes, although it may produce a basic food for some marsh animals. Algae may clog drains controlling marshlands, and may restrict the movements of fishes and other animals living in marshland waters.

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Compact floating mats may cut off light under water to limit the growth of certain plants there. May serve as food for ducks and other plant-eating animals of the environment. Are to be found almost wholly in the warmer summer seasons, vanishing with the onset of cooler weather.

Mosses do not ordinarily enter into the diets of many animals, and their prosperity is dictated more by chemistry than by systematic zoology, since the associated animals use the moss more as a cover than as food. It may be interesting to note the sparisty of mosses in the marsh environment.

Plant parts of *marsilea* are eaten by ducks and to an extent by fishes. The plants are relatively free from injury by insects and fungi. The fruiting bodies are hard and dry, and serve to tide the plants over times of unfavorable conditions. These fruiting bodies, or sporecarps, are remarkably hardy.

Cattails have few natural enemies abundant enough to do serious damage, in spite of their storage of rich, starchy food underground. Waterfowl lack the strength to harvest cattail wealth, and soft mud bogs down such animals as might adjust to grazing on cattail roots.

Bulrushes provide food and shelter for many forms of wildlife, both bird and mammal. Muskrats and ducks are often largely dependent on these plants for survival. Most land mammals cannot pursue them in marshy areas, and a patch of bulrushes provides a superior hiding place for lesser life.

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This species is sometimes known as the purple-fringed riccia, because of the abundant scales underneath. It has been described as looking like duckweed, but this is far-fetched. It is likely to be confused only with those plants that are most closely related to it.

Spagnum mosses are valuable as retainers of water, and are widely used to pack commercial shipments of plants. The peat of commerce, used as a fuel in many parts of the world, is derived from dead spagnum mosses, that, although compacted, have not reached the stage of complete decay.

Water-clover fern may serve as a valuable anchor in holding soft muds intact against the action of currents, waves, and the actions of animals. It provides good shelter for a number of marshland animals—muskrats, for example—and helps build up marsh bottom.

Leaves are used by man in making rush-bottom furniture, in calking barrel staves, in manufacture of insulating material. Fluffy fruits are used in pillows and blankets. Starchy rootstocks are a good emergency survival food; young fruiting stalks are sometimes eaten as "Cossack asparagus."

Bulrushes provided concealment for the infant Moses, according to the Bible. They are superior builders of land, while the fleshy rootstocks are eaten raw or boiled, boiled or made into flour. The young shoots or stem bases may provide man with a source of food during an emergency.

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<td><strong>Leech</strong>&lt;br&gt;Placobdella parasitica</td>
<td>Turtles found in marshes are commonly hosts to leeches that attach themselves to the soft under parts of the animals as parasites. From among the invertebrate animals of marshes, we choose this leech of the Family Glossiphoniidae, Order Rhynchobdellae, Class Hirudinea. This leech is free-living during the breeding season, but is otherwise found clinging most commonly to the legs of snapping turtles. This is the largest species in the genus, to over 2&quot; long, dark greenish-brown, variously spotted and striped with yellow and orange.</td>
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<tr>
<td><strong>Disc Pond Snail</strong>&lt;br&gt;Helisoma trivolvus</td>
<td>Marshlands are both a blessing and a curse, and mollusks contribute to making them so. Involved are both univalves, like snails, and bivalves, like clams and mussels. Of the univalves, the disc pond snail is of the Family Planorbidae, the Order Pulmonata, and Class Gastroprada. Pond snails, for the most part, live in waters from 1 inch to 6 feet deep, and have shells to nearly 3 inches long. They are most abundant in waters having a pH above 7.0, and more species are to be found in large bodies of water than in small. The shell of this snail is a flat coil.</td>
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<tr>
<td><strong>Crayfish</strong>&lt;br&gt;Cambarus bartoni</td>
<td>Marshes rich in decaying plant material and with soft bottoms provide homes for many crustaceans. Freshwater shrimps and water sowbugs revel in abundant food, and serve as food for others. Abundant also may be the crayfish, of Family Astacidae, Order Decapoda, Class Crustacea. Of some 70 species of Cambarus, C. bartoni is from streams east of the Mississippi. Cambarus has 17 pairs of gills, while Pacific Slope genus, Astacus, has 18 pairs. There are about 100 species in all. Length is up to 5 inches, with 2 large front claws and 4 pairs of walking legs.</td>
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<td><strong>Mosquito</strong>&lt;br&gt;Culex pipiens</td>
<td>Man's establishments near marshes have sometimes failed because of insect populations. Abundant are mayflies, dragonflies, water bugs, water beetles, caddis flies, and many others; but representative is the mosquito, of the Family Culicidae, the Order Diptera, and Class Insecta. Culex pipiens, the house mosquito, is common wherever there is stagnant fresh water, but it is most abundant in marshes. Female is to 1/6&quot; long, proboscis slender, brown, dark-tipped. abdomen is black, with bluish bronze reflection. The hind legs, at rest, are held upwards.</td>
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<tr>
<td><strong>Carp</strong>&lt;br&gt;Cyprinus carpio</td>
<td>Marshes are the habitat of many amphibians, including frogs, toads, and salamanders, particularly during breeding seasons. The bullfrogs and green frogs may pass entirely and black, with yellow be- neath, black and red spots, finned tail. Eastern news, Diemictylus sp., and Pacific news, Taricha sp., populated marshy areas from coast to coast. D. viridescens may be to 4&quot; long. Adult is bright green, with black, yellow beneath, black and red spots, finned tail. Land form, immature, is mostly pale red, lacks tail fin.</td>
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<tr>
<td><strong>Vermillion-Spotted Newt</strong>&lt;br&gt;Diemictylus viridescens</td>
<td>Shallow waters, deep muds, and abundant animal life provide ideal habitat for turtles such as the soft-shelled, musk, mud, spotted, painted, and diamond-backed. Highly representative among these is the snapping turtle, Family Chelydridae, Order Testudinata, Class Reptilia. Snapping turtles range eastern North America, east of Rockies, from southern Canada south. Length, to more than 3 feet. Upper shell, 1 foot; lower, to 8&quot; long. Under parts poorly protected. Weight up to 86 pounds, while that of related alligator snapping is more than 200 pounds.</td>
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<tr>
<td><strong>Snapping Turtle</strong>&lt;br&gt;Chelydra serpentina</td>
<td>Many marshes are created by man to supply breeding grounds for valuable bird species. Representative birds include ducks, some geese, rails, coots, and many others. Among most representative of marsh birds is the mallard, Family Anatidae, Order Anseriformes, and Class Aves. Mallards and close relatives are probably commonest of all ducks, being found nearly world-wide where habitat exists. Length to 28&quot;, including a 4½&quot; tail. Wingspread to 40°. Drakes commonly with green heads and white collar, with a purple breast and gray under parts. Flesh superior as food.</td>
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<td><strong>Mallard Duck</strong>&lt;br&gt;Anas platyrhynchos</td>
<td>By draining, flooding, and cultivating, man makes or destroys more marshland than any other mammal. Representative mammals are beavers, mink, otters, nutria, rats, and mice. Also typical may be the muskrat, of the Family Cricetidae. Order Rodentia, Class Mammalia. Muskrats range most of North America north of Mexico. Adults weigh to 3 pounds, are 25&quot; long, with 10&quot; scaly tail. Except for tail, his heavy, fine pelt. Fur is sold as a Hudson seal, Russian otter, red seal. Flesh is excellent and often is included in dishes in which chicken or terrapin forms the basis.</td>
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| **Musk Rat**<br>Ondatra zibethicus | 42
FOOD | REPRODUCTION | GENERAL IMPORTANCE
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**Leeches** feed primarily by sucking the blood of the host after piercing the skin. They are primarily external parasites, unlike the blood-sucking ticks, and hookworms of closely related classes and order, all of which may be found in the marsh type of habitat in some development stage. | Individuals bear both sex organs, but two individuals reciprocate in the breeding act. No egg cocoon is formed in this case, the young remaining attached to the parent animal. Are easily carried over wide territories, attached to feet of ducks or in water as parasites attached to fishes. | Important members of the Phylum Protozoa are to be found in fresh-water marshes. On these two pages, we have chosen to representative each of the Mollusca, Arthropoda, and Insecta; and one fish, one amphibian, one reptile, one bird, and one mammal as typical of marsh life. **Pond snails** feed largely on oozes and plant wastes of waterways, using a rasp in the mouth to prepare food. They are eaten freely by fish and other aquatic animals. Schistosomiasis, a disease of man, is caused by a parasite of a pond snail closely related to and resembling *Helisoma trivolvis*. | Both sexes are represented in an individual pond snail, with mating reciprocal between two individuals. Eggs, laid in small jelly masses, hatch in from two to three weeks into snails whose shells are at first left-handed, with opening to left when spine is pointing upward. | On a world-wide basis, probably the most important role of pond snails is in connection with parasites that affect domestic animals and man. Schistosomiasis, involving pond snails, may defili- tate their populations, and make them ineffective, especially where men free wastes in water. **Male house mosquitoes** feed largely on plant juices, and do not bite animals. Females feed on the blood of animals, including man, and are active day or night, feeding mostly in dim light of morning or evening. Greatest enemies probably are drouth and the poison sprays of man's civilization. | About 2 years from egg to egg. May breed through the year. Female carries to 200 eggs under her body for about 2 months, eggs hatching 2½ months after mating. Larvae may be free of mother after 3 months. May be reared in captivity, largely for use of fishermen as bait. | Management for profit consists primarily in controlling water supply, keeping enemies away from the animals, and providing needed food supplies. May be pests in hatcheries, or where fish eggs are available. Valuable as laboratory animals. Some 330 tons are harvested annually. **Carp** feed on decaying organic matter or on plants or small animals found in mud. They are largely scavengers, but also destroy fish nests and young. Their reproductive capacity makes it difficult to control their numbers, and they pre-empt territory more valuable for other species of fishes. | Eggs are laid in early summer in shallow waters with no nest, no parental care. Eggs may number two million per female, hatch in 5-13 days, and young may reach maturity at 2-3 years. Have been known to live over 47 years. Can survive salinity up to 10 per cent for a short time. | Ordinarily a most unwelcome fish, but one that is now considered of some sporting value if taken on light tackle. Food value of the fish is low, but may be of value in a crisis, since the fish are usually easily taken on a hook and line with nothing more elaborate than plain bread dough as a bait. **Newts on land feed almost wholly on small invertebrates. Adults in water may feed on eggs of fish and frogs, on mosquito larvae, tadpoles of frogs, toads, and salamanders. In destroying many aquatic insects, like mosquitoes, salamanders may prove themselves highly useful to mankind.** | Adults mate in shallow water in spring. Fertilized eggs deposited separately on submerged water plants, a single female laying to more than a hundred eggs. Eggs hatch in 20-35 days into gilled larvae, which may live in water to 3 months, absorb gills, and then take to land for from 1 to 3 years. | Serve as food for fish and other animals of the habitat, but more important as enemies of eggs and young of other animals their size. May be particularly destructive in hatcheries. The land form is known as the “red eft,” seen commonly on woodland paths after a summer rain. **Snappers feed mostly on animal matter like fish, ducks, and carrion. Are essentially scavengers. Pond may support two or three per acre. May wander over a wide territory. Chief enemies of snapping turtle are man and the elements, although skunks may also destroy many turtle eggs.** | Males may fight for mate. Breeds April-November. Eggs laid May-Octo- ber, in two or more clutches of to 80 eggs that are white, parchment-covered, 1½" spheres. Nest adobe in dry earth or sand, usually within 75 feet of water. Young hatch in 81 or more days, take to water promptly. | Dangerous predator of habitat, particularly to raisers of ducks, fish, frogs, and other marsh animals. May concentrate in numbers during hibernation. With floats attached to shells, have been used to locate drowned persons. Commercially captured in wire- cage baited traps. **Feed mostly on plant material, including grain and vegetable, but also destroy great numbers of mosquito larvae. Domestic mallard is of same species as wild mallard. Enemies include fire, epizootic disease, starvation, and over-hunting, as well as natural animal predation.** | Nest is usually built near water, commonly on a mound, a fairy well hidden. Eggs, gray-green to brown, 6 to 13, with nest sometimes shared by two females. Incubation 26-28 days, by female only. Duckling downy, yellow, and able to swim soon after hatching. May be domesticated easily. | Most valuable game bird, but becomes domesticated too easily to satisfy average hunter, who might as well go hunting in poultry yard. Abundance of mallards and ease of harvest helps sell hunting licenses, thus building up financial resources of state conserva- tion departments. **Muskrats feed largely on plants. Using wastes, they build mounds that, when frozen, provide protection from ene- mies. They also burrow in the mud, leaving deep holes for protection. The muskrat has been known to attack and kill a human.** | Muskrats are polygamous, and may breed 4-11 young, 19-42 days after mat- ing, and may have to 3 litters a year. Can survive without food for 10 minutes. Good marsh management, including intelligent harvest, may have a beneficial effect on a muskrat popula- tion. Do not flourish in captivity. | Muskrats have been considered as the most valuable fur resource in the country. They are generally harvested by the most modern methods, and make their role in human economy may be taken over by the nutria or by syn- thetlic furs. Can cause damage to earthen duns, some farm crops.
IT IS HARDER, sometimes, to keep youngsters out of marshes than it is to keep them in schoolrooms. This is an observation that applies with as much force to youngsters who are just beginning their school lives as it does to those about to finish high school. But it must be admitted that marshes are most interesting places, particularly at the time of year when school is about to close. At that time, a marsh is fascinating in what may be heard, seen, smelled, tasted and felt.

Now, the frog choruses are at their height. The peeper orchestra, which commenced almost as soon as the water was free of ice, has begun to wane, it is true. Wood frogs may also have become quiet, but the tree toads will likely continue on into summer—although not in chorus proportions. A few bullfrogs, and certainly a number of green frogs, will add to the sounds that may be heard in the marsh.

At this time of year the school might make a study of the frog sounds that are to be heard in some nearby marsh. At least two valuable recordings of frog and toad sounds have been made in this country, recordings that will be found most useful in identifying the various sounds. A class may decide it would like to locate such animals, using the available professional recordings; or it might decide to make its own recordings of marsh sounds with a portable sound recorder.

OTHER youngsters might be interested in collecting the egg masses left in the marshes by various species of frogs and toads. Should this be done, it is important that “wholesale” collections of such egg masses be discouraged as leading to unnecessary destruction of future highly useful animals. An explanation of the reason for this tempering of enthusiasm may be effective as a general lesson in conservation.

If a few egg masses of frogs, toads, or salamanders are brought into the classroom and kept in an aquarium, youngsters may derive from them a notion of events that take place in a marsh. One such egg cluster might be broken up, and a few of the eggs placed in an aquarium whose sides and bottom have been thoroughly cleaned, and in which the sticks and stones have been cleaned of all their ooze.

After a few days it may be observed that the polliwogs in a clean aquarium are not so prosperous as those in an ooze-supplied aquarium. From this fact the youngsters may draw some conclusion as to the role played by ooze and slimes in the general economy of the marsh. Many tadpoles, in their earliest stages, will remain suspended on the sides of the aquarium, rather than resting on the bottom or among the water plants, and such individuals may be observed feeding on the ooze of the aquarium wall.

Two aquariums of approximately the same size may be stocked with clusters of frog or toad eggs so that nearly equal numbers of tadpoles will develop in each. For the purpose, two-quart fruit jars may equally well be used. If an adult newt or other aquatic salamander that is normally an inhabitant of the marsh be added to one of the jars, it will be observed how nature takes care of surplus populations. The salamander may sometimes be seen resting on a mass of frog eggs, waiting for tadpoles—and a salamander’s meal—to emerge. Some pupil might like to find out whether the salamander’s reaction would be the same for its own eggs. Such observation may suggest to the students how natural control is accomplished, and also the reason why it is necessary for frogs and toads to lay so many eggs. The egg-laying habits of the newt are observed, it may be found that these animals lay their eggs singly, as do the peepers that lay their eggs early in the season.

It is not likely that school will be in session when the bullfrogs and green frogs lay their great sheets of floating egg masses. The tadpoles of these frogs require two full summers of development in the nest before they can transform into the adult frog form. Under such circumstances, it may be obvious why order that a species may survive, such frogs must be as many as 20,000 eggs, as compared with the hund or so laid by frogs whose larval development-time is shorter. Frogs, either as tadpoles or adults, are relished by many of the inhabitants of the marsh. Through observation and reading, a class should note the affinity of fish, reptiles, birds, and mammals for a good meal of “frog,” no matter what the stage of development of unfortunate amphibians may be!

THE class lesson in frog study might lead to a better understanding of conservation problems if it followed the life history of the frog or the toad beyond scope of aquarium study. For example, frogs may migrate, and if a student should be riding in an automobile on a rainy night, he might see these animals migrating in great numbers. He might notice that barriers such as railroad or highway embankments may sometimes interfere with such frog migrations.

In the past, great numbers of frogs were captured simply directing them, during migration, into convenient enclosures by means of barriers. So successful was this practice that it became necessary for a number of states to make it illegal.

For our marsh-life example in this article we have used the well-known frog; but we might well use almost any of the other marsh dwellers. Further exploration of the marsh is sure to reveal a rich variety of animal life, a better understanding of which will be most rewarding to the young naturalist.
we have plumbed the depths

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SKY REPORTER

An Astronomer of the Sixteenth Century

By Simone Daro Gossner

The Danish astronomer Tycho Brahe was born in Scania (now part of Sweden) on December 14, 1546. His early studies did not in any way prepare him for a scientific career. The uncle who supervised his education wanted him to study law and frowned on his budding interest in astronomy. As may be expected in youth of that age (Brahe was sixteen that time), such constraint gave the boy of constellations and celestial bodies all the attraction of forbidden study. Without formal instruction, he taught himself the essentials of mathematics and astronomy. As soon as circumstances allowed it, he acquired his instruments, and eventually gave up other studies to devote all of his time to his scientific pursuits.

European scholars of that epoch were accustomed to travel extensively to the great centers of learning. After several trips to Germany and parts of Italy, in the course of which he perfected his observing techniques, Brahe and himself won over by the pleasant living and academic atmosphere of the city of Basel. He was preparing to settle there permanently when an unexpected event brought about the latest turning point in his career. King Frederick II of Denmark, aware of Brahe's growing reputation, offered him the island of Hveen as the site for an observatory, with the promise of substantial remuneration. In 1576, he began the construction of his castle (for Urania, muse of astronomy) and of the greatest observatory of his time.

Hveen is a diminutive island, about 16 miles wide, located in the Sound which separates Copenhagen from the Danish mainland. Brahe designed his castle to serve as residence for himself and his assistants, and as headquarters for his instruments. The castle was surrounded by a walled garden. A short distance away, outside the walls of the castle, Brahe established a second observatory, named Stjerneborg (from stjerne, the Danish for "star").

Stjerneborg was a most peculiar structure. The entire building was underground, with only its cupolas showing. The purpose behind this was to provide a firm foundation for the instruments and to protect them from the elements. Brahe, however, had another, and more subtle, reason for Stjerneborg. He wanted to segregate his assistants, that they might not compare the results of their observations before he could inspect them himself.

Telescopes were still unknown when Uraniborg was built. Except for the brass globe (bottom picture at right), which merely helped in locating the naked-eye stars, Brahe's instruments were all intended for the accurate measurement of angular distances between celestial bodies. Designed by Brahe and built under his supervision, they were the finest in existence. With his great mural quadrant (see opposite page), Brahe boasted that he could measure angles to within five seconds of arc.

Paradoxically, it was the accuracy of his observations that made him reject the theories of Copernicus. His latter's calculations had been based on earlier and less reliable data, and his predictions of planetary positions were bound to reflect these inaccuracies. Brahe, in turn, could not fail to notice them—but drew the wrong conclusions.

On the other hand, Brahe's careful records of accurate positions for the planets furnished the material on which his disciple Johannes Kepler based his theory of planetary motions and thus laid the foundation of modern celestial mechanics.

The tide of Brahe's fortune turned abruptly in 1597. The new king, Christian IV, who did not share his father's regard for astronomy, withdrew the royal subsidy. Embittered and heartbroken, the aging Brahe left the island of Hveen to seek another patron in a foreign land. Fifty years later, there was nothing left of Uraniborg but a mass of ruins, and the island of Hveen had been completely deserted.

Zodiacal Armillary was an invention of Classical times - to find position of stars - that Brahe later perfected.

Brahe's globe, five feet in diameter, showed a thousand of the stars seen by sixteenth century naked-eye observers.
THE SKY IN APRIL

From the Almanac:
First Quarter: April 4, 2:05 A.M., EST
Full Moon: April 11, 3:28 P.M., EST
Last Quarter: April 18, 7:57 A.M., EST
New Moon: April 25, 4:45 P.M., EST

For the visual observer:
For the most part of their diurnal course, all planets will still be in the morning sky in the month of April.
Mercury will rise in the east, about an hour before sunrise on April 1, forty-five minutes before sunrise on April 15, and half an hour before then on April 30. On April 7, Mercury will reach its greatest western elongation and the alert observer may catch a glimpse of it, low on the southeastern horizon, between dawn and sunrise.
Venus (magnitude — 3.3) will be close to the sun, rising approximately half an hour before sunrise during most of April. Observers who have an unobstructed view of the eastern horizon may see it very low in the east after dawn.
Mars (magnitude +1.2), in Aquarius, will rise about ninety minutes before the sun on April 1, and one and three-quarters hours before it on April 30; the planet will be found low in the southeast shortly before sunrise.
Jupiter (magnitude —1.9) will rise in the southeast at about 1 A.M., local standard time, on April 1; at midnight on April 15; and at 11 P.M. on April 30. It will be located in Sagittarius, low in the southern sky at dawn.
Saturn (magnitude +0.7) will be also in Sagittarius, about fifteen degrees east of Jupiter. It will rise in the southeast at approximately 2 A.M., local standard time, on April 1; at 1 A.M. on April 15; and at midnight on April 30. It will be found in the southern sky by sunrise.

Meteors:
The Lyrid meteor shower (April 21-23) is expected to reach its maximum on the night of April 22. The radiant of the shower—that is, the point from which the meteors appear to diverge—is located near Vega in the constellation Lyra (see sky map, right). In fact, shower meteors enter the earth’s atmosphere in essentially parallel paths. The effect of divergence is only one of perspective.
The number of Lyrid meteors seen by an individual observer at the time of maximum may vary considerably from one year to another. In the past few years, it has been of the order of twenty per hour. The number depends also on the latitude of the observer. For example, fewer meteors are seen where the radiant is low in the sky, because atmospheric extinction obliterates the fainter ones. Finally, the presence of bright moonlight also has the effect of dimming the meteors’ brightness. In this respect, however, the 1960 Lyrids will be favored by a nearly moonless sky, because the moon will be four days past last quarter on April 22, and will rise in the latter part of the night.
The Lyrid meteor shower is associated with the comet 1P/Halley. Historically, it is one of the first for which such an association was discovered. The particles that cause the shower have escaped from the comet whenever it has passed near the sun, and are now scattered along the comet’s orbit. These particles travel through the earth’s atmosphere with an average speed of thirty miles per second.

The former Astronomy Editor for Nature Magazine, Mrs. Gossner, continues in that role for Natural History.
MAGNITUDE SCALE

-0.1 and brighter
0.0 to +0.9
+1.0 to +1.9
+2.0 to +2.9
+3.0 to +3.9
+4.0 and fainter

TIMETABLE
April 1  10:00 p.m.
April 15  9:00 p.m.
April 30  8:00 p.m.
(Local Standard Time)
First Maritime Trade

The Egyptians, with the Nile's traffic as inspiration, ventured

By LIONEL CASSON

BRINGING OF FORTY SHIPS filled with cedar logs." So wrote an ancient scribe in listing the accomplishments of Pharaoh Snefru, ruler of Egypt about 2900 B.C. This handful of words brings the record of man's maritime endeavors across the threshold into the period of history proper. There exists, for the first time, the strong light of written words to serve as a guide.

As in the case of so many phases of civilization, the record begins in Egypt. Very little wood grows in the valley of the Nile. Cedar most certainly does not and, to get it, Snefru had to look overseas. So he sent to Phoenicia, where a famous stand grew on the mountain slopes of Lebanon. Snefru was blazing no trail, for Egypt had been in touch with this area even before his time. Archeologists have found in the tombs of Pharaohs and nobles of earlier dynasties jugs and pitchers that were made in Palestine and Syria, and they have dug up in the latter countries objects that unquestionably came out of Egyptian workshops. Were these carried overland or by boat? Before the time of Snefru there is no way of telling.

But the scribe's words remove all doubt; some three thousand years before the birth of Christ a fleet of forty vessels slipped their moorings, sailed out of a Phoenician harbor, and shaped a course for Egypt with a burden of Lebanese cedar. This is the world's first articulate record of large-scale overseas commerce.

Not far north of where Beirut stands now was the port of Byblus,

SNEFRU'S FORTY SHIPS were probably of the river traffic type seen at the right, with sail on a two-legged mast, a hawser looped around stem and stern.
In History

their frail river vessels at sea

Illustrations by Hans Guggenheim
HUNDREDs of years later, when Egypt lost much of her power and could no longer maintain her overseas contacts, she felt the loss of this commerce keenly. “No one really sails north to Byblus,” wailed one sage some four or five hundred years after Snefru’s time. “What shall we do for cedar for our mummies. Those trees with whose produce our priests were buried and with whose oil nobles were embalmed?” It was not the Egyptian shipwrights and carpenters alone who needed Lebanese timber; the undertakers wanted it too.

Egypt had need of imports for which she had to turn to countries other than Phoenicia. Every year, enormous amounts of incense—myrrh and frankincense—were burned on her altars. These products were available only from southern Arabia and the African coast below the Red Sea, an area which the Pharaohs’ scribes called Punt and which we know today as the Hadramaut and Somaliland (map). For centuries, these supplies had come overland, maintained by countless small traders who passed the merchandise along from hand to hand, and, presumably, passed along an increase in price at each exchange. The earliest Pharaohs set themselves the task of cutting out these middlemen. In so doing they created one of the first great state-operated maritime enterprises in human history.

The task was not easy. The only alternative to the overland route was by water down the Red Sea. But Egypt’s centers were all strung along the banks of her great river—separated from the Red Sea at the closest point by an eight-day march across the desert. The easiest route was along a gorge in the desert called the Wadi Hammamat. On the rocks lining it, one point, Henu, minister of Pharaoh Menutuhotep III, some two thousand years before the birth of Christ, inscribed an account of his services to the state. “My lord sent me,” he writes, “to despatch a ship to Punt to bring him back fresh myrrh. . . . I left [the Nile] with an army of 3,000 men. Every day I issued to each leathern bottle, two jars of water, 2 loaves of bread. . . . I dug 12 wells. . . . Then I reached the Red Sea, made the ship and despatched it.”

Not very long after Henu had accomplished his mission, sometime in the twentieth century B.C., Pharaoh Senusret took a step that rendered such an assignment from then on unnecessary: he dug a canal from the northern end of the Nile to the Red Sea. Cargoes this way were spared both the wearying caravan trip and the work of transshipment; every item from ship to donkey and then from donkey to riverboat.

Boating scene, which decorates temple of Userkaf, first of the Fifth Dynasty kings, shows this detail of the odd, centipede-like stroke—from a standing position to a deep crouch—that paddlers used. Dotted lines show restoration...
Palermo Stone, above, a record prepared in Fifth Dynasty times (2750-2625 B.C.), includes an account of forty-ship fleet that bore cargo of cedar home during the reign of Snefru (c. 2900 B.C.).
Cross-cultural influences, as stimulated by trade, are depicted above. From top left, and reading clockwise: Mycenaean lion gate has Asiatic motif; lid of ivory box from Syrian coast shows Minoan custom of dress, despite Asian carving; gold dagger and sheath from Byblus show Egyptian motifs; bear and one-handled flask from Egyptian tomb are Syrian touch; ax is typical of ones traded at Punt; dolphin at bottom of Lisht jar was borrowed from Minoan wall paintings; cupbearer from Knossos shows the conventional Egyptian eye.
Yeas the famous valley across the river from Thebes, where so many of the Pharaohs dug their tombs, stands the huge temple of Bel-el-Bahari. It is a monument erected shortly after 1500 B.C. by Hatshepsut, the first great queen of Egypt. On its walls she carved a record, with magnificent illustrations, of some of the great achievements of her rule, a large-scale voyage to Punt. Many years before Hatshepsut's reign, Egypt had fallen upon difficulties. Civil war had split the country, and the fragments were ruled by many princelings or by invaders. One was in a position to maintain a strong navy as sizable as the Red Sea fleet. Senusret's canal was abandoned and gradually silted up. The shipping of incense, as in centuries before, was once again carried on by land through the desert. But, by 70 B.C., a new dynasty arose that united the country, established a strong rule, and inaugurated an age of peace that was to be Egypt's most celebrated. The fifth member of the line is Hatshepsut. Her contribution, as a woman, was an act of peace: she restored direct maritime connections with distant Punt.

On one of the walls of the queen's mortuary temple, exquisitely carved in relief, the story of her expedition is told. We see a fleet entering the harbor at Punt: three sleek, snake-lined vessels are still under way, their great sails billowing with the wind. Two others have doused their sails and are ready to tie up. Next to the disembarkation: an Egyptian royal messenger heads a file of men and carries a heap of familiar objects of barter—necklaces, hatchets, daggers—to the king of Punt, who advances to meet him, followed by an enormously fat wife, two sons, and a daughter. Then ensues a scene of frenetic activity as a long line of Puntites brings the products of the country to the tent of the royal messenger, while another file carries jars and myrrh trees up gangplanks onto the visiting vessels.

Then comes the departure, the ships leaving the harbor under full sail, their decks piled high with cargo. Each scene has a caption to describe it down to the minutest details of action ("Hard to port!" calls the pilot of one of the ships as they maneuver; "Watch your step!" is carved over the stevedores in the loading scene), and from them an almost complete cargo manifest can be compiled. It is imposing: various woods, including ebony, myrrh-resin, live myrrh trees, ivory, gold, eye cosmetic, skins, 3,300 head of cattle, natives, and their children. And some souvenirs of the distant land: native spears, apes, monkeys, dogs; even "... a southern panther alive, captured for Her Majesty."

The vessels shown on Hatshepsut's reliefs represent the height of the Egyptian shipbuilder's skill. Yet, though they are fine-looking ships, their design had serious weaknesses and, for good reason, was not to play an important role in the history of naval architecture.

In Egypt, stretched like a ribbon along the banks of a river that offered a clear course of over four hundred miles, it was natural that the designing and sailing of boats would begin early and develop rapidly. The Nile offered the best and easiest highway. It was even blessed with a prevailing wind that blew from the north: one could sail upstream and then drift back downstream—or row, if in a hurry.

The tombs of Egypt have yielded pictures and even models of a bewildering variety of river craft, from tiny rowboats, through swift yachts and dispatch boats, to enormous barges that were built to carry huge obelisks, weighing hundreds of tons, from the granite quarries far upstream. Life on the ancient Nile must have been every bit as varied and picturesque as on Mark Twain's Mississippi. And, as designers of river craft, the Egyptians were unsurpassed. This was their weakness: when they turned to the design of sea-going ships, they simply constructed oversize Nile boats.

In building ships, in almost all times and places, people have used a framework of keel and ribs. The keel was the spine; the ribs curved upward and outward from it, and to them a skin of planks was made fast. In this way, strength and rigidity were imparted. Not so the Egyptians. Building for use on a river where storms, violent winds, battering waves, or rippling currents were rare, they constructed even their largest vessels without a keel and with few,
Reconstructed detail from shipyard scene shows laborers, above, smoothing the hull planking of a small river vessel.

Nile traffic, below, included fishermen's papyrus canoes at left; quarry barges, center; rich pleasure craft, right.
very light ribs. The planks of the
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and the
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were pinned to one another, rather
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than to a skeleton. The only
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harness provided, beyond the hand-
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sifting provided, beyond the hand-
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of ribs, consisted of beams run
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from gunwale to gunwale, on which
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the deck was laid. This was adequate
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for a river. A good deal more was
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needed for a ship that went to sea.

About 2550 B.C., Pharaoh Sahure
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built a fleet of transports to
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try his troops to some Asiatic coast.
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The event is commemorated on
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the walls of his pyramid, thereby
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leaving the earliest clear picture of
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such ships extant. So carefully did
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the artists execute their assignment
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that almost every detail of construc-
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tion appears; we see precisely
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how the Egyptian naval architect
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had to adapt for use on the sea a boat
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originally built for a river.
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Around the bow of the vessel, he
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dipped an enormous hawser, carried
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along the centerline above the
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dock, and looped it about the stern.
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By placing a pole through the strands
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of the hawser where it passed over
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the deck, and twisting, one could
tighten the whole harness like a tour-
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niquet. This was his substitute for
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keel and ribs; twisted until it had the
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proper tension, the hawser held the
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ends from breaking off when the ves-
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sel was forced to batter her way
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through heavy seas.

The architect could not use an or-
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dinary, single mast, for there was no
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keel in which to sink its butt securely
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(the heel of a mast exerts tremendous
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leverage against its socket). So he
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designed a two-legged mast, which
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distributed the pressure, and he
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stayed it carefully with lines fore and
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aft. On this, a tall slender square
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sail was mounted, in a fashion pecu-
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liar to Egypt: two yards spread it,
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the usual one along the head and
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another along the foot.

But the ship was not solely a sail-
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ing vessel; when there was no wind,
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or when it was foul, sail was taken
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in, the mast was lowered and rowers
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sent her on her way. The Egyptian
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artists in their scrupulous attention to
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detail have added a homely touch that
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permits us to figure out what kind of
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stroke the rowers used. Oarsmen are
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always pictured with a special type

of loincloth, one made of a netted
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material with a square patch of solid
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leather on the seat. This obviously
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was chafing gear: the rower must
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have handled his oar the way they
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did in the Middle Ages, rising to his
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feet at each stroke and throwing him-
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self on the seat with the pull: with-
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out a sturdy patch on his rear, he
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would have rubbed through his loin-
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cloth in short order.

A thousand years later, naval archi-
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crates were designing the ships shown
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on Hatshepsut's reliefs. They are
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cleaner and faster than Sahure's.
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Their lines have the graceful curves
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of a racing yacht. The sail has given
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way to one much larger but no
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longer tall. Enormously broad in-
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stead, it was still spread in the old
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manner by a yard along the foot as
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well as along the head. It was so wide
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that the yards were made of two ta-
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pering spars, with their butts fished
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together. The broad sail has per-
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mitted the use of a much shorter
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mast, one that exerts less leverage,
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and the architect has accordingly
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given up the old, two-legged arrange-
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ment for a single pole.
Hatshepsut's ships, shown here receiving cargo at Punt, were Egypt's finest. Stubby, single mast supported a low, wide sail of great area: lines of hull were clean and rangy. But the great hawser, a substitute hull-stiffener, remained...
Kenamon was an official under Amenhotep III, charged, among other things, with the Levant commerce. He had a picture painted on one side of his tomb, complete to the last detail, showing a typical moment in an Egyptian harbor four centuries before Christ.

A fleet of ships has just arrived. One can tell where they are from by the dress and looks of the skippers and mates, who wear gaily embroidered, ankle-length robes and have full beards and prominent, hooked profiles. They are unquestionably Semites. The vessels, consequently, must be from Syria and Phoenicia, perhaps even from Byblos itself. Are the ships, too, foreign or are they Egyptian? With their gracefully curved bow and stern and prominent overhang fore and aft, they seem very like Hatshepsut’s vessels. Yet they lack the telltale looped hawser. Perhaps it is the artist’s fault: as an Egyptian, he may have unconsciously grafted a native look on to ships that were really foreign.

A number of the ships are already made fast, their sails furled, the boarding ladders lowered from their prows to the shore. Harbors were rough-and-ready affairs in those days; since there were no wharves, ships were simply run up on the beach. Other vessels are shown making ready to land. Sailors have sprung aloft to take in canvas and, on one, the skipper stands in the bow carefully taking soundings as the ship inches in toward the beach.

On shore, everything is bustling. An Egyptian customs official, standing before an officer and file of men from one of the ships, is entering information about them on a tablet. One Egyptian tradesman is busy trying to sell his wares; he points with emphasis to his scale to assure prospective customers that it is accurate. Another is actually transacting a piece of business with one of the ships’ officers. The latter is trying to sell a large jar, probably of wine or oil; for no good grade of either was ever produced in Egypt: behind this officer, a file of hands unloads several more jars.

In one corner of the panel, a ship’s officer leads two women and a child before an Egyptian official. Are they slaves? In another corner is the procession before Kenamon himself: men from the ships stolidly file before him with wares of all sorts, while their officers grovel in the dirt before the great man.

Active as Egypt’s trade was, it had strict limits. Her lightly built ships raced south to Punt and north to the Levant but very likely not much farther. Many of the products the Egyptians imported and exported were carried in foreign bottoms, like those in Kenamon’s picture. The distinction of being the first great traders of the Mediterranean goes to another people, a race of born sea sailors rather than foolhardy rivermen.

Some decades before Kenamon, a noble named Rekhmire, vizier of Egypt and second in importance only to the Pharaoh, ordered pictures for his tomb showing all the world paying tribute to his master, the great Thutmose III. As in Kenamon’s picture, there appear Semites from Phoenicia and Syria. There are men from the south, Negros from the Sudan and people from Punt. Alongside these by now familiar figures appear others that are completely new. They wear unusually decorated kilts and queer sandals, and do their hair in a strange fashion. The bowls and other vessels they carry have unfamiliar shapes, “The People of the Isles in the midst of the Sea,” the caption calls them.

“Mino is the first to whom tradition ascribes the possession of a navy. He made himself master of a great part of what is now termed the Hellenic Sea; he conquered the isles of the Aegean and was the first colonizer of most of them.” So wrote Thucydides, one of the most sober and scientific historians who ever existed, in the fifth century B.C., some thousand years after the times of Thutmose and Rekhmire. Minoan traders have left a trail of their pottery in Palestine and Syria and Asia Minor in the east. They reached north as far as Macedonia. Southward, they knew other parts of Africa besides Egypt. One of the signs found among their carvings is a representation of a plant, highly prized in ancient days as a medicine and spice, that grew only in one particular spot on

Professor Casson, of the Classics Department at New York University, is the author of a current volume, The Ancient Mariners (Macmillan), from which this article is excerpted. Mr. Guggenheim, the illustrator, has regularly contributed to these pages.
the coast of Libya. A tiny seal found in their ruins shows a kneeling camel: another, an ostrich. To the west, they pushed as far as Sardinia: ingots of copper, stamped with the telltale Minoan double-ax, have been found there. Sicily they knew well: objects made of lapisite, a rare form of stone originating only in the islets off Sicily, have been found on Crete. Legend says Minos, himself, died on Sicily.

Our knowledge of the objects of Minoan trade is lopsided because the evidence is limited almost entirely to the sort of things the archaeologist can dig up. Yet enough has been found to show that the outside world clamored for the products of Cretan workshops. Alike among the highly civilized nobles of Egypt and Phoenicia and the semibarbaric chieftains of Greece, there were those who preferred to eat off dishes decorated in the Minoan fashion, to carry Minoan-style weapons in battle, and to wear Minoan jewels and garments of Minoan textiles in court. The women of Crete wore a tight bodice of sorts and a bell-shaped skirt, made up in a number of tiers: in an Egyptian tomb painting, a Semitic princess appears wearing precisely such a skirt, and the skirt reappears in the harbor scene of Kenamon's tomb. (See opposite page.)

In return, the Minoans imported many things: gold, beads, faience, figurines, and probably papyrus from Egypt; copper from Cyprus; ivory from Syria; porphyry from Greece. Amber, following routes across Europe from the Baltic, made its way to their workshops.

The inhabitants of Minoan Crete were, then, the first great sea power of the Mediterranean, the first to explore that great sea in a fruitful way and to lay out trade lines that were destined to last for millennia. Must they not, therefore, be the "People of the Isles" on the wall of Rekhmire's tomb? The figures there wear their hair in the same manner as the men that appear in Cretan murals and they carry vases shaped and decorated like those found in Minoan sites. Can we not conclude without further ado that these "People of the Isles" came from Crete? The problem is not quite that easily solved.

No more than a day's sail from Minos' palace in Crete lies the southern portion of the peninsula of Greece. Early in their history, Cretan traders had made their way here. The effect of their arrival was startling. The local inhabitants gobbled up Minoan civilization as avidly as Japan in the nineteenth century did that of the Occident. Their whole lives were transformed. They decorated the walls of their houses, their pots and dishware in the Minoan manner. They fashioned the same sort of seals and jewelry, wore the same sort of armor, dressed in the Minoan style. The women did their hair à la minoëme and looked to Crete for their fashions the way we do to Paris and Rome. Much of what was native disappeared under an overlay of culture imported from Crete.

In due course, these barbarian Greeks established themselves as heirs to the Minoans' maritime empire. They seized and held Crete, with its fine location astride the trade routes. They set up their own colonies: near Syracuse in Sicily and Taranto in Italy; on Rhodes; on Cyprus; along the Phoenician coast. Their cities in the homeland grew rich—especially Mycenae, where, in later days, Homer's King Agamemnon ruled. This was the first of their centers to be excavated and, as a result, scholars refer to the Greeks of this time as Mycenaeans and the period as the Mycenaean Age. From almost the middle of the second millennium B.C. to its end, they were the trading nation par excellence of the Mediterranean. "The People of the Isles" in Rekhmire's tomb and in other Egyptian paintings may have been Minoans, but it is just as likely—the frescoes all date in the fifteenth century B.C.—that they were the venturesome Mycenaeans, instead.

The lords of Mycenae, like their Minoan predecessors, were rich and powerful men. They were able to build grand palaces to live in and sumptuous tombs to be laid away in. In them, excavators have found the rich trappings of their daily life. They fought in beautifully wrought armor, drove in handsome chariots, wore fine clothes, and dressed their wives in style. They fed from magnificent dinnerware and drank from superb, golden goblets. The age was a great one, great enough to linger in men's memories long after its end—for it was of the last days of the Mycenaeans that Homer sang.

Reconstructed detail from Egyptian tomb painting depicts the arrival of...
The Egyptian fleet during the fourteenth century B.C., when Pharaohs' seapower had declined. These ships do not show the looped hawser that marked Egypt's vessels. Levantine merchantmen, they unload a cargo of oil or wine in jars.
THERE ARE SOME fourteen sub-
cies of albatrosses, of which the
three, or four (science still differs
their exact classification) are the
“great” albatrosses. By common op-
ion the greatest of them all is the Wa-
dering Albatross. Sailors have cal-
it by a variety of names—Goney, C
Sheep, Chocolate Albatross, Man
War Bird, Toroa. It features in the
catalogue of birds of the British Mu-
seum as Diomedea exulans.

D. exulans is the largest of fly-
creatures, although its dimensions
have often been exaggerated. A la-
number, accurately measured, gave
the tip-to-tip wing dimension averag
over ten feet (very big ones, in- 
y^p\y

ver males, running up to twelve 

feet. The length from tip to tail is 

four feet. Weights up to twenty-

and three-quarters pounds for a 

male and twenty and three-quarters 

pounds for a female are known, but 

weights up to twenty pounds would be 

considered average.

Even in an age that attaches great 

importance to records, it is not the 

length of the Wandering Albatross that 

makes it so remarkable. The never-

ending source of wonder is the extra- 

ordinary ease of its flight: a bird, as 

light as a swan and weighing perhaps 

only a few ounces, that swims through 

the 

air as easily as a trout in a quiet pool.

The albatross, more than any other 

bird, has the habit of following ships. 

It would be nice to think that they 

crave company in the loneliness of the 

ocean, but the facts are more prosaic. 

Scraps thrown overboard make a 

pleasant change, and their usual diet 

(squids and shrimps) is brought con-

veniently to the surface by the tur-

bulence of a vessel's wake.

All agree that immense distances 

can be covered by albatrosses, though 

proven information about a bird that 

spends most of its time in rarely vis-

ited places is hard to come by. I have 

a photograph, taken in 1940, of a 

Wanderer with distinctive white-tipped 

primaries, which followed H.M.S. 

York for four successive days, during 

which the cruiser, steaming at eight-

een knots, covered over 1,700 miles. 

A Wandering Albatross shot off the 

coast of Chile had a small vial hanging 

on a cord from its neck. In it was 

a message, only twelve days old, from 

the whaler Euphrates in New Zealand 

waters, 3,150 miles away on a great 

circle course. A bird ringed on Ker-

guelen Island was recaptured near 

The albatross, floating easily over wind-whipped waters of the Southern

Ocean, may accompany a ship for many miles to seize discarded food scraps.
Cape Horn, 6,033 miles from the point of release, by the French four-master A.D. Bodes. Yet the birds that cover these vast distances hardly ever seem to flap their wings, for the most remarkable thing about the albatross is its seemingly effortless flight. How does the bird do it?

Imagine a typical Southern Ocean day in the Roaring Forties. The wind is blowing strongly from the west—seven to eight on the Beaufort Scale (thirty-five to forty-two miles per hour). The sea, rolling eastward at about twenty miles per hour, has not yet risen with the wind, but there is a long swell left over from a recent gale. The waves are one hundred yards from crest to crest, with troughs some fifteen feet deep. Our ship, steaming southward with the wind and sea on the beam, is rolling heavily. A single Wandering Albatross is in company and, as I come on deck, it is some fifty-five feet up on the starboard quarter, just to windward of the broad lane of disturbed water spread by our passage over the heaving waves astern.

The bird is overtaking us rapidly. As I watch, it turns downwind across the wake, “reefs” its wings into a shallow W and dives rapidly to leeward. Moving fast through the air and with the wind behind it, its speed over the water is very high. In a few seconds, it is well to leeward, turning north and vanishing in a trough between the waves as it banks steeply just above the sea. A few seconds later, it emerges several hundred yards away on the port beam, facing the wind on fully extended wings and rising. This leg of its flight track—against the wind—takes rather longer, but the albatross has soon crossed the wake again, turned south on to the same course as the ship and is back in its original position—fifty-five feet up on the starboard quarter.

For an hour I watch the albatross, flying on this same curved flight path and returning at perfectly regular intervals to the same position. Not once do I see it flap its wings. How does the bird regain the height it loses in its downward swoop to water level? Why is it not swept bodily away to leeward by the forty-mile-per-hour wind?

The albatross is, of course, capable of powered flight, but it is as a glider that it is so remarkable. Let us consider the constructional details of a typical sailplane and see in what ways its layout compares with that of a Wandering Albatross.

The motive power of a sailplane is the force of gravity: it must use this power to the best advantage, traveling forward as far as possible with the minimum loss of height. The wings must therefore give the required lift with the minimum drag. Wind-tunnel experiments, backed by practical experience, have proved that long, narrow, tapered wings give the best results. The ratio between the average width of the wing and its length must be high. This aspect ratio, in a high-performance sailplane, is around eighteen—the same as that of the Wandering Albatross. The lift drag ratio of such a wing, considered alone, may be as high as forty to one: that is, for every forty pounds of lift acting upward at right angles to the wing there is a resistance to forward motion of a pound.

Even with the best modern materials and technique, it is not easy to build a sailplane with such long, narrow wings and with the required lightness and strength. In the albatross, nature has solved the problem notably by providing the bird with hollow wing bones, filled with air instead of marrow. The bones of an albatross are very strong for their weight. The skeleton of an albatross—with a weight of twenty pounds—scales under three pounds, including the breast bones, back, head, neck, beak, skull, legs, and feet.

Scientific studies extending over many years have determined the best section and form for the sailplane’s wing and wing-loading gives the highest lift/drag ratio. To give a sailplane the dimensions and form used must be a compromise, as the best shape and size for low speeds is different from that required at high speeds. Here the bird has a great advantage over the machine. Its wings is a living entity; the bones are rigid but the feathers and joints are controlled by muscles and can be mot
Looking in a few seconds to parallel course. It then swings toward

... a wide variation in the and area of the wing in flight.ing a flying albatross through

... one sees that not only of the wings, but their camber, back, and dihedral are con-

... being changed. By opening or rig the feathers fanwise, the area

... wing is also being adjusted, rig the bird to fly at something

... the optimum lift: drag ratio what-

... s speed at the time.

... albatross is a splendid sail-

... but no man-made sailplane

... emulate the performance of the floating above the stormy seas

... it lives out its existence, and

... gaining, with very little muscu-

... l, its ceaseless food quest.

... bird or any sailplane, gliding

... through the air, is continually over-

... g drag; dissipating energy

... the store made available by the

... s weight, height, and speed. To

... at a constant or increasing

... height must be sacrificed. That

... say the glider must be going

... hill” through the air current in

... ship, wings fully extended, and rises

... into wind to regain initial position.

... which it moves. By seeking out places

... where this current is moving upward,

... the pilot maintains or gains height.

Such upward currents are found

... on the windward side of hills: in “thermals” where warm air, heated

... by the sun, is rising from the ground;

... and in “standing waves”—where air,

... passing over a range of hills, dips

... down on the lee side and rebounds

... in a series of waves. The first and

... last types of lift are available, in

... some degree, above the great waves

... of the ocean—upward-flowing air on

... the flanks of the waves when the wind

... is moving faster or slower than the

... swell, and rebonding air on the lee

... side of the crests. But such upcurrents

... are too irregular and operate too

... near the surface to give the bird the

... sustained lift it requires for con-

... tinuous flight. The albatross flies as

... it does by exploiting the power of the

... wind in quite another way.

Wind blowing over the sea is slowed down by friction. If the speed

... of the wind is, say, forty miles per

... hour at fifty-five feet above the sea, it may be only twenty miles per hour

... close to the surface. If we measure the speed of the wind up to an altitude

... of fifty-five feet and if we plot wind speed against height, the result will

... look quite like the graph on p. 64. The bottom layer of air is held back

... by its friction with the water and, as we go upward, each succeeding

... layer is slowed by friction with the slower-moving air below.

A Wandering Albatross gliding in still air on outstretched wings, at fifty-five feet with an airspeed of thirty miles per hour, starts a dive toward the water—using the force of gravity to increase its speed—and levels out just above the surface. flying at about forty-eight miles per hour. It immediately starts to climb, converting back into height the extra energy it has gained in the dive. When it has risen to, say, forty-five feet, it will have used up this surplus energy. Its airspeed has now fallen away to thirty miles per hour, it has lost ten feet of height and must now start down again. The next upward swoop brings it only to, say, thirty-two or thirty-five feet: and so on, in gradually diminishing upward curves, until it must flap its wings or settle on the water. Evidently there is no future for our albatross in this type of effortless flight.

Take the same bird, gliding at thirty miles per hour airspeed, fiftyfive feet up, not in still air, but before the wind. The wind is blowing over the sea at forty miles per hour at this height and at twenty miles per hour immediately above the surface. The albatross starts a dive exactly as before. In still air, it would reach an airspeed of forty-eight miles per hour at the surface, but now the bird is gliding downhill. As it dives, it enters layers of air that are moving ever more slowly over the water. In consequence, the airspeed of the bird builds up more rapidly and—by the time the albatross reaches the surface—it will be much greater than before. The albatross will have attained an airspeed of sixty-seven miles per hour when it levels off just above the sea. An albatross skimming along at an airspeed of sixty-seven miles per hour has a lot of surplus energy—more than enough to enable the bird to soar back to its original height of fifty-five feet before its airspeed again
IDEALIZED FLIGHT PATH for a Wandering Albatross during moderate to strong winds is plotted here from the author's data. At start of downwind descent, left, bird has minimum airspeed of 30 mph; bird, with wind behind it, has built

GROUND SPEED, plotted against bird's altitude during flight circuit, above, shows bird's maximum speed over water to come during steep, leeward descent.

drops away to thirty miles per hour, provided it is in still air or clim across the wind gradient.

This is a considerable improvement on the first state of affairs, but still not good enough for following a sharp. For the bird, in the course of its downwind descent, the wind has been moving downwind at very high ground speeds (up to eight seven miles per hour when airspeed and wind speed are added together) and it has made considerable by way, which must be regained.

Luckily, the albatross, when it begins its upward swoop, is not in still air, but has turned into the wind, which—as we have noted—is blown over the sea at varying speeds. As the bird rises, it is constantly entering faster-moving layers of air. At this feet, the albatross has an airspeed.
speed to near 60 mph as it approaches surface and turns into wind. Long, upwind ascent now carries bird into increasingly fast wind layers, so that loss of airspeed is gradual. Finally, altitude regained, bird starts next dive.

...seven-five miles per hour; it has fifty-five feet not at thirty but seventy miles per hour. It has been going much faster over the ground windward all the way up, is still going against the wind at the top of climb and has regained all the way lost in the dive!

...the reader is still with me, we can now go back to the Southern scene of three pages ago, among the data we have just related the flight first described. At the highest point of its flight the bird has an airspeed of thirty-five miles per hour. It turns downward and dives toward the sea, maintaining a steady angle of descent but losing airspeed rapidly because of successively slower-moving layers of air into which it flies. At twenty feet, its airspeed is forty-six miles per hour; the wind directly behind it is blowing at thirty-six miles per hour, giving a ground speed of eighty-two miles per hour to leeward. The bird now begins to turn across the wind, diving into a trough between the waves, and finishes its downward trajectory with an airspeed of sixty-seven miles per hour but moving to leeward at the same speed as the sea, twenty miles per hour.

The bird, using any upcurrents it finds on the flanks of the waves, flies for some distance along the trough, banks and turns rapidly into the wind, using the strong updraft near the crest of a wave to gain considerable height— an initial kick off, as it were, of ten or fifteen feet. Its airspeed, instead of dropping, actually rises as, propelled by its own momentum, it suddenly meets the faster-moving wind, and it forged quite rapidly to windward as it begins its steady upward climb, moving continually into layers of higher wind speed. At twenty feet, its airspeed is still over seventy-seven miles per hour and its ground speed— to windward— forty-one miles per hour. At thirty feet, its airspeed is seventy-five to seventy-six miles per hour and it is still moving steadily to windward at about thirty-eight miles per hour. By keeping a fairly steady airspeed, the surplus energy accumulated in the dive is used to gain height. It finishes the upward climb with an airspeed of sixty-five to seventy miles per hour, still forging slightly to windward as it...
Admiral Jameson's account of the albatross's soaring flight is taken from his new book, The Wandering Albatross (Morrow). Guy Tudor, whose work has appeared here before, did the accompanying bird paintings.

turns across the wind, and regains its position above the starboard quarter of the ship without having lost height or made any leeway.

The cycle described is a typical one, susceptible to a very large number of variations, according to the strength of the wind, state and direction of the sea, mean course followed by the albatross in its search for food, and so on. The principle followed in all cases is the same, the bird making but incidental use of air currents near the waves—relying on the variations in wind speed for sustained flight.

Scientifically accurate data about the flight of any bird are almost impossible to collect. One cannot make a live bird fly in a wind tunnel, nor force it to follow a prepared track along which instruments have been set up. Records of the movements of birds in flight and of the surrounding air are susceptible to considerable error. The difficulties are greatly increased for sea birds, moving fast over great waves through air which, in its lower levels, is as turbulent as the stormy sea below.

In the 1920's, a careful field study was carried out by Professor P. Idrac of the Ecole Polytechnique, in Paris, using both automatic cameras to take photographs every tenth of a second and smoke floats and anemometers to measure the direction and velocity of the wind. It was Professor Idrac who first established the now generally accepted theory of the albatross's flight, which I have endeavored to explain here. In his conclusions, given in a paper published in 1924, he stated:

First: only birds that are aerodynamically very "clean" and that can fly at high airspeeds can keep aloft in this way. High speed is essential to build up plenty of kinetic energy in the downward dive. The energy accumulated varies with the square of the speed, that is, it is four times as much at sixty miles per hour as at thirty miles per hour.

Second: albatrosses (and Idrac included the smaller albatrosses) usually fly at airspeeds varying between thirty-five and eighty-five feet per second, that is, thirty and sixty-tenths and fifty-seven and eight-tenths miles per hour. Their mean airspeed is about sixty feet per second, forty and eight-tenths miles per hour. They fly in a shallow layer of air, extending from sea level to about forty-five feet, although this maximum height is exceeded when the wind is giving greater differences between the "free" and surface winds and providing more assistance from eddies and updrafts close above the waves.

Third: the complete flight cycle is often very regular, with an elapsed time, summit to summit, varying by as little as one second, proving that there is little dependence on the highly irregular air currents and eddies around the waves.

Fourth: soaring flight without wing-beating is possible only if the minimum wind velocity at sea level is more than eighteen feet per second—that is, eleven and five-tenths miles per hour.

Fifth: the trajectory of the bird is adjusted according to the strength of the wind and its direction relative to the mean course followed. When the wind at sea level reaches fifty feet per second (thirty-four miles per hour), the bird must make leeway, unless it can find an area of slower-moving air in which to fly; that is, in the eddies and updrafts close to a ship.

Mankind's own efforts at soaring flight in his most modern sailplanes, helped by the best instruments he can devise, seem clumsy when compared with the natural performance of this great bird. The Wandering Albatross's utilization of meteorology, aerodynamics, and applied mechanics is as marvelous as its split-second reactions to constantly changing conditions, particularly in the highly turbulent air around the waves. One of the greatest of glider pilots, Philip Wills, has admitted that a man-carrying sailplane, even with a wing span as low as thirty feet, would be far too cumbersome to operate in such a shallow layer of constantly varying air. It seems unlikely that man will ever be able to emulate the albatross, except within the confines of his imagination.

Long wings of the albatross, ideal for gliding, are embarrassment when bird must leave water during times of calm.
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FEATURE AND THE CAMERA

By David Linton

The most important thing to know in order to take good pictures is that a fine camera with fast lenses is a fine camera if it has an extensive lighting apparatus. Apparently not, because we have seen many pictures taken with the simplest equipment (witness Arnold Genthe's photographs of the San Francisco fire, done with a borrowed box camera). Would it not be true that the understanding of the fundamentals of photographic technique--most of the good pictures we see--wouldn't exist.

But the first requirement is an ability to see--to see without preconceived ideas--of what they should look like or of what was possible or impossible to photograph. I think we should be less concerned with the wide aperture of the lens and more concerned with the wide-open aperture of the minds of those who take pictures.

The reason for learning photographic technique is to be freed from it. It's out of the way so we can see what we see. In fact, ignoring technique is sometimes a problem. We have all seen exciting pictures made by beginning photographers who didn't know that what they wanted was impossible, and who succeeded in doing it. While this may be disconcerting to the experienced photographer, it is undeniable.

A few of the most lively pictures ever made were in the early years of photography, using techniques that would make us turn our heads today. Why did the mid-nineteenth century photographers, like Julia Margaret Cameron and David Octavius Hill and their contemporaries, produce a remarkably high proportion of pictures? One explanation that has been advanced is that most of them had trained in art before they took up photography. This explanation, however, helps not much--we find lots of photographers with art training today and doing just the same as the rest of us. It has also been suggested that the difficulty of the new medium made the early photographers work harder. That is certainly true. After William Henry Jackson scrambled up a mountain in the 1870's with his 20x24-inch camera, a wooden case of glass plates, a stove, chemicals, and a portable darkroom tent; when he set all this up on some wind-swept pinnacle, heated and mixed the emulsion and coated the plates with it, then rushed the wet plate to the camera in a light-tight box, he surely was not inclined to take photography lightly.

But whether this explains the results Jackson got is another question, and a most important one. We do not find that pictures taken now with great difficulty are necessarily better than those that are easy to take. If anything, they are worse.

I think there must be another reason. The early photographers did not have their memories cluttered with pictures. The "rules" had yet to be invented, and nobody knew what was possible. Of course, they had studied paintings and drawings, but the quantity was negligible compared to the deluge of pictures that engulfed us today. Thus their minds and eyes were open. They didn't have ready-made ideas of what a picture should look like, and they didn't know what was technically possible. But they wanted to find out, and that challenge helped them produce pictures that are still memorable, after 120 years.

Today, very little is really impossible to photograph. The tools have developed far beyond our ability to think up ways of using them. It is now possible to photograph anything that can be seen, and a lot that can't. But technical progress has not found us ready with corresponding progress in our thinking about what a picture should be. Instead of opening up ways of doing new things, the vastly improved tools have often simply done the same old things less well. In just the same way, the invention of the flash bulb ushered in a twenty-year period of stagnation in newspaper photography. Taking pictures became so easy that a chimpanzee could learn to do it, and there was no effective challenge to the press photographers' thinking. Fortunately, the dark ages are past in that branch of the field, and the creative intellect...
Perfect weather is not necessarily a requisite for fine pictures. The eye behind the lens can often take advantage of unusual situations to produce dramatic photographs. Fog pictures on these pages are examples of a "seeing eye."
The diligence of newspaper photographers is now channeled toward the content of pictures rather than ways to take them.

Photography is something like Antaeus, the giant with whom Hercules wrestled. He was invincible as long as he touched his mother, Earth, and Hercules fought a losing battle until he lifted Antaeus off his feet. So photography must touch home base—the real world—to keep its strength. No photographer, no matter how brilliant, can create better pictures than nature invents. Our problem is to find these natural inventions, isolate them, and fit them into the small compass of what we call a picture.

The biggest obstacle in this endeavor is the preconceived idea. No two events in nature are ever exactly alike, just as no two snowflakes are alike. But all of us have seen so many pictures that, when we go to photograph something, we are likely to start out with an already formed idea of what it should look like. When we get there, and find it does not look like our mind's-eye view, we may be disappointed and miss the real picture.

Planning a picture in advance is good, but not when it replaces seeing. The picture of the two fishermen in a dory is an example. It was part of a picture story on a Newfoundland fisherman and his family. One picture of fishing was ab-
olutely essential to the story. But most of the time I was at the fishermen's remote village, the weather was so bad that the boats stayed on shore. On the one day that looked promising, I got up before dawn and went out with two boatloads of fishermen. The fog was so heavy they could not find the fishing grounds. Rain drenched my cameras, and I was frighteningly seasick. After catching nothing for a couple of hours, the fishermen turned back. I had only a few pictures, and was sure that the story was ruined. But one picture later became one of my favorites, told the story better than a well-lighted shot with the boat full of fish.

The other two pictures seen here have something in common beyond the fog. Both were totally unexpected—they were scenes that suddenly presented themselves in front of my lens—and both were taken under light and weather conditions that were seemingly prohibitive.

Every photographer has had the unsettling experience of finding relevant, important elements in his pictures that he did not notice when he took them. I say "finding," because there is no doubt that they were seen, but the photographer's reaction was so quick and instinctive that the conscious mind never got into the act. These "accidents" are not accidental at all; they are simply another indication of the vast, often untapped, resources of the human mind. They are of the same stuff as the sudden, original insights that are often so crucial in scientific discovery: the unconscious synthesis of years of training, study, and practice.

One of the most memorable pictures of the Vanguard rocket that blew up on its pad was taken by Burt Glinn. In the foreground, forming a perfect frame for the conflagration, are four pelicans, obviously frightened into flight by the noise of their flightless neighbor. As Glinn tells the story, he shipped his film off to the laboratory and waited nervously for the report. The next day he got it by phone: "The picture is good and the birds are just wonderful." His answer was, "What birds?" (See photograph above.)

This has happened to me perhaps a dozen times. Not long ago, I was photographing a busy street from a second floor window. As I squeezed the shutter, a curious and quite irrelevant thought entered my mind. I remembered a story I had heard a couple of years back. It concerned a man who went to the opening of a Broadway play. During the first act he noticed that the seat next to him was occupied by a dog, who sat up and watched the action on the stage with great interest. At the end of the act, the dog applauded vigorously. As the lights came on, the man turned to his dog's human companion and said, "Don't understand. He seems to be following the play and enjoying every minute of it. Is that possible?"

"I don't get it either," said the companion. "He didn't like the book at all!"

I was completely at a loss to understand why this story came so forcibly to mind while I was photographing a busy street. But later, when I examined a enlargement of the picture, I found the answer. Someone had left a dog in one of the parked cars on the other side of the street. The dog, sitting in the driver's seat with its paws on the steering wheel, seemed to be about to drive away.

There is probably a certain unconscious element in every good picture. There has to be, because there are many facets to most pictures that the conscious mind could hardly encompass them all at the moment of exposure. They all fall into a perfect relation so frequently that it cannot be accidental. The open mind—the open eye—responds to them and organizes them into a picture. The mind limited by received images cannot.
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A masterly study of life in the ocean

Reviewed by Norman J. Beresford


The open sea has caught the fancy of sailors and naturalists for ages past, and Alister Hardy—although he is a scientist, concerned with marine biology in general and fisheries in particular—is one with the rest. These two books, especially the first, are written with the enthusiasm that a genuine naturalist is bound to feel about the life of the ocean.

Awareness of the ocean's beauty was perhaps commoner in the days of sail than it is now—the seas today are increasingly flown over or crossed by engined ships so fast that no one has the chance to see beneath the surface. Today, few but the professional biologist or oceanographer is likely to get a close view of the sea's living form and activity in all its astonishing variety. Who else now knows at firsthand the nautilus of the ancient Greeks or the by-the-wind sailor of early English seamen? Drake's chaplain on board the Golden Hind wrote, enchanted, of the try of flying fish scudding like bees over the calm equatorial Atlantic. Another Elizabethan mariner, Richard Hawkins—waiting off the Azores to intercept the Spanish fleet—beguiled his time by hauling buckets of water to the deck and watching with fascination the "corruption" they contained. A marine biologist of today would give his eyeteeth for a similar opportunity.

It was not until early in the nineteenth century that naturalists were well enough informed to take an intelligent interest in the creatures that drifted with the ocean currents. It was during this period that the tow-net was invented as a means of capturing the smaller or near-visible kinds. Vaughan Thompson, amateur naturalist serving as an officer surgeon in Ireland, was the first to use a net to collect plankton: on the British five years later, young Charles Darwin... often towed astern a net of his own, and thus caught many curious animals. But it was the German naturalist Haines Müller whose use of the tow-net, beginning in 1844, established it as a principal instrument for explorations in the seas, other than that of the floor or of fish and other large forms.

Refrigements in tow-netting have increased from Müller's day to this, nets of graded texture or nets designed to operate and close at different depths becoming widely employed, as the analysis of planktonic life progressed from the purely qualitative to the quantitative. Müller became customary to haul nets at stations plotted along a course, as a test of sampling the state of the plankton across a given sea, or at a certain depth in the surface. Such figures have been invaluable, though their nature they have been some what spotty. Hardy's own great contribution to plankton investigation is the continuous plankton recorder, now known as the Hardy plankton recorder, which was designed by the Discovery Antarctic expedition of 1925-27. Since then, this apparatus has been employed everywhere to make continuous samplings of planktonic life for hundreds of miles at a time.

Life in the sea is remarkably both in variety and quantity; and this is especially true in the uppermost layer which absorb most of the sunlight penetrat ing the surface. Acre for acre, oc
The sea is about as productive as land; and whether plankton comes directly as food or whether we come to eat only the fish and whales that are at the top of the food pyramid, the over-all productivity of the sea that we will necessarily turn more and more. For, since oceans enclose three-quarters of the globe, by far the larger part of our life on the planet is found in them. Indeed, we must turn regionally, the more so since planktonic zone, where life is dense, the mid-ocean depths, and floor each requires different techniques of examination.

Hardy's two volumes, the first deals the planktonic life in general, to with life in the depths (except in), and the second is concerned with fish and fisheries. The mafie of the seas are not included—for this the must turn to The Seashore, by Young, published in the same series as The Open Sea, illustrated by P. Wilson's superb photographs.

The World of Plankton begins by describing the microscopic forms of animal life, as numerous as a small, to be found in the upper one. These are the pasture types, which depends the existence of all higher creatures visible to the naked eyes include the jellyfish—from the forms, liberated by hydroids attached to the sea floor, to colorful and in small numbers like the complex siphons. But it is the planktonic sea, especially the minute copepod and the more shrimplike euphausid that serve as the main link between the complex plants and the larger forms animal life, for they are the principal producers. Most of the basic green food of the oceans, which is ultimately reduced into animal tissue, is produced by these small crustaceans of the oceanic layer, and by the numerical forms of other creatures that, nature, will live on the sea floor. Primarily a matter of relative size: much as these—small youthful stages all adults—can collect and feed upon the diatoms and flagellates that take the place of the vegetation of the land. Hardy's delicate water colors, along with Wilson's photographs, illustrate this section especially well.

The last part of this first volume is concerned with some of the marine life, as aspects of marine biology, among them the vertical migration of plankton. Migration of the plankton toward the sea's surface during dusk and dark, and down from the surface during dawn and daylight, has been shown everywhere to be a general phenomenon affecting all the plankton's components. The intensity of the light, and its effect on responses to gravity, appear to be involved, although the general explanation of why such migration occurs still remains a mystery. For the phytoplankton—the microscopic plant life upon which zoo plankton feeds directly or indirectly—remains in the uppermost layer, and the migration is a phenomenon of the animal life alone. It is possible that, in changing location relative to the surface grazing layer, the planktonic animals utilize currents at different levels. Or perhaps the explanation is to be found in the so-called animal exclusion hypothesis, turned a many years ago by Hardy himself. This theory, based on observations that dense phytoplankton rarely contains much animal plankton and vice versa, suggests that the phytoplankton has some antibiotic principle that permits only brief excursions into it by animal forms. The whole problem remains wide open for investigation.

Life in the depths is only remotely and indirectly dependent upon events near the surface, and the section of "The World of Plankton" dealing with it is perhaps the most intriguing of the whole book: the inhabitants of this region are strange, and the problems they pose are not less puzzling. Vertical migrations are found once again, but now several thousand feet from the surface; while the nature of the relatively dense stratum called the deep-scattering layer is as unknown as when it was first discovered by echo-sounding. Bathyscopes have passed through it without recognizing it, yet

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**DIAGRAM:**

A diagram of the distribution of a copepod. At far left are “wing” positions of a tieropod rising (a-e) and sinking (f).
The second volume, "Fish and Fishery," is both an extension and a development of the first, successively taking up the pelagic fish with particular emphasis on the herring, then the life of the ocean floor, and finally the great assortment of bottom-living fish that are mainly upon the invertebrate bottom fauna. In many ways, all this is no more familiar: we are dealing directly with our own sources of food and commerce. This is the economy of the fisherman, with a human bias, where the fishermen interests seem more important than those of the biologist.

The two volumes make a fascinating and instructive contrast in other ways, too. For the plankton and the bottom fauna represent the two extremes of the oceanic life; the one forever contending with the force of gravity but flooding the primary source of food, other supported by the sea floor and nourished by the bottom fauna. In both cases is the greatest supply of food, in the form of minute particles, life microscopic organisms in the case of the plankton and dead, particulate matter below. The sea floor animals, however, have two opportunities for retaining this material. They can filter the water from the bottom, while it is still in suspension (which is the habitat of bivalves, colossus worms, ascidians, corals, and many lesser forms). These are the deposit feeders. The other method is that of the suspension feeders, which burrow into the soft upper layer of the sea floor and swallowing large quantities of sand matter for the sake of the digestible material, which contains. Both kinds of feeders are preyed upon by other creatures—such as gastropods, starfish...
BEREILL is professor of zoology at McGill University, in Montreal. Among his numerous books are Men's Emerging Mind and The Living Tide.

—and these, in turn, together with filter-feeding and deposit-feeders as are possible, are preyed upon by the bottom-fish. At the same time, most of these benthic echinoderm, mollusks, and crustaceans were seen in “The World of Echinoidea” as larvae or as such relatively reduced forms as the copepods. Ecologically, economically, and in terms of the cycles of individual organisms, the main faunal regions of the sea are elementary.

The second book is not exclusively an account of the bottom fauna. It includes fish living at all levels; and, in fact, the first section of this volume contains an excellent general introduction to fish in the deep, pelagic zone, and the living in particular and also considering such diverse forms as mackerel, sunfish, and the pelagic rays. These are all described in relation to their means of feeding, and there is some discussion of their probable reproduction.

The pelagic fish are, in the main, built for speed, and have blue-white cording or an over-all grayness that furnishes a degree of invisibility. On the other hand, the colors are predominately browns, yellows, and drab greens, usually mottled—also an effective camouflage. And the body shape of the most highly adapted bottom fish is flat, and the same form being very differently expressed in the cartilaginous and bony fish, respectively. Skates and rays have well treated in the book; but the flat fish, of so much greater importance as food fishes, naturally hold stage.

The European flounder, in particular, is fully discussed, both in the book and, through its breeding migration in the North Sea, in connection with fisheries generally. This account leads Hardy to a discussion of breeding methods and the over-fishing of them, although here he is rather brief. If, since the two volumes of The Open Sea are intended to encompass all of life in the sea, he considers porpoises, and sea turtles, these books are outstanding: enthralling, detailed, personal, and inexcusable to students of biology, whether inclined toward the sea or not, should be required reading.

And both volumes of The Open Sea, one would be better biologists for having read them, and might even take an interest in the sea in consequence. In any case, and any other reader would better be grateful not only the fundamental dependence of life in the world’s oceans but some of its beauty as well.

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Spring in the Forest

vanescent tree flowers present dozens of reproduction patterns

By John W. Andresen

In the woodlands of the eastern United States, the death of winter announced by spring beauties, dog's-trot-violets, bloodroot, and wild ginger emerging from the forest floor. At same time, warming temperatures and lengthening days stimulate growth and swelling within the flower buds of the entire forest canopy.

The flowers of many forest trees are nute, simple, devoid of bright color, and relatively ephemeral. They surge, shed their pollen, and begin formation all within a few days, discussing these varied blossoms, it is simplest to adopt the policy of botanists and separate them into two basic groups—those that bear petals and those that do not. Petal-bearing flowers can be divided into those in which the petals are separate and those in which they are fused together. Petalless flowers, in turn, can be divided into those forming aments or catkins and those that do not. Because petalless flowers are more simple in construction, we will consider them first.

Pines, firs, and spruces, as well as other coniferous trees, bear "flowers"—reproductive structures, variously known as strobili, cones, conelets, aments, or catkins. They are unisexual; they lack petals; and they are remarkably uniform in shape throughout the various genera. The names of the two large subdivisions of higher plants, Gymnospermae and Angiospermae, help explain this major difference. Female "flowers" of gymnosperms (including the conifers, the ginkgo, and the cycads) lack an ovary—the protective wall that, in the angiosperms, surrounds the ovules and later develops into part of the fruit. Instead, gymnospermous ovules are

Gymnosperm “flower” is unisexual and apetalous. Ovules borne on inner surface of scales that make up the cone.

Angiosperm flower has an ovary—a structure that protects the ovules and later develops into a part of tree’s fruit.
Pussy willow’s female flower cluster is composed of dozens of vase-shaped

grown on the inside of a scale; the term "gymnosperm" means naked seed. In contrast, the angiosperous ovule is enclosed in an ovary—a structure composed of one or more carpels—that covers and protects it; the term "angiosperm," means seed vessel.

In pines, clusters of male or female flowers are usually separate and are found on different branches. Even though the genus *Pinus* and related genera usually bear both sexes on one tree, cross-pollination with other trees is essential for a high yield of fertile seed. If the female flower is pollinated by a male of the same tree, the seed of the mature cone will usually be sterile.

In early May, the crimson-colored female conelets of pine are borne at the tip of the elongated shoots or candles. Each conelet, only about a quarter of an inch long, may consist of as many as forty to fifty individual ovuliferous scales—arranged in a tight, compact spiral about the conelet axis. The fleshy scales are upright and slightly spread before pollination, but after pollen grains reach the ovule, the cone scales close tightly, gradually become more woody, and the conelet begins to assume a pendant position.

In hard pines, such as the red, pitch, and the Virginia pines, male flower clusters, or aments—which look like miniature ears of corn—are formed within buds by autumn. The soft pines differ: the spherical aments do not develop until spring. After the male flowers shed their pollen, they wither, dry, and drop from the tree.

The cones of most pines require two years to mature. During the first year, a tubelike outgrowth from the pollen
grain pushes through the outer ovary tissues until it contacts the egg cell and effects fertilization; in the second year, the cone and the seeds it contains are large and mature. Spruces, hemlocks, firs, and yews, in contrast, require only one growing season to reach full maturity.

On rare occasions, individual coniferous trees will bear flower clusters that contain both sexes. Records of this abnormality in the spruces indicate that these hermaphroditic structures are functional; that is, they bear viable pollen and receptive ovules. Young conelets from these trees sold as mature into seed-bearing cones.

SEXUAL maturity in the conifers varies between species, but some phallicous individuals of black spruce, northern white cedar, and many other different pines have flowered at five years of age. Pitch pines growing in New Jersey have produced flowers when only two years old, and there is a record of a Chinese pine bearing mature aments when only one year old.

Among angiospermous trees, all too many examples of unisexual flowers may be found. Indeed, most botanists recognize that trees and shrubs being simple unisexual, catkin-like clusters of flowers are primitive members of the angiosperm subdivision. The ament or catkin that typifies this group is really a compound flower or inflorescence of up to a hundred individuals, but very simple flowers, lacking petals or sepals. Each ament contains flowers of one sex.

All of the willows, aspens, poplars, and cottonwoods, and many of the sweet gales bear either male or female flowers on separate trees. The incidence of such male or female trees of considerable importance to practicing foresters and horticulturists: if the male or female trees are cut from an area, fertilization will be drastically reduced so that there will no longer be a source of seed from which the species can regenerate.

Broad-leaved trees that bear the flowers in male or female aments, but have both sexes on the same tree, are considered to be somewhat more highly evolved than those that bear flowers

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Dr. Andrisen, a research associate in vegetation studies at the American Museum, was formerly at Rutgers and is now an instructor in the Department of Forestry, Michigan State University.
Maple flower buds emerge in April before any leaves appear. Flower and leaf buds are separate, and sexes are found on different trees. Here, male flowers are enlarging and a number of the anthers have already shed their pollen.
only one sex. The familiar gray and white birches are good examples. One unusual feature of the birch family is the preformed, staminate aments found in the alder, birch, hazelnut, and hop-birchbeam. The male inflorescences hang at the branch tips until early spring, when they distend and shed their pollen. The female, or pistillate, aments bear a close resemblance to dwarf spruce cones.

The oaks also possess male ameni-ferous flowers (its female flowers are merely an inconspicuous budlike cluster), and the American chestnut bears both male and female flowers in the catkin-like cluster.

In contrast to the unisexual, ameni-ferous trees there is another category, composed of species that bear both sexual and unisexual flowers that are not in aments. In this group, represented by the elms, hackberries, and mulberries, petals are still lacking. A close examination of American elm twigs during the winter season reveals two types of buds. One—shaped like a small dome, about an eighth of an inch long—contains the unexpanded twig and leaves of the spring growth. The other, about twice as large as the first bud, contains compressed clusters as leaves that appear simultaneously. The female catkins are knob-shaped.
In mid-May, the waxy, sticky buds of the horse-chestnut appear, above. As the days lengthen, the dramatic changes seen in this series of pictures occur.

Perhaps the most spectacular tree blooms of the eastern United States are found among the magnolias, members of the group with separate-petal flowers. One beautiful native magnolia, hardy as far north as New Jersey and Michigan, is the umbrella magnolia. Its snowy-white petals, which compose a flower one foot in diameter, and the two-foot leaves that surround it suggest a tropical origin. The majestic tulip tree, which may reach a two hundred-foot height in our eastern forests, bears large, orange and green flowers very similar to the magnolias but with more of a garden-tulip form.

The much-admired “blossom” of the flowering dogwood is really not a flower at all. Its petal-like, white bracts are expanded bud scales. In winter, these scales cover and protect the center cluster of the dogwood’s true, minute, yellow flowers, which are located in the center of the mat of scales. Another striking tree flower is that of the horse-chestnut, a commonly planted shade tree. The primordial flowers of this tree are composed of bisexual flowers, each only a quarter of an inch wide when mature. These flowers, which appear in late March or early April, begin to mature in fruit even before the leaf buds burst.
pressed within the same sticky bud as tiny, preformed leaves. By early May, the bud scales unfold and within a week the tree is covered with large white clusters of flowers much relished by bumblebees. This tree, a native of Asia Minor, is not related to our American chestnut.

One of the most highly advanced groups of the flowering plants is that with fused petals, represented among tree flowers by the tubular blossoms of the various ashes, the persimmon, and the catalpa.

Tree flowers are essential, of course, to the perpetuation of the species. The seed—which is the ripened ovule—contains the hereditary traits evolved during the long history of the species, and will give rise to new generations of trees. The tree produce we eat—apples, pears, peaches, and dozens others—are the ripened parts of tree flowers. Another, now neglected, springtime delicacy is the firm amant of the white pine, added to venison stew by the Ojibway Indians.

The basswood tree—from which we obtain sugary sap, bark for rope and pine, and a valued, ivory-white wood also bears flowers with many uses. An epicurean delicacy is the tangy

Moisture and sun are necessary for bud's growth, forcing the outer scales to separate, above, exposing outside of the leaves that frame the flowers.

Scales now pull completely away from contents, above. Expanding compound leaves and the miniature flower cluster have separated and push into the open.
Summer-blooming basswood, above, produces fragrant, cream-colored blossoms that are favorites with bees. Clusters hang beneath elongated, modified leaf, or bract, which unlike serrated true leaves that emerge before the flow-

honey derived from the small yellow flowers. Frederick the Great relish a chocolate-like confection made from the crushed flowers and fruit, as did soldiers of the Confederacy, as well, peoples of Europe, used the aroma flowers as a substitute for tea. The redbud, one of our attractive ornamental trees, bears delicate pink buds and flowers that can be used in salads and pickles, or that can be fried in butter. Over the years, tree blossoms have been used in a variety of recip-

Systematic observations of tree flowering can be an instructive and enjoyable realm of natural history. The dates of bud swelling, flower elongation, pollen shedding, fruit enlargement, and final maturation can be noted over several years. The close pattern of annual coincidence that should be established by such observations will enable the amateur botanist to predict the date of blossoming in his are-

Fused petals are a characteristic of highly advanced plant groups. Tubular blossom of the catalpa, above, appears in late May after leaves are formed.

Huge bloom of magnolia tree, right, foot in diameter, with separated peta
Of Love in Infants

Studies of monkeys show how affection for mothers is formed

By Harry F. Harlow

The use of infant monkeys in many laboratory experiments is now dictated by necessity, but few scientists would deny that it is also markedly convenient. Monkeys are better co-ordinated at birth than human infants; their reactions can be evaluated with confidence at an age—ten days or earlier—that is as that of humans.

The monkeys' well-being and even survival pose a number of problems, especially if they must be reared from their mothers only a few hours after birth. Nonetheless, at the University of Wisconsin's Psychological Laboratory we were able, using techniques developed by Dr. Gerrie van Wagenen of Yale, to rear two groups of monkeys on the bottle with a lower mortality than is found among monkeys reared by their mothers. Now one of the components of the technique involved the use of a wooden head. In the other, the wire framework was covered by a layer of terry cloth. We put eight newborn monkeys in individual cages, each with equal access to a cloth and to a wire mother. Four received their milk from one type of mother, four from the other—the milk being obtained from nursing bottles in the mothers' "breasts."

Physiologically, the two mothers proved to be equivalent—the monkeys in both groups drank as much milk and gained weight at the same rate. But psychologically, the two

theory on this subject is abundant. Psychologists, sociologists, and anthropologists usually hold that the infant's love is learned through the association of the mother's face and body with the alleviation of such physical tensions as hunger and thirst. Psychoanalysts specially emphasize the importance to emotional development of attaining and sucking at the breast. Our experiments suggest something else is involved.

We contrived two substitute "mothers." One was a bare cylinder made of welded wire and surmounted by a wooden head. In the other, the wire framework was covered by a layer of terry cloth. We put eight newborn monkeys in individual cages, each with equal access to a cloth and to a wire mother. Four received their milk from one type of mother, four from the other—the milk being obtained from nursing bottles in the mothers' "breasts."

Physiologically, the two mothers proved to be equivalent—the monkeys in both groups drank as much milk and gained weight at the same rate. But psychologically, the two

Infant monkey, seen clinging to cloth mother, illustrates finding that breast feeding plays small role in infant love, while bodily contact is crucial factor.
Rubbing against toweling, the monkey gives entire attention to cloth mother, ignoring wire mother despite fact that nursing bottle is fixed in its "breast."

Mothers were not at all equivalent. Both groups of monkeys spent far more time climbing over and embracing their cloth mothers than they did their plain wire ones; they even left their electric heating pads to climb on the unheated cloth mother. Those that suckled from the wire mother spent no more time than feeding required.

The theory that infant love is related to satisfaction of hunger or thirst was thus contradicted, and the importance of bodily contact in forming affection underscored. This finding was supported by the next phase of our investigation. The time that monkey infants spent cuddling their surrogate mothers was a strong indication of emotional attachment, but it was perhaps not conclusive. Would they also turn to their inanimate mothers for comfort when they were subjected to emotional stress?

With this question in mind, we exposed our infant monkeys to strange objects likely to frighten them, such as a mechanical teddy bear that moved forward, beating a drum. It was found that, whether the infants had nursed on the wire mother or the cloth one, they overwhelmingly sought comfort in stress from the cloth one. The infant would cling to it, rubbing its body against the toweling. With its fears thus assuaged, it would turn to look at the previously terrifying bear without the slightest sign of alarm. It might even leave the comfort of its substitute mother to approach the object that had frightened it only a minute before.

It is obvious that such behavior is analogous to that of human infants, and we found that the analogy held in situations that less obviously involved stress. If a human child taken to an unfamiliar place, for example, he will usually remain
group of monkeys showed the greatest distress of all.

In a final comparison of cloth and wire mothers, we adopted an experiment originally devised by Robert A. Butler in this laboratory. Butler had found that monkeys enclosed in a dimly lighted box would press a lever to open and reopen a window for hours on end, with no other reward than the chance to look out. The rate of this action depended on what the monkeys saw: a glimpse of another monkey elicited far more activity than that of an empty room.

When we tested our infant monkeys in such a box, we found that those raised with both cloth and wire mothers showed as great an interest in the cloth mother as in another monkey, but responded no more to a wire mother than to an empty room. In this test as in all others, the monkeys that had been fed on a wire mother behaved in the same way as those that had been fed on a cloth-covered mother surrogate.

Thus, all objective tests we have been able to devise indicate that the infant monkey's relationship to its substitute mother is a full one. There are, of course, other factors than bodily contact involved. For example, the simple act of clinging, in itself, seems important: a newborn monkey has difficulty surviving in a bare wire cage unless provided with a cone to which it can cling.

Yet our experiments have clearly shown the importance of the comfort derived from bodily contact in the formation of an infant's love for its mother, and revealed the role of breast-feeding to be negligible or non-existent. They have also established an experimental approach to subtle and dramatic relationships.
Frightened by many strange objects, monkey seeks comfort from its cloth mother, above.

Hugging cloth mother, a baby monkey obtains reassurance from texture of toweling, left.

Confident again, the monkey leaves its mother to investigate new objects around it, below.
IFIED by strange environment, baby monkey is unable to
composure in absence of cloth mother. Wire mother
was of no more comfort than no mother: in fact, the monkeys
that had had only a wire mother were most distressed of all.
During the twelve months I spent in a survey of the human geography of the Middle Zambezi Valley (Natural History, April, 1960) I found it an incredibly beautiful place much of the time. Seated outside a thatched hut on a sunny day, with a fresh breeze blowing off the Zambezi only a few hundred yards away, I even at times considered the Valley an earthly paradise. And so it may be to the European who is not tied to the land. But to the agriculturally inclined African, the area is one of the harshest environments that a man may attempt to farm. Not only is he plagued by the fickle Zambezi and the extremely irregular rainfall, but his crops are also threatened by insects, birds, and mammals, his livestock by predators and sleeping sickness, and his own body by a variety of ailments.

Disease is prevalent throughout the area. Malaria is endemic, along with elephantiasis, bilharzia, leprosy, and the human form of sleeping sickness— although the latter is found only in restricted areas today. At the beginning of the rainy season, with sudden changes in humidity and temperature, many people are struck down with illness and confined to their huts at the very time when sowing the fields is essential. For, if planting is late, wild grasses are already well up, threatening to choke off the germinating food crops unless immediate cultivation is completed. Indeed, causes of crop failure are many, and no harvest is assured until it has been stored safely within village granaries. Even then, termites and rot must be reckoned with.

Part II:

A Zambezi People's Food Quest

In this river culture, game and fish supplement farm produce

By Thayer Scudder
Under such circumstances it is not surprising that harvests in certain areas are insufficient nearly every year. Even, more than ever, people are thrown back on the natural produce of their environment—which is insufficient to support such a large population. The result has been periodic famine. On the other hand, whereas famine is the result of insufficient quantity of food when grain crops fail, the diet of the Valley Tonga appears at least adequate in quality—judging from the general absence of obvious dietary deficiencies and the nature of supplementary food materials utilized. These include other cultivated crops, such as cucurbits, sweet potatoes, beans, and peanuts, and a tremendous variety of animals and uncultivated plants. The abundance of wild produce, in fact, makes the Middle Zambezi Valley a far more suitable habitat for a small population of hunters and gatherers than for an agricultural community, regardless of the latter's size.

If, as we have seen, existing agricultural practices appear reasonably well adapted to local conditions, the same conclusion is even more warranted in regard to fishing and hunting techniques. Many observers who consider...
Still pools such as this, in upper reaches of the Chezia River, were once fished in dry season by means of vegetable poisons infused into water from mixture of macerated leaves and chips of wood. Poison took effect within several hours.

In actual fact, however, the Zambezi flows much too rapidly to be fished by other than highly modern practices, utilizing power-driven boats, and seine and gill nets. If the people are to fish at all, they must concentrate on areas outside the river’s main channel—which is exactly what they do. Women, either alone or in groups of varying size, are often seen dragging fish baskets through shallow backwaters or cut-off pools, both along the margin of the Zambezi and in its tributaries. Sometimes, many baskets will be placed completely across a shallow tributary and a drive organized by the women. Small fingerlings of several species are caught, the baskets being well built for fish of this size that, of course, make up the larger proportion, in weight, of fish in the region. An afternoon spent in such activity will generally guarantee sufficient fish to supplement the daily staple of boiled porridge.

In the proper season, barriers are built across tributary streams. Conical, valved traps are placed at scattered points along their length, their entrances facing upstream or downstream depending on which way the fish are running.
PLAY in newly risen river, unconcerned over the flooding of alluvial field. Premature floods at end of wet or dry seasons are a major cause of famine for Valley Tonga, destroying crops along river before they can be harvested.
Some months later—if the Zambezi rises in April or May, which is the general pattern—its remarkably silt-free waters push slowly up the lower reaches of the now nearly dry tributaries. Then the men spear fish at night. With the aid of torches they obtain those larger species that move in with the flood. Later, when the Zambezi flood waters recede, shallow portions are cut off by man-made dams of sand or mud, built both in the tributaries and along the margin of the main channel of the Zambezi itself.

The women later scoop out the fish thus trapped with their baskets. If the water is too deep for this, they may speed matters up by shoveling it out with their hands, or with dishes, to the rhythm of their singing. In some tributaries, still larger and deeper pools do not dry up before the next rains. Formerly, these were fished out through use of vegetable poisons (Adenium multiformum, Euphorbia ingen, and Acacia albida, to mention three). The proper mixture of macerated leaves and chips of wood from several species was said to be effective within several hours.

Special fish baskets are even made for use in the swift Zambezi itself. Sizable affairs, these are staked out—in narrow channels permeating mudflats above the water level—just before the Zambezi begins to rise in its primary channel after the onset of the rains. As the water rises, fish swimming through these channels are trapped. The baskets are relocated only after the rising water spreads on either side. Tangle nets—constructed along the lines of a butterfly net but up to six feet long—may also be set in the main channel to catch sizable fish (one to four pounds) that swim close to the shore. These indigenous nets are fastened to a hoop that is attached, in turn, to a long pole secured to the river bank. Smaller nets of this type are also used as scoops by the Valley Tonga fishermen.

While still other techniques of fishing are known, it should already be clear that the Valley Tonga are well aware of fish as a natural resource within their environment. They obtain fish whenever possible, through techniques adapted to meet specific conditions. Of the different genera collected in the Zambezi by myself and others, (and identified by Government fisheries experts), the Valley Tonga had names for every genus except one (and that found almost exclusively in swifter Zambezi waters). In some cases (D. mossambicus, for example) names are even given species. In other cases, several species are lumped within one category (example: Clarias sp.). Lack of a name, however, does not necessarily indicate that forms in a given category are not distinguished. In several cases, Valley Tonga observers pointed out morphological differences downstream or up, depending on which way fish are running and are used chiefly to catch fingerlings, not larger fish.
MINING THEIR CATCH, women lift baskets out of water. Fishing has an important role in the life of Valley Tonga, whose language is rich in terms to designate various fish: all genera that are caught have names, as do many species.

Practically every day, someone in a Valley Tonga family brings in some source of animal protein to add to the pot. While fish provided a major source in 1956, frogs and lizards, birds, rodents, and larger mammals also played an important role, as did those domestic animals that either died or were slaughtered for social or ritual purposes. Regardless of the time of year, some such source of animal protein is available. During the height of the rainy season, small boys frequently return after a day of herding with a string of large frogs. The end of the rains anticipates the beginning of the rodent season—during which women and children may spend an hour or so each day digging small rodents (such as Succostomys sp.) out of the ground. A species of larger termite, caught some years in tremendous numbers at the start of the rains, is fried and eaten. Although primarily considered a delicacy, these insects also play their seasonal role in expanding the protein diet.

While fishing techniques, as we have seen, are adapted to various water conditions rather than to the various species of fish, hunting techniques are ingeniously adapted to the habits of the animals involved. Although variations were to be expected to suit different mammals, I was interested to find noose-snares also set specifically for different kinds of birds—such as sandpipers, drongos, green pigeons, doves, rollers, and even small raptors. Indeed, the proliferation of hunting and trapping techniques for all sorts of game was quite amazing. A spring-pole snare would be changed in specific details depending on whether the hunter was after a jackal, a mongoose, or a duiker. This sort of variation is, of course, in addition to the trap being

for unknown reasons, did not warrant terminological distinction between the fish species concerned.

When the Valley Tonga are resettled and the Kariba, or Zambezi, fills up, Government hopes that many villages will go to fishing, developing the type of small-scale industry exists elsewhere in Central Africa. Full-time specialization, with boats and nets could allow entire villages to support themselves on the basis of fishing. This is especially important in areas where population increase will soon outstrip agricultural production. Although major changes in social organization must accompany any conversion of fishing from a respected part-time activity to a full-time occupation, there is little reason to believe that the Valley Tonga, with patient instruction, will not be able to make this transition. In 1956-57 a number of Valley Tonga already owned gill nets, some of which were used on a full-time basis when the Zambezi flood backed up into the lower reaches of certain major tributaries.
situated where the particular beast was most likely to pass. In the case of jackals, for example, a hollow log would slip down the snare rope after the trigger mechanism was released, to prevent the captured animal from gnawing away the fiber rope ensnaring its foot. Bait for a mongoose, in contrast, would be placed in the bottom of a small, open pit, so that the animal would have to thrust his head through the noose to retrieve it.

A generation ago, big game hunting was considerably more important than today. A larger human population, with many more guns than in the past, has driven much of the remaining game back into isolated areas. In the interests of conservation, game laws at present are rigorously enforced and many indigenous hunting techniques have become illegal. No longer are hippopotami in the Zambezi harpooned from dugouts, or elephants speared from trees with poisoned blades. Although pits are still dug to trap these same animals, and snares set for eland and other large antelope, these techniques, too, are rapidly dying out, along with the ritual that accompanied them. Hunting shrines still exist, but in many cases the owner only digs a token pit or sets a token snare to appease the ancestors from whom his techniques were inherited.

Like fishing and hunting, gathering also plays a role in the food economy far more important than the actual quantity of produce collected in this manner might indicate. Different types of vegetation are associated with different soils and water conditions so that, within walking distance of any village, there are several vegetation complexes, each with its distinctive species. The people have an intimate knowledge of many of these plants—used for ritual and curative purposes, as well as for food. Throughout the year, fruits of one kind or another are available, and the Valley Tonga select certain types for consumption depending on the season. Nutritional analyses by W. R. Carr, of the Federation Ministry of Health, would seem to indicate that the fruits most important in the food economy are those with the highest ascorbic acid—Vitamin C—concentrations (baobab, *Adansonia digitata* for example).

Other wild food plants—such as grasses, tubers, and leaf spinaches—may also be critically important sources of vitamins and minerals otherwise absent in the diet. Unfortunately, few nutritional analyses of these wild food plants have been made and many more data are needed. The fact remains, however, that the Valley Tonga are acutely aware of the plant resources of their environment and the women spend considerable time throughout the year collecting and preparing certain plants as they come into season.

When the Kariba Dam was completed in December, 1958, over 40,000 Valley Tonga already had been resettled. By 1962, when the new lake will be stabilized within its basin, slightly over 50,000 people will have been moved. Although all the major resettlement areas are located within the Middle Zambezi Valley, the environment of these areas differs in many respects from that of the Valley Tonga’s former villages along the Zambezi and the lower reaches of its tributaries. Because of the close relationship between environment and Valley Tonga culture, these differences will stimulate changes within the subsistence economy and social system of the people. Changes in the size of individual settlements have already occurred, since soils in the resettlement areas cannot support population densities equivalent to those of the fertile alluvia.

Other changes are inevitable. In the immediate future, the Valley Tonga will have to reorient themselves to a situation where dry season crops are no longer possible and where new soil and rainfall conditions will not permit the same agricultural practices. Because rain shrines and ritual leaders are tied to certain areas (katongo), which will soon be inundated, many aspects of the religious system must undergo change if this system is not to be permanently...
kened through resettlement. The new homes of the Val-Tonga have long been settled by other Tonga, whose culture differs in many respects from that of the resettled people. It remains to be seen whether or not the ritual and political leaders of the Valley Tonga will be able to transfer their authority to the resettlement areas.

R. Colson and I plan to return periodically to the resettlement areas to observe whatever changes occur in Valley Tonga society, and correlate these changes with conditions in the resettled peoples' physical and social environment. Our first restudy is planned for 1962. At that time, we will be able to observe the extent to which the people have adapted their subsistence economy to their new environment, and the effect to date that the social system of the indigenous Tonga has had on Valley Tonga society. We will also be able to check the validity of predictions we have made concerning specific changes, and to formulate new predictions for the future. Because of the size of the population involved, we have an unparalleled opportunity to carry on through time a study that could have considerable theoretical importance concerning the processes of social change in underdeveloped areas, although it remains to be seen whether or not our eventual conclusions will be applicable to other societies that must be shifted from one location to another.
Two of America's first satellites, Explorer I and III (launched on January 31 and March 26, 1958), may have looked tiny in comparison with their Russian counterparts, but they were destined to bring about a complete revolution in our understanding of the earth's upper atmosphere.

Explorer I carried aloft a simple Geiger counter, for the purpose of observing cosmic rays, and some broadcasting apparatus to send these observations back to earth. The experiment had been devised by Dr. James A. Van Allen and his collaborators, at the State University of Iowa. It may be recalled that the satellite had an elongated and very eccentric orbit. Whenever it passed close to the earth, its Geiger counter readings proved to be in good agreement with values obtained from earlier rocket soundings.

But when it traveled to the far reaches of its orbit, the results were at complete variance with anticipations.

Suspecting a malfunction of the equipment, Dr. Van Allen and his group repeated the experiment with Explorer III (Explorer II had failed to orbit). The new results were no less remarkable. At high altitudes, the radiation counts were so high that the counter jammed, in spite of the fact that it had been built to withstand as much as a thousand times the counting rate expected from cosmic rays alone. There could be no doubt that a region of extremely high radiation had been discovered in the outer regions of the earth's atmosphere. Immediate plans were made to keep the region under observation by means of more refined equipment. Radiation counters were included in all later U. S. satellites and in the lunar probes (Pioneers).

As the gigantic jigsaw puzzle of observations was gradually fitted together, a clearer picture of the phenomenon began to unfold.

It was found that this intense radiation is mainly concentrated in two belts (illustration, above). The inner belt lies mostly above the equatorial and tropical regions of the earth. Its maximum intensity occurs at about 2,000 miles from the earth's surface. The outer belt envelopes both the inner belt and most of the earth, but curves in toward the earth's surface just short of the poles. The peak intensity of the outer belt above the Equator is found at about 10,000 miles, beyond which it decreases gradually. The entire region of radiation seems to extend to about 60,000 miles.
Van Allen belts of radiation around the earth are diagrammed, schematically, here. Inner belt blankets the tropical regions; outer one leaves gap at poles.

The Van Allen belts are composed of tronically charged particles trapped by the earth's magnetic field. This fact explains the characteristic shape of the belts, which follows closely the sym of the magnetic lines of force. The nature of these charged particles is difficult to determine at the present time, and is still the object of much theoretical speculation. It is believed that the outer belt is constituted almost entirely of free electrons. The intensity of the radiation within that belt fluctuates widely and seems to be affected by the occurrence of solar flares (sudden disturbances on the surface of the sun). This would indicate that the particles in the outer belt are of solar origin. The inner belt, on the other hand, seems to contain protons (hydrogen nuclei) as well as electrons. It is much more stable than the other.
and has not shown any appreciable change in the two years that it has been under observation. There is evidence to support the current theory that the particles in the inner belt originate from the radioactive decay of terrestrial neutrons.

THE SKY IN MAY

From the Almanac:

First Quarter: May 3, 3:01 p.m., EST
Full Moon: May 11, 12:43 a.m., EST
Last Quarter: May 17, 2:55 p.m., EST
New Moon: May 25, 7:27 a.m., EST

For the vis.

Mars, Jupiter, and Saturn will be the planets most favorably located for observation in the month of May. Mercury will be too close to the sun in the early part of the month. It will be in superior conjunction on May 17, and will enter the evening sky on that date. Toward the end of May, it will set an hour and a quarter after sunset, and may be found very low in the northwestern sky on May 31. Its magnitude on that date will be -0.8.

Venus (magnitude -3.3) will rise less than thirty minutes before sunrise during all of May. Observations will be difficult because of the planet’s closeness to the sun.

Mars (magnitude +1.2), in the constellation Pisces, will rise in the east at approximately 3:00 a.m., local standard time, on May 1, 2:30 a.m. on May 15, and 2:00 a.m. on May 31. It will be in the southeastern sky at sunrise.

Jupiter (magnitude -2.1), in Sagittarius, will rise at 11:00 p.m., local standard time, on May 1, 10:00 p.m. on May 15, and 9:45 p.m. on May 31. It will rise in the southeast and will be west of the meridian by dawn.

Saturn (magnitude +0.6), in Sagittarius, will be found east of Jupiter, rising at midnight, local standard time, on May 1, 11:00 p.m. on May 15, and 9:45 p.m. on May 31.

The Eta Aquarid meteor shower will reach its peak on May 4-5, with a probable maximum rate of twenty meteors per hour. The moon, a day past first quarter on that date, will have set before this shower’s radiant rises. Look southeast between 2:00 a.m. and 4:00 a.m. Some meteors belonging to this shower may be seen from May 1 to 10.

For binoculars and small telescopes:

Although they are visible to the naked eye, the following objects, appearing in the evening sky in May (see map), are seen to better advantage with a small instrument.

Praesepe, also called the “Beehive,” is located in the constellation Cancer. It is a loose aggregate of stars, known as an open, or galactic cluster. All the stars composing it share the same motion in space. Because of its large angular extent, it is seen best at low power.

The Great Cluster, in the constellation Hercules, provides a striking contrast with Praesepe. This is a globular cluster, containing many thousands of bright stars, densely packed into a spherical shape. Some estimates place the total number of stars within the Hercules cluster at well over a million. A six-inch telescope should reveal individual stars in the center of the cluster.

The former Astronomy Editor for Nature Magazine, Mrs. Gossner, continues in that role for Natural History.
The First Hawaiians
The earliest origin of the Polynesian explorers who sailed through the South Pacific and eventually reached the Hawaiian Islands is a mystery that may never be fully solved. However, from bits of evidence gathered through the years, some intelligent speculations can be voiced concerning those early Pacific pioneers.

The race of people we know as the Polynesians probably migrated, in the course of centuries, from the Asian mainland (from as far as India? Almost certainly from as far as Southeast Asia) toward the archipelago of Indonesia. Pushed on—perhaps by the pressure of warring tribes behind them or by their own restlessness—they eventually became acquainted with the hundreds of islands, large and small, that constitute Indonesia.

It is likely that these proto-Polynesians first learned seamanship in this archipelago’s relatively safe and narrow channels, gradually changing from land-dwellers to a race of sailors. In more and more daring ventures, they sailed eastward, entering the open sea, hoping to find islands somewhere over the horizon. From the first of these groups—the islands of Melanesia—the pioneers sailed east into the far vaster, watery triangle, the islands of which make up today’s Polynesia. The experience of each new generation helped to perfect the great ocean-going canoes and added bits of information to the seafarers’ lore about stars, currents, winds, and seasons.

Through the study of basic vocabulary it has been determined that the ultimate source of the Polynesian language can be traced to prehistoric Indonesia. As the Polynesians moved eastward, these Indonesian words—farther and farther from their source—became worn down to simpler forms. By studying the amount of change in the Polynesian language and estimating the length of time required for such changes to take place, Dr. S. H. Elbert of the University of Hawaii has estimated that by at least 1500 B.C. the western border of Polynesia was occupied. Using the same measure, it is estimated that Tahiti was occupied by Polynesians by 550 B.C. From Tahiti, the restless ones moved on to Hawaii. Recent radiocarbon tests from the earliest known camp sites in Hawaii indicate that these islands—some 2,200 sea miles from the Societies—were being occupied by A.D. 500. The twin-hulled voyaging canoes, which brought the first Polynesians northward from Tahiti, were probably similar to the great canoes that Captain Cook saw in use, 1,300 years later, in Hawaii (see illustration, top of page 41).

Kona Coast of Hawaii and the gentle slope of Mauna Loa, viewed across Kealakekua Bay in the illustration at left, formed background for death scene of Captain James Cook.
These canoes varied greatly in size. One measured by Cook's expedition was seventy feet long, twelve feet broad, and nearly three and one-half feet deep. There are reports of canoes over one hundred feet in length, which could carry up to one hundred forty men.

The twin hulls of the canoes were fastened together by several stout booms. The underbody of each hull was made from one piece of wood and the other parts were carefully fitted, lashed, and calked. A platform was lashed to the top of the booms between the hulls. Passengers and cargo were carried on this platform, three or four feet above the water. The hulls themselves were reserved for paddlers. During bad weather, mat coverings were placed over the hulls to avoid swamping. Koa wood was the material most commonly used for canoe construction, although drifting trunks of Oregon pine, carried by the prevailing currents, were highly prized whenever they were discovered.

The canoes were propelled both by paddlers and by a single triangular sail, made of matting, which was rigged from a mast set on the platform. A helmsman steered from a position aft on the platform. Canoes were given names, as were the large steering paddles. There was usually little ornamentation on the canoes, although a statue of a god might be carried at the stern.

When the first pioneers' canoes touched shore in the Hawaiian Islands, the voyagers saw little to encourage them. Untouched by human beings and thousands of miles from any other land, many plant species had evolved from a small, initial endowment of plant families. The same held true of the native fauna—birds, insects, and land snails. Hawaii was a bleak place for human habitation.

The Polynesians, however, brought to the islands an impressive number of plants that they had found useful in their old homes: ginger, several varieties of yam—gourd, taro, ti, banana plants, bamboo, hibiscus, mountain apple, sweet potato, breadfruit, sugar cane, the coconut, turmeric, and several kinds of mulberries. They also brought four kinds of animals to their new home as well—the pig, dog, chicken and, as stowaways, the rat.

All these new plants were strong competitors for space with the indigenous plant life that had developed in relative isolation. They spread quickly, sometimes almost eliminating the native flora. As a result, native birds, insects, and land snails also suffered both from the gradual decrease of familiar flora and from the introduction of the hardier strains the voyagers brought with them. Many of the new plants needed no special care. The staple food plants, however, had to be carefully cultivated. Chief among these was taro, a large-leaved plant that grows to a height of eighteen to twenty-four inches. The root of this plant, pounded to a paste, produced their poi—the gray, starchy food that is still popular in Hawaii. Farmers tilled with a simple, crude instrument. For breaking and cultivating the earth they used long, sharp-pointed sticks of hard wood. Terraced patches were usually located near streams so that the fields could be kept under water, in much the same manner as rice fields. Sweet potatoes were another impo
FISHING at sea required considerable equipment: lines (made from twisted fiber of olona bark), hooks of many sizes and types, stone weights and ropes, and nets. Various sorts of nets were used. Net twine also came from olona bark and the nets were woven with the aid of a large netting needle. For certain types, floats were required—often small pieces of wood from the hau tree. The Hawaiians used scoop nets of varying sizes, similar in appearance to those used by trout fishermen today, as well as rectangular dip nets and funnel-shaped ones. Still another method of fishing involved the use of traps. Small, flat traps were used in freshwater streams to catch small fish and shrimp. Larger traps—some funnel-shaped, some cylindrical—were used at sea.

The Hawaiians designated special gods for fishing just as they had gods for other occupations. The principal fishing god was Kuula, a great fisherman of the past. His shrines were heaps of stones by the edge of the water: men going off to sea would contribute a stone to the shrine. Returning from a successful expedition, fishermen would make Kuula an offering of a fish.

areas, beyond the range of vision, he discovered the best fishing grounds by experimenting with different types of bait and hooks. Live bait was used on the open sea, especially to catch large fish such as bonito. It was thrown into the water as chum, as well as fixed to hooks. Ground bait—strips of fish, cut and pounded—was used both on hooks and thrown into the water to attract fish. Still another bait was made from the ink sacs of squid or octopus, cooked and worked into a paste. The great competition among fishermen meant that the locations of choice fishing grounds—known from cross-bearings previously established on landmarks ashore—were kept as secret as possible.

eat and milk as food. Coconut makes best growth near salt water, and is thus a plant of shore line and coastal plain.
Housing for the Hawaiians was not a critical problem because of the relative uniformity of temperature the year round. Caves were sometimes used as such by the Hawaiians, but more often they were refuges for children and old people when warring tribes presented danger. They were also the common place of burial for chiefs, and sometimes served as storehouses.

The dwellings that the Hawaiians built were always rectangular in shape. The home of a chief might be from forty to seventy feet in length, while the shelter of lower classes was small hovels, sufficient only to protect them against rain. The general pattern for house construction started with the builder hiking into the mountains to seek suitable trees to serve as house poles. When the timbers had been cut, they were carried to the building site and set upright in the ground, usually three or four feet apart. Grooves were cut at the ends of the posts and poles lashed horizontally into place. Higher posts were centered at either narrow end of a rectangle and on these was placed the ridgepole to form the framework of small poles and sticks was then lashed to the sides and roof. After that began the tedious work of tying leaves or grass to the framework: A variety of plant material was suitable for this purpose and usually local availability dictated what would be used, pandanus leaves, pili grass, ti leaves, sugar cane leaves, or cocoanut fronds. The earth floor of the new house might be covered with grass—over which mats were thrown with small pebbles or fragments of lava. The latter seem to have been less hospitable to vermin.

The home-building tools of the Hawaiians were few and simple. They included, first, the all-important adz, used both to fell the trees in the forest and to groove the posts. Stone rasps were also in the carpenter's kit, as were crude pump-drills. Post holes were dug with the same sort of pointed stick the farmers used.

When a house of any size was completed, a kahuna, as a Polynesian priest was titled—was called to say a prayer at the entrance. Sometimes a ceremony occurred in which the grass that hung down over the door was cut away. On occasion, the kahuna would stay for a night in the house as a safeguard against evil spirits that might try to take up residence.

Clothing needs of the Hawaiians were as simple as their need for shelter. The common apparel for men consisted only of the malo, or loincloth. The women's costume was a skirt, called a pa'u. Both were of bark cloth, a tree bark product. Tapa-making was usually women's work and these steps were required to produce the bark cloth. First, of course, the bark had to be stripped from its tree. A number of trees proved usable bark, but that of the paper mulberry, a plant carried to Hawaii by the early immigrants, seemed the best.

The bark was soaked in sea water and its outer layer removed. Then these prepared sheets were overlaid on another, so that they formed large pieces. These were beaten firmly until they matted together, and resulting large pieces were then put in the sun to dry. After this, the second stage of manufacture began. Sheets were beaten once more, this time with short, square, wooden clubs, Designs, carved in the face of these beaters produced patterns on the cloth. Finally, a number of dyes were used to make decorative designs on the surfaces of the finished tapa sheets.
Twin-hulled voyaging canoes, similar to but larger than Those above, brought pioneer Polynesians to the Hawaiian group from Society Islands. Cargo platform, supported by booms between hulls, carried mast, freight, and a helmsman.

Javan men, clad in simple loincloths, prepare offering food for Captain James Cook and accompanying officers.

Typical rectangular dwelling occupies background; visible at right are banana and taro plants, and the coconut palm.
The Hawaiians' brief apparel was satisfactory in coastal areas, where the majority of the population lived, but it was not enough in the colder and wetter mountain regions. There, additional protection was needed and the garment favored was some sort of cape, a fabric arrangement to which leaves were tied to keep out rain and provide warmth. Undoubtedly the most colorful of Hawaiian apparel were the feather cloaks and helmets that became famous from the time of Captain Cook's visit (illustration, page 40). Such costumes were a designation of social rank in Hawaii, reserved to the chiefs. In all the Pacific, feather capes appear to have developed only within Polynesia and, even in this area, they are found only in New Zealand, Tahiti, and Hawaii. The making of such a garment—a task reserved for men—was a tedious process. Feathers were gathered from five different sorts of birds; the feathers were small and many birds carried only a few feathers of the desired color. It is little wonder that the task was undertaken by professional bird-hunters.

In the early era of Hawaiian settlement, red feathers were the most sought after, probably because red was the traditional color of high chiefs and gods throughout Polynesia. Later, yellow feathers often dominated the garments. Whatever their color, the feathers were secured to a coarse fabric base with the ubiquitous olona fibers and tied so closely together that the resulting surface had the appearance and even the texture of velvet.

Helmets covered with feathers were the natural complement to feather cloaks. These were of many types; some bore elaborate, extended crests; others, of simple design, had a single, broad ridge running from front to back. The early Hawaiians' only other item of winter garb was the sandal, occasionally used when walking across lava or coral. Sandals were simple arrangements—soles woven of any tough fiber, secured by fiber straps which were tied about the ankles.

Early Hawaiians continued in the general pattern of religious worship that had been brought from southern Polynesia. There were many gods, each usually symbolized by a figure of wood or stone. A god's assurance was gained by reciting prayers and accompanying the prayers with offerings. The symbolic figure gained its power only through such means, and not because of any craftsmanship that had gone into its actual carving. As a result, the figures were often crude and, in some cases, were actually uncared pieces of wood or stone. The pioneers brought four major gods with them from the South Pacific: Ku, Kane, Lono, and Kamehameha. They were worshiped by chiefs and commoners alike. In addition to the major four, innumerable special gods were worshiped by persons engaged in different occupations—for example, Kuila, the previously mentioned king of all the Islands. This highway, passing over lava flows and across ravines, was used by the royal messengers.
ONE WALLS in the shallow waters of lee shores created ponds, regularly stocked with small fish. Such ponds and waters inside the reefs were fished by the women and boys; men, using variety of hooks and nets, fished the open sea.

Temple's deity, Farmers, bird-catchers, hula dancers, a-makers, even thieves and robbers had their own special gods. Still other gods were deified ancestors. Iiefs could be deified immediately after their death, the process of cleaning and preserving their bones.

Temples, called heiaus, were important in religious ceremonies. They generally consisted of a raised platform, a heiau. Atop the platform might be a stone or wooden fence and several small shelters designed for various religious functions. An "oracle tower"—a high framework, made of poles—was often an important part of the heiau. The temple's god was thought to communicate with priests who climbed atop such towers. The heiaus were not constantly in use. Between ceremonies, they were neglected. For routine religious purposes, a variety of shrines—built along roadways, in houses or any other convenient place—were available.

Special occasions, however, a chief might decide to conduct ceremonies in a heiau, and these might last for days. The ceremonies, which could include the offering of human sacrifices, were deemed to provide a chief guidance in making decisions affecting his people.

PORTS in primitive Hawaii included swimming, surfing, foot-racing, boxing, and wrestling. Among children's games were walking on stilts and flying wooden-framed kites, covered with tapa cloth or pandanus leaf. Children also played with a kind of spinning top, knew a form of jackstones, and enjoyed whistles and rattles.

The Hawaiians came by swimming and surfing naturally. Both body-surfing and board-surfing were popular. The boards were of two general sizes: the shorter, six to nine feet in length, and the longer approximately fifteen feet. These longer boards could weigh as much as one hundred and fifty pounds. Surfers would lie flat on their boards and paddle offshore to where the long, ocean rollers began to break. Selecting a suitable wave, each surfer would match its speed shoreward and then ride the crest toward the beach; skilled riders could sit, kneel, or stand on their boards as they raced with the wave toward land.

Another sport involved sledding down steep hillsides. A smooth, sloping runway was constructed and covered with grass. Some participants used only a cluster of ti leaves as sleds, but chiefs had special sleds that were equipped with wooden runners.

Adult games were often simple in nature. One guessing game, called no'a, pitted two teams of five against each other in trying to guess under which of several piles of tapa the opposing team had hidden the no'a, or stone. Games of skill, such as throwing spears at a mark or rolling disks in competitions for accuracy or distance, were popular. One such game of skill involved a stick with a loop at one end and a ball attached to the
Canyon trenching by Waimea River on Kauai Island shows in horizontal lines of rugged walls the innumerable flows of lava—continuing today on Island of Hawaii—that slowly built up archipelago from floor of deep P...
A mouthpiece was made from a small piece of lumber or a larger piece of vardi or ler. A small, pear-shaped gourd was selected. Air was blown through a nose hole, and the number of finger holes usually made in such whistles was three.

Shell trumpets served a practical purpose; the sound from these instruments would carry for as much as two miles. The usual types were made from the conch (or ton) shell and the Cassis shell, with a hole drilled about the third whorl to serve as a mouthpiece. The Hawaiians devised a number of drums, usually made of hollowed coconut logs with drumheads of sharkskin. A short drum was used for the hula, and a taller one for religious ceremonies. A type of knee drum was similarly constructed and tied just above the knee so that the player could beat it with one hand while ticking a larger drum with the other. Drums were also made by combining a large gourd, with the top off, and a small gourd, inverted and glued into a circular hole. Such gourd drums are still used in hula. Lengths of bamboo, open at one end, were tied to sound by pouring them on stones in time with the music. Other instruments included bamboo drums, about twenty inches long, split for most of their length into thin sections, small stones—used castanets—and rattles that were fashioned from gourds, bamboo, and coconut shells.

Death and burial in early Hawaii involved special ceremonies. The relatives and friends of the dead would show their sorrow by cutting their hair in some peculiar way, or by more permanently disfiguring their bodies. Such ceremonial disfigurements might include picking out a tooth, tattooing the tongue or burning a face or arm to produce a scar. When a person died, a kapu, or “keep out” sign, was placed on his house and was not removed until the corpse had been exposed. Any person who broke this kapu had to undergo ceremonial cleansing.

Bodies were wrapped in successive sheets of tapa, a linen, inner sheet and one or more thicker ones. Sometimes an additional wrapping of mat was added. On occasion, corpses were burned and the surviving bones lined and kept. Relatives might divide the bones among them and then eventually place them together in a resting place. Bodies that were kept intact were buried, either stretched full length or with the knees pulled toward the chest. The latter style of burial seems to have been usual with commoners. Burial could occur at any number of sites. Chiefs were usually buried, secretly, in caves. Commoners were most often buried in sand.
hills. Other burial sites included stone cists or platforms built slightly off the ground.

Gradually, the idea of preserving only the skull and leg bones of chiefs seems to have evolved. After Captain Cook was killed, the Hawaiians treated his body in this way and these few remains were eventually returned to the British sailors. In death, Cook therefore was honored as a chief in the traditional Hawaiian way.

In first discovering the Hawaiian Islands for the Western world in 1778, Cook had stumbled upon a population of some 300,000, participating in a highly organized, feudal society that knew nothing of the existence of metals or a written language. This society was never the same again. Following discovery, the islands became popular ports of call for whalers and traders on long Pacific voyages. Soon, European settlers came and the Neolithic civilization of Hawaii was catapulted into the eighteenth century. Old methods and old mores, followed from the beginning of time, were shattered by new techniques and principles. When King Kamehameha I died, in 1819, the society’s last prop was pulled out. The old gods and the traditional religious system fell before the enthusiastic teachings of the first New England missionaries.

Those who held to the old ways were no match for the newcomers. For generations, the Hawaiians had known only a non-competitive, communal life. The sudden transition was too great: the Hawaiians became, in a real sense, strangers in a land they had occupied for some thirteen hundred years. Not only were the old standards shattered but, by 1872, the Hawaiian population had dropped to less than 60,000 persons—a decline brought about partially by a low birth rate, but principally by diseases against which the Hawaiians had no immunity. Common Western maladies, such as the flu or measles, wiped out entire families and even whole villages in a few weeks’ time.

As agriculture became increasingly important in the new order of affairs, the bulk of the land passed from the native Hawaiians into the hands of the Western settlers. Field laborers were essential to the plantations: first Portuguese, then Chinese, Koreans, Japanese, and eventually Filipinos were brought to the Islands. Many of the surviving Hawaiians intermarried, particularly with the Western settlers and the Chinese, and began to produce a part-Hawaiian population. Today, the Islands contain only 11,000 or so persons of pure Hawaiian blood and some 75,000 others who can claim part-Hawaiian ancestry.

After one hundred and eighty-two years, the few remaining pure Hawaiians—less than four per cent of the prediscovery population—have not made much progress by the standards of Western society. Those who live in the cities are mainly employed in manual labor. Most are to be found on the less populated islands of the chain. They prefer isolated areas and a simple existence, a taro patch, and fish from the sea satisfying their needs.
many times, although now deserted. Hawaiians, numbering more than a quarter-million at the time of Captain Cook’s visit, have since then been reduced by intermarriage and Western diseases to a small handful of the original stock.
The "Beagle"—a search for a lost ship

Darwin's voyage is immortal. But what did his vessel look like?

By Lois Darling

Honors have been given and fine models made of great sailing ships with well-known names and bellicose histories—the Constitution, the Constellation, the Bon Homme Richard, H.M.S. Victory, even the ugly Monitor. But a small ship, quietly going about her business in the search for human knowledge and understanding—science—was and is considered of little account. Nelson's Victory is kept enshrined by the British Admiralty. H.M.S. Beagle—the survey vessel that sailed the world's oceans during the decade from 1826 to 1836 and bore Charles Darwin on his five-year circumnavigation of the globe—is gone.

My husband and I write and illustrate children's books in the field of natural history. Occasionally we give talks at the Connecticut schools near where we live. Some time ago, so that we might illustrate more vividly the epic venture of Darwin's voyage on the Beagle, I bought a perfect model of the American whaleship Charles W. Morgan. Assembled, she is four inches long. Explaining to audiences that the Beagle was somewhat like this ship, we voyage with Darwin and the Morgan-Beagle. With perfect sails set, we head for Brazil, and then south along the coast of Argentina. We trail imaginary nets astern, catch plankton; we see the water's phosphorescent glow.

In port, we leave the Beagle and board a horse. We Darwin and the Gauchos gallop the pampas. We catch “ostriches” (rheas) with a bolas. We note that Darwin learned to handle the bolas the hard way—by entangling his own horse's hind legs while the Gauchos laughed.
ENAMIST'S POSITION is seen, below, on model of Beagle as it by the author on the basis of the research recounted in her article. Scale of model is three thirty-seconds of an inch to one foot; thus, the hull length is nine inches.
Back aboard the Beagle once more, we head toward Cape Horn. Buffeted by high winds and great seas, we sail the forbidding Fuegian coast and explore its dark forests and high mountains. Then we send free into the Pacific. In Chile, we experience an earthquake and see land newly risen from the sea. We find fossil sea shells high in the Andes; study Galápagos lizards, tortoises, and finches; visit South Sea islands and speculate upon the causes of coral atolls. We attempt to share with the children Darwin's delight in all he found and saw. With the help of the Mor-

gan-Beagle, we try to make his great adventure come alive.

But what was H.M.S. Beagle really like? In his account of the voyage, Darwin scarcely mentions the ship. Although he did describe the Beagle, and her officers, in letters to family, there is nothing very concrete in these descriptions—only bits and snatches, here and there. For example, September 19, 1831, on first seeing the ship, he wrote to his cousin W. D. Fox: "My objection to the vessel is its looks, which cramps one so for room for packing my body and all my cases. . . . As to its safety, I hope the Admiralty are the best judges; to a landsman's eye it looks very small. She is a ten-gun three-masted brig, I believe, an excellent vessel."

So the puzzle starts. For, if a brig has three masts, is not a brig! Brisas have but two masts, with square sails on each. Darwin should have known what he was to embark in, however much a "landsman." Yet he was calling the Beagle a brig when his account of the voyage was first published in 1839.

For years I have come upon the same old print—published in books and newspapers—which I have found to be an authentic portrait of the Beagle, done by one of the artists aboard during her celebrated voyages. This shows her with three masts, right enough; therefore, technically, not a brig. If all three masts had carried square sails, H.M.S. Beagle would have been a true ship, in the technical sense of the word. But the third mast shows fore-and-aft sails only. The Beagle, then, was a bark, not a brig. Did Darwin persist in calling a brig a vessel that was obviously rigged as a bark?

My curiosity slowly began to take the form of an idea. I decided to make an authentic model to replace our jaded

Pritchett's drawing of the Beagle has long been thought authentic. Actually, sketch includes a number of mis-

Crossing the line in 1832, ship's artist Earle recorded this scene of traditional merrymaking on board the Beagle.

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gan-Beagle. There would doubtless be plans, authentic drawings, or a fine model of the Beagle somewhere. I would go to the British Admiralty.

A tiny note, written in a spidery hand, came in prompt reply to my letter:

Dear Madam. In reply to your letter of the fourteenth about H.M. Ship 'Beagle,' I write to say that such plans and drawings of H.M. Ships of that period as now exist are deposited in the National Maritime Museum.

I am, you write the Director, National Maritime Museum, Ennich, London, S.E. 10, he will inform you as to the extent to which your requirements can be satisfied.

Yours faithfully, Deputy Librarian."

Wrote with the Deputy Librarian suggested, here are some extracts from the reply:

With regard to the 'Beagle,' we have the Admiralty plans for the class of 10 gun brigs to which the 'Beagle' belonged. These do not show the ship as fitted for Darwin's age, but they give the shape of the hull which was not very altered. Unfortunately no rigging plan exists, although the 'Beagle' was a brig, a small third mast was fitted in order to assist with steering. This was also fitted to the other types of brigs at this time and we have illusions showing the sail plan with the three masts, in her class of brig.

I will send you copies of four of our plans and I think you should be able to get sufficient information to make an accurately accurate model of the 'Beagle.'

A. H. Waite, Deputy Curator of Models and Relics."

Was lucky that my letter had found its way into Mr. Waite's able and co-operative hands. The brig-bark problem, which he cleared up in such short order, was only one of many that he was later able to solve. In due time, photostats of the beautiful old Admiralty drawings arrived (three details are reproduced here). I began to realize that the search for the Beagle was only beginning. Exactly how was she fitted for Darwin's voyage? What changes, other than the addition of a mizzenmast, had been made? The true Beagle was becoming a mystery. If I were to find out how she really looked, I would have to do my own research.

One of Loren Eisle's splendid articles in Scientific American contains two sketches by P. G. King, showing details of the Beagle. But exactly who was King? Had he
Mrs. Darling, a frequent collaborator with her husband in the writing and illustration of books in the field of the natural sciences, is an old salt at heart and onetime U.S. Women's National Sailing Champion. Her model of the Beagle has been displayed at the American Museum.

done other sketches of the Beagle and, if so, when? I would have to find out. Library work was in order.

I first tracked down the Beagle that I had seen so often before (see page 50). The New York Times had printed it: a Life artist had copied his Beagle from it, reversed, in that magazine's memorial series on Darwin. The original print shows a canoe with four Fuegians in the foreground; the impression is that the drawing had been done on the spot by one of the Beagle's own artists.

But such is not the case. The print proved on investigation to be one of many done especially for an illustrated edition of Darwin's Voyage of the Beagle, published by John Murray in 1890. It was used for the frontispiece: opposite it, on the title page, is another view of the Beagle, stern on (see page 54). In his introduction, Murray says: "Most of the views given in this work are from sketches made on the spot by Mr. Pritchett, with Mr. Darwin's book by his side." This statement is ambiguous at best.

Robert Taylor Pritchett (1828-1907) was a well-known illustrator. It is possible that Pritchett could have drawn his "view" (in this case, Mount Sarmiento in Tierra del Fuego) "on the spot." But the Beagle, the subject of his picture, had upped anchor and left "the spot" fifty-six years before, while the artist was only six years old! Had he known that his sketch would become very nearly the defini-

Brig's stern, reproduced, above, from Admiralty plan, is compared with stern-first photograph of the author's model Beagle, at right. Pair of cabin windows are conjectural, taken from Darwin's comment on "remarkably light" quarters.
tive representation of the Beagle, I think Pritchett might have taken more pains. In his drawing, the lovely hull—which the Admiralty drawings show so well—is made gross. The position of the masts is wrong. Waist davits are placed as they were on whalers, while the boat hanging from them is not only an unseaworthy type but too small, scaling only some seventeen feet in length. The boat on the quarter davits is equally unseaworthy and even smaller—about fifteen feet in length.

Nor are these the only faults to be found with this traditional Beagle picture. In his narrative of the voyage, Captain Fitzroy mentions that twenty-five-foot whaleboats hung from the Beagle's quarter davits, while two twenty-eight-foot whaleboats, when not in use, were carried upon skids over the quarter-deck. The Beagle's largest boat, her yawl, was carried amidships. The cutter was nested in it, to save space. There simply were no waist davits.

Again, the gunports and portholes shown in Pritchett's drawing, aside from being out of scale, are not as they are shown in the Admiralty profile of a brig of this class. Although she carried seventy-four persons, the Beagle was a jaunty little ship—scarcely one hundred feet long. Finally, in Pritchett's stern view of the Beagle, lofty royal sails, as well as studding sails, are set. The ship did set studding sails occasionally, as Fitzroy's account attests. But all the evidence suggests that her rig was too reduced to permit the carrying of royalties.

So much, then, for Pritchett's ex post facto study. What about King's sketches? King, I learned, had been a midshipman aboard the Beagle when she set forth on her momentous voyage two days after Christmas in 1831 (December 26 had been spent in sobering-up the seamen). He was the son of Admiral P. Parker King who, as captain, had been in command of the first expedition of Adventure and Beagle, 1826-1830. On the second expedition, young King had accompanied Darwin on many a trip ashore. In one letter, Darwin says, "... he [King] is the most perfect pleasant boy I ever met with, and is my chief companion."

About 1890, when he was close to eighty, King prepared his sketches of the Beagle at the request of Mr. Hallam Murray. These sketches were then used in several editions of the Voyage, without acknowledgment. In a letter of 1897, King says that he had done the sketches from "old drawings and recollections." To what old drawings he referred I do not know. I do know that the old gentleman's sketches from memory check remarkably with the Admiralty drawings. King, incidentally, shows the yawl stowed amidships.

Some later editions of the Voyage either use King's sketches, or elaborate copies of them. In various of these copies, the Beagle's figurehead—drawn obscurely by King in his simple profile, has somehow evolved into an actual representation of the front half of a beagle. I have an etching of "The Wolf, Brig of War," done in 1829. Wolf shows a wolf for a figurehead, so it is not beyond possibility that the Beagle had a beagle. But, as we shall see, this romantic detail is suspect, to say the least.

When the Beagle sailed on her second voyage, Augustus Earle was aboard as ship's artist and draftsman. In a published sketch, he shows Beagle's deck as she crossed the Equator in 1832. Mainly, the scene depicts rollicking sailors (see page 50). But, in the foreground, the main skylight is seen and a cannon points forward along the starboard bulwarks. Here were more welcome details.
In August, 1832, Earle was replaced by C. Martens, who remained as the Beagle’s artist for the next two years. Many of the beautiful steel engravings that illustrate the 1839 Colburn edition of *The Surveying Voyages* are from Martens’ sketches and gentle water colors. Unfortunately, most of Martens’ drawings show the Beagle and her small boats as unimportant parts of the general landscape. A magnifying glass helps a little, but the only detailed drawing that Martens made of the Beagle shows her laid ashore for repairs (see page 51). Here, the bow shows a simple billet head, or scroll, carved under the bowsprit. It seems reasonable that Martens would have copied such an obvious thing as a carved figurehead had it existed. But he saw neither man, maid, beast, nor beagle, rampant or otherwise.

Between visits to various libraries in my search for **Beagle**, I sought help from Gordon Grant, marine artist and model-maker extraordinary. I have known him since I was a child, when his famous painting of **U.S. Constitution** first sailed across my youthful horizon. Grant has sailed on square-riggers. Although now in his eighties and nearly blind, he was no end of help. He loaned me **The Young Sea Officers Sheet Anchor, or a Key to Leading of Rigging, and to Practical Seamanship**, by E. L. Lever (the second edition, published in London in 1884).

Pritchett’s conception of the Beagle under full sail is also a plate from the 1890 edition of Darwin’s *Voyage*. Topmost sail shown on mainmast, the royal, is a product of the artist’s imagination, as are seven gun ports across side.
The Beagle's sail plan, above, derives from Admiralty plan for mizenmast-fitted brig of another class. Other sources of information include sketch made by the mate of the Adventure on the previous voyage.

"Fitz-Roy's character," Darwin writes, "was a singular one, with many noble features, he was devoted to his duty, generous to a fault, bold and determined and indomitably energetic, ..." Obviously his seamanship must have been superb. He suffered from terrible fits of depression and a vicious temper. He was also compassionate and very religious. One of the reasons Fitzroy wanted a naturalist aboard was to help in eventually proving the literal truth of the Bible. In Volume I (January 1830) he gives another reason. "It is a pity that so good an opportunity of ascertaining the nature of rocks and earth of these [Tierra del Fuego] regions should have been lost.

"I could not avoid often thinking of the talent and experience required for such scientific researches, of which we were wholly destitute; and inwardly resolving, that if ever I left England again ... I would endeavor to carry out a person qualified to examine the land; while the officers and myself would attend to hydrography."

Captain (later Vice Admiral) Fitzroy's intense, sensitive temperament shines through his writings. Forming a picture of the Beagle from his words became like piecing together a jigsaw puzzle—but far more engrossing—with the many parts in this case scattered tantalizingly through a lengthy volume. Captain King's earlier expedition, also, could not be neglected. If this account of my search seems now to grow disjointed, that is how I found it, too. The first and second voyages swim together unavoidably.

In Volume II, Captain Fitzroy states: "The Beagle was commissioned [actually, recommissioned] on the 4th of
July, 1831, and was immediately taken into dock to be thoroughly examined, and prepared for a long period of foreign service. As she required a new deck, and a good deal of repair about the upper works, I obtained permission to have the upper-deck raised considerably, (eight inches abaft and twelve inches forward) which afterwards proved to be of the greatest advantage to her as a sea boat, besides adding so materially to the comfort of all on board.

"While in dock," Fitzroy continues, "a sheathing of two inch fir plank was nailed on the vessel's bottom, over which was a coating of felt, and then new copper. This sheathing added about fifteen tons to her displacement, and nearly seven to her actual measurement. Therefore, instead of 235 tons, she might be considered about 242 tons burthen . . . a patent windlass supplied the place of a capstan . . . and the lightning conductors, invented by Mr. Harris, were fixed in all masts, the bowsprit, and even in the flying jib-boom [these were to be tested]. The arrangements made in the fittings, both inside and outside, by the officers of the Dock-yard, left nothing to be desired. Our ropes, sails, and spars, were the best that could be procured; and to complete our excellent outfit, six superior boats (besides a doughty carried astern) were built expressly for us, and so . . . stowed that they could all be carried in any weather.

"Considering the limited disposable space in so very small a ship," Fitzroy adds, "we contrived to carry more instruments and books than one would readily suppose could be stowed away in dry and secure places; and in part of my own cabin twenty-two chronometers essential equipment for surveying voyages were carefully placed."

I learned in my reading that the Beagle carried only six of her normal complement of ten guns; these were long six pounders and long nine pounders of brass. Here are some more notes, taken at random from Fitzroy's narrative. Each offered some clue in my search. "At three in the morning of the 13th [January 1833] . . ." he wrote, "the vessel lurched so deeply, and the main-mast bent and quivered so much, that I reluctantly took in the main-top sail (small as it was when close reefed), leaving set only the storm-trysails (close reefed) and fore-trysails. At ten, there was so continued and heavy a rush of wind, that even the diminutive trysails oppressed the vessel too much, and they were still farther reduced.

"Soon after one," he continued, "the sea had risen to a great height, and I was anxiously watching the successive waves, when three huge rollers approached, whose size and steepness at once told me that our sea-boat, good as she was, would be sorely tried. Having steereage way, the vessel met and rose over the first unharmed, but, of course, her way was checked: the second deepened her way completely, throwing her off the wind; and the third great sea, taking her right a-beam, turned her so far over that all the lee bulwark, from cat-head to the stern davit, was two or three feet under water. For a moment, our position was critical; but, like a cask, she rolled back again, though with some feet of water over the whole deck. Had another sea then struck her, the little ship might have been numbered among the many of her class which have disappeared; but the crisis was past—she shook the sea off her through the ports, and was none the worse—excepting the loss of a lee-quarter boat, which although carried three feet higher than in the former voyage (1826-1830), was dipped under water, and torn away. It was well that our hatchways were thoroughly secured, and that nothing heavy could break adrift.

"Soon after the main-top sail was hoisted again, a little water found its way to the lower deck, though Darwin's collections, in the poop and forecastle cabin-deck, were much injured."

The Beagle's yawl is described. "She was a beautiful boat, twenty-eight feet in length . . . pulled and sailed and was roomy, light, and buoyant . . ." I learned that Beagle's boats " . . . did not hang idly at their davits. Being sometimes gone a month and more, exploring in and rock-strewn channels, Fitzroy tells of one of them being stolen by the Fuegians, of a fruitless search, and how, finally, ship's carpenter Jonathan May and three were set on that wild and lonely shore to build a new boat. This they accomplished in twenty days, I had hoped to see the building of the replacement described. Alas, mundane an affair, I suppose.

The Beagle's many anchors are mentioned and her anchoring losses and problems discussed. " . . . we never had one good anchor out of two broken ones . . ." Fitzroy relates. He had no sooner turned in, one midnight, when the link on an anchor chain parted at the hawse hole, Fitzroy attributed " . . . to the action of frost . . ." Davie mentions losing four anchors within three weeks, leaving only one good bower.

"The bearing compass," Fitzroy notes. "though partly good, and well placed, was of very little use—never trusted in important bearings." This is undoubtedly a compass that King's sketch shows on the quarter deck.

Fitzroy describes the Beagle's call at Otaheite (Tahiti). Anticipating a visit from the Queen of Tahiti, Fitzroy says, "We tried to make such preparations as our little vessel could accomplish. Dressing the ship with flags and saluting with [cannon] we could not, on account of chronometers [jarring them would be serious]."

" . . . the seamen manned the yards, and we all gave Queen three cheers.

"The work necessary for securing the ship being completed, permission was given to admit the natives, and
P. G. King, a midshipman at the time of the voyage, from memory about 1890, above. Fitzroy’s account speaks of the theft of one of the many brass knobs shown. Ratlines will be added to the model’s shrouds at a later date.

Darwin describes the Beagle’s Lieutenant, John C. Wickham as a “glorious fellow.” But, being responsible for the shipshape order of his vessel, Wickham was somewhat reserved. He objected to Darwin’s scientific litter about the decks, spoke of specimens brought aboard as “d-d beastly devilment” and told Darwin, “If I were skipper, I would soon have you and all your d-d mess out of the place.” At the foot of the port ladder to the poop deck, therefore, I have scattered some of Darwin’s “mess”—barrels, tubs, and boxes, with silent apology to Wickham.

The Beagle flew a common commissioning pennant from the top of her mainmast. This bore Saint George’s Cross and a tail of red, white, and blue. Its length would have been almost thirty feet (see illustration, page 59).

As to the ship’s name. I quote Mr. Waite again: “Strangely enough, names of war ships were not shown at all. There was a period in the 1770’s when they were painted in large letters across the stern, but this only lasted for about seven years. In later years, their names were exhibited on the deckhouse aft, but only merchant ships had their names prominently displayed on the transom. . . . It is often shown erroneously in pictures or on models. Rather disappointing, I fear, but there it is.” On Mr. Waite’s advice, therefore, I left the model’s transom nameless.

Recently, I happened upon a plan view of the Beagle’s deck in a Murray 1902 edition of the Voyage I had pre-
I tried to make the model Beagle come alive by paring her after another quotation from Captain Fitzroy: "At midnight," he wrote, after months of exploration in the Strait of Magellan, "we were in the Pacific, and after anxiety about weeks of beating to windward upon allowance of provisions, vanished as quickly as they appeared. The glass falling, with the wind astern in the quarter, foretold unusually bad weather; we then shortened sail by degrees, making all secure. At six, in the morning, it was blowing a gale of wind, with so little sea, that it was necessary to steer right before it—or before to—which with a fair wind was not preferable: accordingly, I found the vessel steered extremely well, under close reef before and main topsails, and double reefed foresail."

This is the canvas the model carries. "Close reefed sails" means that the topsails were reeved as much as possible. The Beagle's topsails carried five rows of reef points; if the final row was used, the sails were reduced to their maximum size. The topsail yards were lowered accordingly. Since the topsails were sheeted to the yards, these did not generally move up and down.

Lower sails commonly had only two rows of reef points; the foresail was thus double reeved "up" to the spanker yard. This raised the sail away from grasping, wind-swept seas. When the weather caused sails to be much reefed, Fitzroy mentions, topgallant masts and yards were frequently on deck. The model shows this. But I left the topgallant mast housed (slid down along the main mast) so that the vessel's pennant streams before the wind.

I did not want to show the Beagle under a cloud of smoke; she was a hard-working, beat-about little brigging her job under almost impossible conditions; in the whole five years Darwin was aboard, she never had a yard overhaul. Her sails must have been worn, patched, mildewed; in any case, I have shown them so.

The fact that the Beagle was such a no-account, six-day brig—one of many in her class—is the reason, I think, that accurate descriptions and pictures of her are so scarce. These "coffin brigs" were frequently lost at sea; not necessarily because of fault in ship or crew, but because so much of them were engaged on a variety of dangerous missions. In the British Navy during those halcyon days, no one thought that there would not always be such brigs at sea, nor that men would not always voyage in this fashion. And yet, no one dreamed that the Beagle would be important enough to be worth depicting exactly until it was too late.
By Julian D. Corrington

Dr. Corrington's column appeared regularly in Nature Magazine for nearly twenty years, and can now be followed in the combined magazines.

By definition, then, the "natural size" of any small object is that that we observe when it is held 250 mm. from the eyes. Most people can still discern the printed page clearly when it is brought to within six inches of the eye, but as the print is carried closer and closer there comes a point at which the letters blur and we can no longer see them distinctly. We behold them enlarged (that is, magnified) but obscured. Try this on your own vision, using a ruler.

According to this interpretation, any view of an object closer than the near point is a magnified one. If you take a piece of black photo mount paper the size of a postcard and puncture it with a pin in the center of the width and one inch from one of the ends, you will have made the world's simplest microscope, the pinhole card. A postcard will do, but still black paper is better. On a second card, paste a photograph cut from a newspaper and examine this illustration through the pinhole card, holding it as close to the eye as possible to enable you to bring the picture up to the pinhole, keeping it a few inches away, and see if you can get it within a few inches of the eye and still note detail clearly. If you can, you have secured a magnification of about ten times, abbreviated in microscope ten times, 10X, a very respectable enlargement.

This is simply the ratio of the near point to the distance of ten inches to the one instance at which you are viewing the Nature. You will also see the half screen, described in our previous installment, and observe that the illustration is no more than a collection of different shades of light and dark, and that you have actually magnified your view of the photograph ten times with only a piece of cardboard. Our first definition of magnification is that it consists in getting the eye closer to the work, so that we can see it clearly at any distance ten times less than the 250 mm. near point.

Seneca, the Roman philosopher, died in A.D. 65, wrote about the circumstances of looking through a tumbler of water at a bowl of apple juice, in his dining table. Most of us have this experience in one form or another, and have observed that the object is magnified and distorted. Had Seneca followed up his observation, he might have discovered that curved surfaces of transparent materials refract or bend rays that pass through them, and that this property of refraction can produce magnified images. He might even have gone on from this to invent spectacles, but Seneca was a philosopher and not an experimental scientist. His tumbler of water was a crude microscope of which we can make a better one by...

This drawing of a mounted human flea shows correct positioning of the insect. Legs are properly bent, each is a small component of the animal, and mouth parts are easily distinguished.
A good fixer does three things: it preserves, hardens, and produces optical differentiation by preparing unlike parts of the subject to take stains and to transmit light in varying degrees. This last is important if contrast of the parts is to be visible when viewed microscopically. Some fixers are mineral acids or their salts, such as mercuric chloride; some are organic acids, as picric; and the rough-and-ready ones are alcohol and formalin, time-honored reagents for gross preservation of whole animals or plants. The washing is usually done under running water, but a few fixers, as picric acid, require washing in alcohol. Dehydration is done with alcohol as a rule, though we shall describe some modern techniques using dioxan or Cello-solve at a later date.

It is important to note that the whole series of steps is one of substitution. We holding black card close to the eye and adjusting the distance of viewed object.

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GLASS PROPS—in this case, thin glass rods drawn out under a flame—are used to replace natural body fluids with a fixer, the fixer with alcohol, the alcohol with xylene, and the xylene with mountant. The microscopist must always remember the correct sequence, based on miscibility (which is merely the technical word for “mixability”). Formalin is miscible with water but not with alcohol; xylene is miscible on the one hand with pure alcohol and on the other with balsam, but not with water. Staining mixtures, to be discussed in later columns, are made up as aqueous or as alcoholic solutions, and are inserted routinely, at appropriate places.

Now, in the case of insect parts we have things that differ from the usual organic material, for the insect wears his skeleton on the outside—it is called the exoskeleton—instead of inside—the endoskeleton—as do vertebrates. The material is also totally different, being chitin instead of cartilage or bone. Chitin is an organic secretion that hardens upon exposure, at the time an insect molts, and sets into a firm but elastic covering that prohibits any further growth until the next molt occurs.

As a rule this exoskeleton is the part that is wanted for slide mounts. It requires fewer steps in the technique, and no staining. On the contrary, because it is usually darkly pigmented, it needs bleaching rather than staining. The soft inside organs may be dispensed with, and are destroyed and removed in one step, called potashing. This makes a flat mount so that even a thick-bodied insect, such as a bee, may be reduced to its exoskeleton and mounted whole. Here, too, we should list the basic classification of slide preparations—whole mounts, smears, and sections. An entire mounted object, whether a complete organism (flea, moss prothallium) or parts of organisms (beetle leg, portion of fern leaf), is described as a whole mount or in toto mount. Smears are actually whole mounts also, but consist of highly microscopic objects, as bacteria, diatoms, or blood cells. Sections are slices of organisms (such as an earthworm across-section) or their parts (cat liver, basswood stem) cut to extreme thinness on a machine (microtome) so as to transmit light well on a slide, revealing anatomical detail.

PROCEDURE: obtain several dog or flea as and put them either in a cage insect-killing jar or in hot water for a few minutes. Then place them in or on the small aluminum dishes in which many frozen items are packed the chicken pies, for example) or in the bottom of a baking powder can—any wooden or and small metal receptacle—and about one ounce of a 10 per cent solution of potassium hydroxide upon them, may be bought at a drugstore, or may buy a stick of the solid and mix your own solution in tap water—one part solid, ten parts water. This potash is a strong caustic and must be handled with the same care you would use with an acid; avoid getting any on the hand or clothing. Heat over a small flame, as from an alcohol lamp or a small burner turned low. Heat for five minutes, but do not boil. Transfer the to a container of tap water to see for an hour or two. The swelling att to the water absorption will cause the expansion of some of the body tissues. Try rolling a flea, gently and carefully from head to tail, with a round narrow stick or small dowel or applicator stick. The action is that of rolling dough with a rolling pin, but on a very much sma scale. This should get rid of the tissues without breaking off any appendages. Now repeat the treatment and the washing in water a second time, carrying the was through several changes of water of period of three or four hours, to get of all traces of potash. This treat will also bleach the specimens from dark to a light golden brown. Do not carry the bleaching so far that the become colorless. It is best to start several fleas lest some be ruined incidentally in these manipulations.

Transfer these midget insects to alcohol for fixing and dehydration. Collect and industrial laboratories may use pure ethyl (grain) alcohol tax free scientific purposes, but there are...
ols, unfit for human consumption, may be purchased without special
uses. The best for microscopy is iso-
propyl alcohol, which comes in two
kinds, commercial and anhydrous. The
latter is cheaper and should be used in
making up dilutions with water. Reserve
the anhydrous for the final step.

In the general routine, you will need a
mixture of each of the following strengths:
90, 70, 82, 95, and 100 per cent. Real
ly, the commercial isopropyl as 95 per
the anhydrous as absolute alcohol.

Do you go about making up a 35
cent solution from a 95 per cent solu-
? Sounds like a math problem, but
method is very simple. Use a gradu-
cylinder marked for 100 cc.; fill to

MAGNIFICATION can be obtained by
adding drop of water in metal loop,

5 cc. mark with alcohol. then add
it to bring the mixture up to the 95
mark. The rule is to use the 95 per
alcohol to the amount of dilution
ed, and then to add water to bring
cc. level. Fleas should be left
utes in each successive solu-
50, 70, 95, and 100 per cent.

An extra step is required in mounting
entire insects—positioning. Nothing
more or is more useless than a
in which the legs are entangled
ings and antennae, when present.
lack. This can be avoided by in-
-avoiding the end of a fine needle into
. A large round match stick (kitchen
or dowel, which acts as a han-
ding it with tape. When the
in the first alcohol, arrange the
aturally with the needle’s point.
lege should be neither straight nor
against the body; pull them out so
ach joint, noise hiding the others; pull
out the mouth parts so that they will be
clearly visible. With other kinds of in-
ssects the antennae and wings will also
require arranging. You will doubtless
have to use bits of glass as wedges to
keep all parts in place until the joints
are completely hardened by the higher
percentages of alcohol.

The preparation is now in a very deli-
cate state, and care must be used to pre-
vent spoiling the positioning. Remove
each successive reagent by sucking it up
into a pipette and add each new fluid by
gently pipetting it on. Liquid can also be
soaked up with paper toweling. Never
let the specimen become dry at any
time. After treatment in the last alcohol,
use a half-and-half mixture of 100 per
cent alcohol and xylene for fifteen
minutes, then pure xylene for a like time.

Swim the flea onto a slide, using copious
amounts of xylene, or work a slide under
the insect and swim it to the center. Tilt
the slide to drain off excess fluid, or blot
it up; then add the mountant, make a
final inspection for positions of parts,
and put on the cover glass.

Before the cover glass is applied, a
cover glass prop is in order in most
cases. The object is to raise the glass
slightly so that it will not crush the speci-
men. For this purpose use bits of broken
cover glass, one small piece in each
corner, or snips of a thin sheet of cellu-
lose acetate. One of our illustrations
shows pieces of thin glass rod, drawn
out under a flame, to prop the cover over
a whole mount of a bug. This process
 aids in preventing breakage of the frag-
gle glass itself.

In mounting insect parts, treat anten-
nae, mouth parts, and legs, if thick or
darkly colored, in the same manner.
Gauzy wings do not require potashing,
but thick, chitinous ones may. Before
long we shall tell you something about
the knowledge that may be gleaned from
slides of this nature. It is really true
of our world; it is an excursion into the
world of the double tripod—the world of
the six-legged insects—and the discovery
of some of their fascinating modes of life.

This list details the photographer, artist,
or other source of illustrations, by page.

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8—John W. Andresen
9—Matthew Kahlenoff,
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10-11—Harold V. Green
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14-15—Harold V. Green
16—Rutherford Platt,
top; Sidney R. Esten,
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17—John W. Andresen
18-23—Gordon Coster
24-31—Thayer Scudder
32-33—Helmuth Wimmer,
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Army for N.A.S.A.,
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34-35—Star Map, after
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36-47—Ansel Adams,
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The winter is long past, and even the rain is over and gone. The voice of the turtle is heard in our land. This is the time, between the passing of cold weather and the boom in the mosquito population, when the backyard astronomer can pursue his hobby with a minimum of discomfort. Here, to help him along, is a handful of new books dealing with this oldest of sciences. Taken in proper order, they may well lead those who are interested in the right direction. Pursued, they will encompass much of modern astronomy.

For the complete neophyte, one of the best jumping-off books that has come along in many years is The Sky Observer’s Guide, by Margaret and Newton Mayall, and Jerome Wykoff. Paintings and diagrams by John Polgreen. Golden Press, New York, 1959; 125 pp., $2.95. This modest book, written by a team of four people—all of whom have been active in the American Association of Variable Star Observers—is exactly what it purports to be: a concise handbook of essential information for the amateur who has the urge to see for himself. Simply and with an economy of words, the non-professional observer is told how to use his equipment; what he should be able to see with it, where these phenomena may be found and why his instruments work. Lucidity is the order of the day, and readers of this little book should be spared the tooth-grinding frustration that is too often the lot of the beginner. Obviously, it is not possible to cover all of astronomy in 125 pages, but the basic information is here, together with tips for getting the most out of equipment and experience. Wherever possible, the authors have given useful leads to additional material.

A valuable by-product of this sort of condensation is a number of lists and tables: these add much to the value of the work for reference. The lists are not exhaustive—nor are they intended to be—but they contain the outstanding examples in the categories they cover. It should be added that the drawings and diagrams are of high quality, and are, in addition, many fine photographs. Most of these come from the same sources for such pictures—the fine photographs of the great observatories—but some remarkable “backyard” photographs have been included among the pictures.

One or two mishaps have slipped by the authors, editor, and proofreader. In one tabulation, the multiple of Theta Orionis, which gives life to the Great Nebula in Orion, is listed as Sigma Orionis; in the accompanying some photographs of the moon, east and west directions are reversed. But such minor transgressions should not be allowed to put the reader off: The Sky Observer’s Guide is intended as the last word in astronomy, but it is an excellent first word.

I am sure that the authors of The Sky Observer’s Guide hope their book will spur some beginning astronomer to further study. For these, El
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less, all the major problems have been dealt with and answered in the light of our present knowledge. It is all the more gratifying to know this book is to know all but the smaller, extraneous details concerning the individual members of the universe. The writing is spare and concise, and no attempt has been made to impose upon the amateur the spurious glamour to the subject. But this is business, it is to be hoped the amateur will not shy away from reading this book.

A generation ago, the field of astronomical books in the English language was dominated by one volume, Splendours of the Heavens, published in 1909. The volume was written by Lucien Rudaux and Gerard de Vaucouleurs, both astronomers of note, and translated by Michael Guest and B. Sidgwick of the Royal Astronomical Society, who have both written well and well on their own accounts. The book, presumably written in the more or less complete vision of the book, presumably written in the more or less complete vision of the book, was accepted by the few astronomers who could afford to own it.

This honored place has now been taken by another magnificent book, Larousse Encyclopedia of Astronomical and Astrophysical Sciences, published in 1959. The volume was written by Lucien Rudaux and Gerard de Vaucouleurs, both astronomers of note, and translated by Michael Guest and B. Sidgwick of the Royal Astronomical Society, who have both written well and well on their own accounts. The book, presumably written in the more or less complete vision of the book, was accepted by the few astronomers who could afford to own it.

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This volume is an impressive list of names and the contents of this volume salute the prestige of the men involved. Every facet of astronomy is presented here in a manner that is perfectly understandable to an intelligent reader, and need this reader have an education in science? Every phase of the universe is treated in an eminently readable, straightforward style.

The minus side of the ledger should point out that several astronomical concepts—valid in 1948—are superseded by more recent advances. Knowledge—age is unfortunately, still the book. Again, far too little space has been given to radio astronomy for a book of this scope. Then, too, the photographs—which are superb—are from the few observatories, understandably enough, or from Mt. Wilson, but there is no photograph that was taken by the 200-inch Mt. Palomar. It is true this great telescope was dedicated in 1947 and that the original, French edition could not, therefore, have contained a 200-inch photograph; but it is a pity that space was not found for some of them in this new edition.
ally, we note with churlish malevolence that even so magnificent a book is not free from the typographical errors that break the hearts of editors. Of the many valuable tables, for instance, the distance of Sirius is given to eight years. But I am sure this is accepted as one of those inevitabilities by every reader and not as a criticism in celestial measurements.

These few debits disposed of, it should be said that this is a book to own, the coldest of professional omers delight. It is the book that will exhibit to his less fortunate friends, holding it carefully and proudly, auctioning them to keep their big, gingers off the plates. This is a present volume, a fitting prize to the student who has begun with The Sky's Guide and gone on through Elementary Astronomy. It is a beautiful manufacturing and printing and a delight to own and to study. Illustrations are like icing on this jellied cake. The publishers say there are 806 of them. I have not seen them, but this appears to be a typical edition. There is a page that does not have one more smaller pictures in the text. There are twelve color plates and many in black and white illustrations.

Of the great problems that must have been encountered in the preparation of this edition was the change of the legends on many of the diagrams from French into English. Whether this meant that most of the diagrams had to be completely re-drawn or not, I do not know, but the fact that the job was done so well is evidence of the care and attention that the volume received.

It is not often that one who reviews astronomical books has any chance of treating the topical or newsworthy. The recent Russian achievement of photographing the hidden side of the moon, however, has made such topicality not only possible but desirable.

The Other Side of the Moon—translated by J. B. Sykes. Photographs and diagrams. 36 pp., $2.50, issued for the U.S.R. Academy of Sciences by Pergamon Press, 1960—is a completely undated account of this staggering feat.

The slim volume opens with a foreword by A. N. Nesmeyanov, President of the U.S.R. Academy of Sciences, in which the implications of satellite photography are discussed. The rest of the book is straight reporting. Perhaps to the detriment of the work, there are no detailed scientific data in it.

The diagrams that show the orbit the vehicle followed are unusually clear and understandable. The drawing of the satellite, however, would certainly not allow anyone to duplicate the device in a home workshop. The photographs of the moon (and there are only two photographs, both printed several times) are the same pictures that were first released—and appeared in almost every newspaper—a few months ago.

These pictures must be accepted as authentic. They are not good pictures, but the remarkable point is that there are any pictures at all. They were only at the least favorable time, so far as the lighting of the moon was concerned. The face of the moon in the photographs is almost fully illuminated, thereby eliminating practically all of the shadows that would have given definition to the markings and accentuated details.

The intricate process of taking the pictures—aiming the vehicle, exposing the film, developing and drying it—took about forty minutes. The result was transmitted to receiving stations in Russia when the vehicle had later reached a favorable position. It may be that these pictures were the only ones obtained, but it would further have crowned the Russian achievement if more than two of them had been reproduced.

More than anything else, this little book is a souvenir of a momentous event—the official record of a vast step forward in man's eternal quest for knowledge.

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THE AMERICAN MUSEUM OF NATURAL HISTORY
Central Park West at 79th, New York 24, New York
Boothbay Harbor area of Maine coast exhibits features of hard-rock shore line "drowned" by rise of sea level during geologically recent time. Resistant rocks have not yielded sufficient material for production of well-defined be

Edge of the Land

The sea's attack makes shore lines places of constant change.

By John A. Shimer

The edge of the land, where it meets the sea, holds a never-ending fascination for us. Here we are conscious of the timeless quality of waves and tides, of the eternal ebb and flow of the waters against the land. Because of the restless motion and turmoil of the ocean, coastal scenery is one of the least secure, the most evanescent of any on the face of the earth. We are aware here, as nowhere else, of the unceasing activity of the forces that have molded the earth's crust in the past and are shaping it today.

Sometimes, after a storm, slight changes in a familiar pattern are discernible along the seacoast—perhaps a subtle difference in the curve of an inlet, or in the outline of a dune against the sky. Perhaps there is a new line of pebbles where there was none before. There are times when storms alter scenery more dramatically—waves break through barriers and pebbles along a shore play a relatively minor part in the long action of the sea. Less suddenly more impressive is the action of the sea on the solid parts of the land,
ARRANGEMENT of islands on Maine coast, well shown in view of Casco Bay, above, resulted from the drowning of parallel ridges and valleys by rise in sea level. Islands represent ridge tops; estuaries occupy the former lowlands.
Gently curving Plum Island, on north coast of Massachusetts, is part of an offshore bar, separated from mainland by salt marsh, tidal rivers. Mouth of Merrimack River occupies foreground.
AERIAL VIEW. ABOVE, was taken from a point near Marblehead, looking to the north. In middle distance is Cape Ann, jutting to the east. Beyond is Castle Neck and Plum Island; in far distance, New Hampshire and Maine coast lines.

yield slowly to the ceaseless pounding of waves and the battering of storm-tossed sand and gravel. The steep coastal cliffs we see today look out over the moving waters that have been gnawing away at them for hundreds, perhaps thousands, of years.

LANDSCAPES are also created by oceans in another and totally different way. A change in sea level produces a unique type of coastal scenery, quite unlike that carved by waves. When the level of the sea rises, it floods low coastal lands, isolating hills to create islands and drowning river valleys to form bays.

The shores of New England afford excellent examples of landscapes that have come into being along a drowned coast, as well as those coastal forms that result from the more direct work of the sea. The scenery along the coast of Maine, in Boston Harbor, and on the outer side of Cape Cod, shows the characteristic results of the sea's activities on contrasting types of land. The ocean drowned the entire coast of New England at approximately the same time. While the rocks along the Maine shore are hard and not easily worn away, the softer materials farther south have yielded readily to the combined action of the Atlantic Ocean's encroaching waves and currents.

For the traveler, a trip following the edge of the land along the coast of Maine is tortuous. Deep estuaries, extending miles inland to form fine harbors, alternate with bold headlands that jut well out to sea—promontories from which many islands are strung, filling in the nearer scene before the open sea is reached. Here, land and sea interpenetrate to a truly remarkable degree. For example, the distance from Portland, Maine, to the Canadian

Dr. Shimer, who is a geologist at Brooklyn College, is the author of the current book This Sculptured Earth (Columbia), from which the article on these pages is excerpted.
border is about 200 miles by air; via the shore line, it is over 2,000 miles—about the distance from Maine to the Rocky Mountains.

From the tops of many of the higher hills in Acadia National Park, on Mount Desert Island, an ideal view of this irregular shore line can be obtained. An island-studded seascape is spread out at one's feet. These islands are not haphazardly arranged, but appear to be roughly organized into long files, as though they were marching out to sea one after another. A number of these island groups are in sight, all trending roughly north to south. They seem to be partially submerged continuations of promontories that we can see on the mainland to the north. To the south, toward the horizon, the lines of islands gradually disappear, the underwater ridges getting lower, until we can only guess that they continue beneath the ocean's surface.

Storms along this granite coast bring breakers, which concentrate on the rocky headlands and outer sides of the islands. Hurling sand and gravel against the land, they have produced such features as Anemone Cave and the neighboring cliffs on the seaward side of Mount Desert. Broken material from the headlands has formed small beaches of sand and gravel between the promontories or sand bars part way across some estuaries.

At the same time that the headlands are being worn away, the streams that enter the landward end of the estuaries, miles from the open sea, are bringing sand, mud, and gravel, which they dump when their flow is checked on entering the ocean. In some places these dunes are very small; the coarsest dunes can be found on the more irregular coast of Maine. These dunes will not be disturbed by the large waves that break on the islands or by the currents that pretend to be heading for inevitable destruction. Thus, the zigzag, deeply indented coast line of Maine would seem to be adjusted to inevitable destruction. While waves and currents are cutting off and filling in the seaward ends of the bays, their landward ends are being choked by accumulations of detritus.

Manifestly, this coast line of estuaries could not have been produced by the action of waves and currents; explanation of its origin must lie elsewhere. What we see suggests the landscape of hills and valleys that has been submerged, the sea flooding valleys to form tidal inlets and turning the hills into islands. This
At Boston, the sea inundated a land liberally covered with piles of loose debris, a great deal of which had been shaped into low, rounded hills before the drowning. These deposits—of gravel, sand, and mud, all mixed together—are called drumlins. They were left by the large continental ice sheet that disappeared from New England scarcely ten thousand years ago. Most of the drumlins have an elliptical ground plan, and are so oriented that their long axes run roughly northwest to southeast, reflecting the direction of motion of the glacier as it overrode them and smoothed them into their present streamlined shape. These piles vary somewhat in size, commonly being from fifty to a hundred and fifty feet high, and from a few hundred yards to nearly a mile in length. After the ice sheet withdrew, the sea rose

...
Cape Cod at right, consists of glacial moraine and its outwash plain, exposed to destructive attack of the open sea.

and flooded the lowland areas, with the result that the tops of many drumlins now protrude from the water to form the typically elliptical islands that dot Boston Harbor.

An excellent view over the Harbor can be obtained from the summit of Weymouth Great Hill. From the top of this drumlin, a bewildering display of islands, estuaries, promontories, beaches, and straits unfolds to the north. In the foreground, toward the east, is Grape Island—with a small cliff notched on its seaward edge. Close by is Bumkin Island, its beautiful, smooth shape looming out of the water, looking like some gargantuan sea turtle basking in the sun. Peddocks Island, a little farther off toward the north, is composed of a number of drumlins joined together by sand beaches; the cliffed edges of two of the drumlins show the source of much of the material that makes up the connecting beaches. Farther to the east, the rounded tops of several drumlins show up against the horizon; they now form the high, rounded parts of Nantasket Beach and Hull.

This peninsula has, very roughly, the shape of the numeral “seven,” with its base attached to the mainland. It extends northward some four miles and then westward a mile and a half more. Its principal feature is a fine sand beach that connects the drumlin hills to the mainland. Such a sand bar, connecting a former island to the mainland, is called a tombolo. In general, the production of any tombolo implies, first, the formation of an island, and then the joining of the island to the mainland by a sand or gravel beach, built by waves and currents. On the north side of Boston Harbor, a counterpart to Nantasket Beach exists in Lynn Beach, which has tied the rocky islands of Big and Little Nahant to the mainland.

The sea still has a job to do in the Boston Harbor area before the results of its activity dominate the landscape and evidence of the past drowning is altogether destroyed. But the work is in progress. Just as in Maine, the estuaries, like the drowned seaward ends of the Neponset and Mystic rivers, are silting up. Far more than in Maine, however, the coastal scenery here emphasizes the work of the sea. Beaches, sand bars, and the wave-cut seaward margins of the drumlins dominate the landscape of the harbor.

Cape Cod, south of Boston, is a peninsula surrounded and largely dominated by the sea. Jutting out miles from the mainland into the Atlantic, this land is completely exposed to the ocean’s relentless activities. Made up originally of glacial debris, the Cape is easily eroded; nowhere can the smallest ledge of bedrock be found. Wherever one may visit, there is evidence of the ocean’s work.

The partially destroyed headlands and the precipitous cliffs that front the open sea reveal the destructive role of waves, while bars, beach ridge sandspits tell of the ocean’s constructive role.

On the Atlantic side of the peninsula where the easternmost bulge of
open water, the sea has been able to its job of destruction without interruption. Indeed, a visitor at Nauset beach on a gray day of rain and sleet may greatly fear for the permanence of the land on which he stands and wonder how it has been able to withstand the ravages of the sea for as long as has. In winter during a northeast gale when flying spray whips across each in horizontal streaks, the rocks shake as the breakers crash on the shore. The roar of grinding sand and pebbles, as the waves break and return, forms a deep background to the high, shrill whistle of the wind.

The time to fear for the land is when such gale winds and waves are accompanied by a high tide. Then it is that the cliffs facing the ocean are undercut, landslides occur, and the land is visibly lessened.

The coast at Nauset Beach Light-
Aerial camera catches pattern of underwater sands that constitute part of Nantucket Shoals, south of Cape Cod. Shoals cover large area east and southeast of Nantucket Island, and are site of first lightship in United
Material forming bars has been supplied by truncation of promontories, and spread by waves and longshore currents.

...
are most extensive wherever solid material is present, and here where the waves and currents strike their attack on bedrock.

South of New York, the coast of New Jersey is almost one continuous sand beach, backed in some spots by low, wave-cut cliffs, and elsewhere by marshland. Extensive lagoons have drowned river valleys.

The northern New Jersey shore is composed of weak layers of sand, and gravel. As the sea wears away, small cliffs—only a few feet high—are produced. To protect the coast here from further destructions of the sea, concrete walls have been built and stretches of the shore have been faced with large blocks of stone. Breakwaters, or groins, have also been built straight out from the shore to curb the drift of sand along the beach. Despite this effort, in a few years there is a storm powerful enough to toss the stone blocks into the sea and to undermine the concrete walls. With each such storm, a few inches or a few more feet of land are surrendered to the sea.

There are still obvious estuaries along the New Jersey coast, although enough time has elapsed since that area was drowned for a number of smaller ones to have been obliterated and new ones to have been formed. Offshore bars are especially noticeable near the central part of the state, where the waves have scoured up the sea floor to build barrier beaches a mile or more from the mainland. Lagoons of quiet water have been formed between these wave-built, offshore bars and the mainland.

In time, these barrier beaches will be pushed shoreward, as storms on the one hand toss sand and deposits, on the other, fill in the estuaries and lagoons from the landward side. The ultimate fate of this coast, therefore, will be the eventual obliteration of the lagoons and estuaries, leaving a low, intermittent wave-cut cliff, backed by a sand beach, extending from one end of the state to the other. If there is a further rise or fall in the level of the sea, the prevailing scenery then will be wholly a product of the sea's erosional warfare against the land.

Barrier beaches of New Jersey, as at that of Beach Haven, left, have built up their sand from scouring of sea bed.
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The Water Walker

By C. H. Conaway
Photographs by Liselotte Dorfmüller

Among the most interesting of all small insectivores are the several species of North American and Eurasian water shrews. The animal pictured on these pages, the American water shrew, *Neomys fodiens*, is remarkably true in appearance and habits to our own North American species, *Sorex palustris*. In the coniferous forests of North America, water shrews live along small streams. Their range extends southward through the Appalachians and Smoky Mountains in the East and through the Rockies into New Mexico in the West. Although common in their habitat, they are rarely seen, as they usually stay hidden in cover of overhanging banks and loose rocks to be at the edge of the stream.

The water shrew has the general appearance of a small, sharp-nosed mouse. It is about six inches long over-all, with its tail composing almost half that length. The eyes are tiny and inconspicuous, as are the external ears. The fur is dense and uniformly a dark, slate color on the back and sides, and silvery gray on the underside.

The water shrew’s major food items are various insects, which are taken both on the bank and in shallow water at the stream’s edge. Aquatic insect larvae (chiefly May fly, caddis fly, and stone fly larvae) are the staple food items most frequently found in their stomachs. As with other shrews, their food requirements are enormous, and they eat slightly more than their own body weight in food each day.

The fur of the water shrew traps the air, giving the animal remarkable buoyancy. This, coupled with its hair-fringed feet, which are disproportionately large, sometimes makes it appear that the shrew is running on top of the water.
In the wild, the shrew usually prefers to feed on insect larvae, which it can find in the cover along streams' edges.

day. A captive animal, weighing 10 grams, ate an average of 10.3 grams of meat and fish every twenty-four hours.

Although these shrews are adept at both swimming and diving, they only occasionally enter deep water. Then it is usually only to "run" across the surface of a small pool and quickly disappear among the rocks at the far edge. Those persons fortunate enough to see this are often startled, since the water shrew does literally appear to run on the surface of water. Its large, fringed feet, and the buoyancy provided by air trapped in its dense fur, prevent it from sinking appreciably into the water. Perhaps one reason a shrew seldom ventures into open water is that it is highly vulnerable: water shrews have been found in the stomachs of trout and a number of other predaceous fish.

Although these little mammals are quite capable of catching small fish, they rarely do so in the wild. In American species that have been analyzed for food content, remains of fish were found in only one of eighty-seven stomachs. Probably only an occasional minnow or small fish, trapped in a pool, would normally be taken. In captivity, however, water shrews are able to catch fish in the confined space of an aquarium with considerable efficiency.

Swimming underwater, below, the shrew utilizes its tail as a rudder, and its bristly feet as efficient paddles.
Shrew avidly pursues minnow placed in an aquarium, above. Sheen on fur is from trapped air bubbles.

Shrew surfaces quickly after it has managed to secure its victim, below, which it invariably catches by the head.
Dr. Conaway is an associate professor of zoology at the University of Missouri. Mrs. Dorfmueller is a well-known nature photographer who makes her home in Munich, Germany.

When a water shrew first enters the water and dives beneath the surface, it has a noticeable silvery appearance, caused by air entrapped in the hair. The entire animal almost seems to be enclosed within a bubble. After a minute or so of active swimming, however, the air is lost, and the hair begins to wet. This is a serious hazard for the shrew, since heat loss—through the cold wet fur in contact with the skin—will cause the animal’s death within a very few minutes. Thus its diving and swimming periods are of brief duration. When the shrew emerges from the water, it immediately begins to dry its fur by vigorously and rapidly grooming itself with its hind feet. The bristles fringing the hind feet act as a comb in this process. Within half a minute, it is almost entirely dry. While drying its fur, the shrew also eats whatever prey it has captured in the water. This renews the energy reserves for its rapidly metabolizing body, and aids in restoring the heat the animal has lost through exposure to the cold water.

In captivity, water shrews seem to learn to hunt fish with unusual avidity. One such captive animal was observed systematically searching its aquarium until all fish there were captured. Minnows that could not be eaten immediately were killed by a bite behind the head, and stacked on a rock like cordwood, heads all laid in the same direction.

Water shrews are intermittently active both day and night. After a period of hunting and feeding that may last as much as fifteen or twenty minutes, they sleep briefly. An animal that is moving about actively may suddenly fall on its side and sleep. On one occasion, a shrew running along a log at the water’s edge was seen to go to sleep in this abrupt manner, and topple into the water.

More than any other animal, small shrews such as the water shrew seem constantly to walk a precarious tightrope between life and death. A period of several hours without food is sufficient to cause death from starvation. A few minutes’ chilling with wet fur, and the animal dies from exposure. Failure to understand this characteristic underlies several common fallacies about shrews. One such belief is that they will die of “shock” if handled. Animals that have spent several hours confined in a trap or container may, indeed, die very suddenly if excited. Their last burst of activity simply exhausts their metabolic reserves, and they literally die from starvation. Well-fed animals, however, can be handled and actually treated rather roughly without any danger to their lives.

This failure to understand the shrew’s continuous food requirement is responsible, too, for exaggerated ideas of their viciousness and savagery. These beliefs have arisen from accounts of the fierce fighting and cannibalism that occur when several shrews are confined together. With shrews, only a few hours are needed to reduce them to a shrew-eat-shrew level of starvation. For that matter, if mice are confined together without food and water for several days, the same thing will happen. From five to ten shrews of several species have been confined together successfully for several months in the bottom of a wash tub, with only sawdust on the bottom and a single, small community shelter. So long as adequate food and water were provided, it was discovered, neither conflict nor cannibalism arose.

Prolonged submersion may cause death, so shrew makes kill as quickly as possible and emerges from water to

While eating, shrew grooms fur with hind foot. In a very short time, the dense, slate-colored coat has nearly dr
Body heat lost in water is restored by metabolism kept in balance through eating more than own weight every day.

Slightly damp, but with energy reserves now restored, shrew will soon either hunt again or quickly fall asleep.
CELESTIAL EVENTS

A list of astronomical occurrences for the second half of 19...

JULY

July 2: The earth is at aphelion in its orbit, 94.5 million miles from the sun—the farthest it can be.

July 7: Saturn is in the opposite direction from the sun in our sky; it can be seen low in the southern sky at midnight, 840 million miles away, looking like a bright yellow star nearly of magnitude zero.

July 8: Tonight the moon, passing north of the planet Saturn, will be full, and also will be at its perigee, only 221,900 miles from the earth. The occurrence of full moon at the closest point in its orbit will result in unusually high and low tides in coastal areas.

July 17: Mercury, only 53.5 million miles from the earth, is at inferior conjunction—between earth and sun.

AUGUST

August 10-12: Watch the northeast sky for several hours on each of these nights: On August 11, the Perseid meteor shower should reach its maximum rate of nearly fifty meteors per hour (as seen by a single observer).

August 31: Mercury is beyond the sun at superior conjunction, 127 million miles from the earth.

SEPTEMBER

September 5: The second eclipse of the moon this year will occur in the predawn hours today, beginning at 5:36 A.M., EDT. The total part of the eclipse will begin about the time the moon sets for observers at stations on the East Coast. Western observers will see the moon leave the dark part of the shadow—the umbra—at 6:07 A.M., PDT. It will set about three-quarters of an hour later.

September 20: Observers in the United States west of the Rocky Mountains will be able to witness a partial eclipse of the sun. The eclipse will begin about 4 P.M., EDT, on the Pacific Coast, and end about 5:50 P.M. Sunset will intervene before the eclipse ends for observers between the Rocky Mountains and the Appalachians, while watchers on the East Coast will miss the event completely. The shadow of the moon will leave the earth at sunset at a point a little east of Roswell, New Mexico.

September 22: The sun passes from the northern into the southern when it crosses over the Equator at 9 P.M., EDT. Autumn begins in the North and spring is welcomed in the Southern Hemisphere on this date.

OCTOBER

October 9: The moon will pass in front of Aldebaran about 5 A.M., EDT. The bright limb of the moon will block our view of this first-magnitude orange star, in Taurus, and the dark limb will uncover the star about an hour and twenty minutes later. East Coast observers may see the reappearance of the star because, at this late hour in the day the sky will already be brightening with the coming dawn.

October 12: The moon is at apogee and last quarter within a period of four hours. This combination will result in an unusually low range between high and low tides.

October 30: This Sunday morning marks the end of Daylight Saving Time for many areas of the country. All your clocks back one hour.

NOVEMBER

November 7: An unusual astronomical event—a transit of Mercury across the face of the sun—takes place today while Mercury is 62.6 million miles from the earth.
By K. L. Franklin

of the planet will first appear on the face of the sun which will look about 240 times larger across than will Mercury) at 9:35 A.M., EST. It will leave the western limb of the sun at 2:12 p.m., EST. For the West Coast, the transit will be in progress at dawn, and end at 11:13 A.M., PST. A telescope or a good binocular is needed to observe this event, but do not look at the sun. Hold the instrument so that an image of the sun can be projected on a white piece of paper. A little practice ahead of time will show you how to get a fine, large image of the sun. You will probably see several sunspots, which may look about the same size as the image of Mercury. Mercury, however, will look bluer and more purely circular, and it will move obviously across the face of the sun. (The photographs of Mercury’s November, 1953, transit of the sun, reproduced here, were taken at the United States Naval Observatory and subsequently adapted to a specially adapted telescope known as a photoheliograph, and may serve as a further guide to the appearance of this event.)

November 12: Observers with small telescopes may look for Uranus. This distant planet (1.720 million miles from the earth tonight) will be 2 to 3 degrees north of the waning crescent moon when it rises, and will look like a star of the sixth magnitude.

November 21: The thin crescent moon, only two days old, will present a beautiful sight in the southwestern twilight, passing somewhat to the north of Jupiter (-1.5 magnitude, 555 million miles), Venus (-3.5 magnitude, 50 million miles), and Saturn (+1 magnitude, 995 million miles). At the same time, Mars (-1 magnitude, 66 million miles) will be bright in the eastern sky, in the constellation of Gemini.

November 24: Planet-hunters have a good chance to see Mercury shortly before sunrise. It will look like a yellow-white star of zero magnitude, and may be found low in the southeast sky.

December

December 3: The full moon will occult Aldebaran about an hour after moonrise for observers on the East Coast. Although Aldebaran is bright, a binocular should be used to observe this event. Otherwise the star will probably be lost in the glare of the moon.

December 10-15: During the late evening and early morning hours of these dates, a meteor shower will be in the sky, appearing to come from the constellation of Gemini. A single observer may see as many as forty Geminids per hour during the peak, on December 13, at about 2 A.M.

December 21: At 3:27 P.M., EST, the sun will be at its most southerly point in its apparent circuit through the stars. Winter begins in the Northern Hemisphere, and summer begins in the Southern Hemisphere.

December 25: Mars is our “Christmas Star” this year, being closest to the earth—56.5 million miles—today.

December 30: While Mars hovers at opposition—due south in the midnight sky—the moon will again occult Aldebaran in the early morning hours. On the Pacific Coast, this event will straddle the change of date: from about 11:00 P.M., PST, December 29, to about 12:30 A.M. of the following day, December 30.

Dr. Franklin of THE AMERICAN MUSEUM—HAYDEN PLANETARIUM prepares this summary each six months.
Kneeling woman, about six feet high, is one of the more than five thousand figures painted on rocks at Jabbaren. Elaborate headdress may identify her as a Libyan goddess.

SAHARAN ROCK ART

By Henri Lhote

In 1956-57, Henri Lhote, the French explorer and archeologist, undertook an expedition to the Tassili n’Ajjér massif in the central Sahara Desert. During a grueling eighteen months, he and his companions discovered a vast collection of prehistoric paintings on the rugged Tassili Plateau. Working under severe circumstances, the Lhote party copied these rare works, which reveal previously unknown cultures living in a Sahara that supported wide varieties of animal life. The text given here is excerpted from M. Lhote’s book, The Search for the Tassili Frescoes: The Story of the Prehistoric Rock-Paintings of the Sahara, translated from the French by Alan Houghton Brodrick and copyrighted, ©, 1959, by E. P. Dutton & Co., Inc.

The illustrations are also from M. Lhote’s book.
Needle-like columns rise to the north of the Sefar massif in the Tassili Mountains of southeast Algeria. The main axis of the Sefar is a canyon, cut by gorges in the sandstone.
The Sahara Desert (especially in the south of the Algerian province of Oran) contains a great number of prehistoric rock engravings, but it was not until 1933 that it was revealed as an area also rich in rock paintings. These discoveries were the more exciting since we knew really very little about the great desert's past, although signs made us think that the Sahara might have had a more abundant rainfall in the past than at present. Also, stone artifacts, found here and there, proved the existence in far-off ages of primitive populations and tribes. Nevertheless, the information, such as it was, could only be called fragmentary: we knew nothing of the nature of those populations.

For many years past I have devoted my life to scientific exploration of the Sahara. I have traveled all over it, and I have studied it from the points of view of geography, ethnography, and, above all, archeology. The Saharan rock engravings and paintings could not, of course, fail to excite my curiosity. After important discoveries of painted rocks had been made in the Tassili by a méhariste officer, Lieutenant Brenans, I visited the Tassili sites in company with several specialists in Saharan geography and archeology. Then came World War II and, of course, it interrupted all my work. It was not until 1956 that I was able, with the encouragement and the support of the famous prehistorian the Abbé Breuil, to organize a large expedition with a view both to copying the paintings already known and also to exploring, in a systematic manner, the whole of the Tassili mountainous mass.

The Tassili n’Ajjer (map, lower left) is sandstone plateau, difficult of access. It forms the base or platform from which rise a considerable number of small, secondary massifs—heavily eroded. Through them one can make their way by means of narrow corridors, overhanging cliffs, and of pillared areas that remind one of deserted cities. Today, all this region is empty of life and an oppressive silence hangs heavy over everything. Once upon a time, however, these passages were streets lined with habitations, and most of the cliffs are eroded at their bases to thus present rather deep shelters that provide natural homes for the early inhabitants of the region. These peoples have, it is true, long since disappeared, but they left hundreds of paintings on the rock walls of their former dwellings.

Our expedition stayed sixteen months in the Tassili. What we beheld among the maze of the Tassili rocks altogether baffled my imagination. We copied hundreds and hundredsof painted walls on which were depicted human and animal figures in their thousands. Some of the figures stood alone, others formed complex assemblages. Sometimes the scenes were enough and related to everyday life or to spiritual and religious existence of the different populations that succeeded one another in that area, to all intents and purposes deserted save for the very few Tuaregs who haunt them. Side by side with little figures very few inches high, we came across other gigantic dimensions such as are unknown in prehistoric pictures elsewhere. Then there were archers struggling for the possession of flocks and herds, figures of warriors armed with e of hunters chasing antelopes, of men in car hunting the hippopotamus. There were of scenes, representations of libations, and so

Expedition to southeastern Algeria covered Tassili area, shown in detail in inset. Place names indicate the sites of some of most important discoveries.
HERDED OXEN
VERDANT WILDS

Although the cave paintings of France and Spain have revealed to us something of the manners and customs of the Paleolithic peoples of Europe, these have not taught us much about the character or the origin of the artists—except that we do know that, at one time, France was inhabited by men who hunted bison, mammoth, rhinoceros, and reindeer. However, if it be compared with our prehistoric European art, the Tassili art constitutes a mass of documentation that allows us to form a clear idea of the ancient populations of the Sahara—of the different types of peoples that swept over the desert in successive waves of pastoralists. We can also note the influences that made themselves felt. Again, thanks to the Tassili pictures, we can now observe the changes in the fauna and, thus, of climate, and trace the progress of the description that was to culminate in the pitiless desert it is known to us today.

The engravings and paintings in the Sahara seem to fall into four main periods:

1: That of the hunters of the Bubalus—that wild buffalo (early Neolithic?).

2: That of the “Bovidian” cattle pastoralists (Neolithic).

3: That of the pastoralists with chariots—cavalry—the so-called “Equine Period” (prehistoric).

4: That of the camel (dating, more or less, in the beginning of our era).

Each phase, of course, presents its own problems. For the present we must be satisfied with a general summary that, I would stress, is subject to revision—a summary based on the evidence as it appears now, presented by overpaintings and various art styles.

The first of these periods may be called that of the “Round-headed men.” It seems that the ancient paintings in the Tassili are those of small human figures with schematic bodies, round heads, all painted in ochre. The features, moreover, were always exaggeratedly large. The arms are variously depicted, but often (indeed, generally) they are reduced to mere sticks. There are also to be noted in these paintings bows and a sort of lance or pitchfork about half again as high as a man (illustrations, page 32). There is no “scene” that can be interpreted as such, and animals are uncommon—when they do occur, they are mostly elephants and various kinds of wild sheep.

The appearance of polychrome paintings marks the start of the next major phase. The style is still that of the Round-heads, but the figures are of larger size and are better treated. The artists have now come to take more and more care in the representation of their subjects, which includes not only human figures but also those of elephants, rhinoceros, Hippoceridae, and wild sheep. The artistic quality improves all the time, forms become more graceful and great attention is paid to details. Bracelets or anklets can be identified and there are belts, hair or shoulder ornaments (for example, feather headdresses). Markings (very numerous) on the breasts, belly, thighs, legs, or arms may be interpreted either as scarifications or painted designs. The marks, made up of regular lines of dots, recall very forcibly those still to be
Hunters carrying trident spears—perhaps used to take birds—were found at Sefar, and may be Neolithic. Crosses at bottom and figures at right are of later date.

Bird-headed goddesses at right, from Jabbaren, are like those on Eighteenth Dynasty Egyptian monuments about 1200 B.C. This fresco is only fourteen inches high.

Hunter, with bow and arrows, is accompanied by a short-tailed dog, rare in "Bovidian" period paintings. This photograph of rock face was taken at the Sefar site.

At the end of the Round-head period—at a date that cannot be fixed precisely—there was an obvious Egyptian influence in the Tassili and this influence is clear in several works of an exceptionally high quality. The new art tradition mingled with that of what I shall call the "Negroid" substratum and gave rise to quite original paintings. Outstanding is a group of figures of which our "Antinea" (page 28) is the most remarkable. This magnificent painting was found in a low-roofed shelter where the picture is difficult to view. It is, indeed, curious that a work of such high quality should not have been put in a more prominent place. The woman, with her straight nose, indicates a Mediter-
Oxen and herdsmen were first engraved, then painted on rocks at Jabbaren by Neolithic artists. Fresco, about five feet long, reveals today’s desert as a once-fertile grazing land.
Detail of giant fresco at Sefar shows great god nearly eleven feet high, with suppliant women. Antelope pair over god is, in turn, overlayed with a scalloped des
Protohistoric drawings at Adjefou depict thin, stylized, "bi-triangular" men with javelins. Both the chariots and the shield-carrying archers are apparently earlier in date.

Phoenician influence, although some Egyptian features can be noticed.

What seems to be the final phase of the Round-head style is, compared with the other art phases in the Tassili, obviously decadent from the aesthetic point of view. The drawing is coarse, the forms are heavy, and there are no carefully executed details. Gigantic size is the characteristic of this phase and one gets the impression that the artists were more concerned with making their pictures imposing than with striving for the beautiful.

For instance, we found on one wall—where it reached from the ground to the roof—a human figure measuring about fifteen feet in height. If we take into account the lower part, now much effaced, it must originally have been over eighteen feet tall. This figure holds the record for being the largest prehistoric painting in the world. In addition to the human figures, this

Cattle with foreshortened legs and heads are remarkably modern in style. Legless, eared figures seem to be engaged in a ritual dance. Five-lobed design is not yet explained.
Elephant, engraved on rock, is perhaps the most ancient of all Tassili discoveries. Photographer filled in lines with chalk to make animal's outline more easily visible.

phase includes numerous animals, which give us a good idea of the variety of the fauna then existing in the Sahara: elephants, giraffes, wild oxen, *Hippocervidae*, wild sheep, wart hogs, lions (one of the feline paintings is over twelve feet long), and ostriches. Certain of these animals may, perhaps, have played a magic role, for they are often found in association with women whose arms are raised in an attitude of adoration or supplication. With this "decadent" phase the great period of the Round-head paintings comes to its close.

Soon the Tassili was invaded by newcomers, who in no way resembled their predecessors and who pushed herds of slow-moving cattle before them into the upper valleys. The walls of the Tassili shelters were to be covered with pictures in a new style and of an entirely new tradition.

These new paintings consist of human and animal figures of small size, treated in an admirably naturalistic way. When we look on the enthralling assemblages of this Bovidian (that is, cattle herder) period we must, I think, conclude that they represent the greatest naturalistic school in the world. Living creatures are caught in movement, seized by the artist as they exhibited their most lively attitudes and reproduced with a fidelity and a vigor that attest to an incomparable acuity of observation (illustration, pages 34 and 35).

Cattle are favorite subjects of these artists. It
Clear from the number of the oxen and from the artistic quality of their representations that these beasts occupied a place of great importance in men's lives. They are fine creatures with the active bodies kept fit and trim by grazing about over the savanna-like steppes. There are no signs of the masses of fat induced by a dentary life in enclosed pastures. The cattle have long horns—either in the form of a lyre or that of a semicircle—and the horns seem to imply the presence of two different species, well known in dynastic Egypt—the African ox or *Bos africanus*, and the *Bos brachyceros* or thick-horned ox. The animals are presented either in flat tints or in outlines, and are generally shown in large herds, followed by their herdsmen.

Wild animals are treated no less skillfully, and the Bovidian pastoralists, who were so hunters, left for us a whole menagerie that gives a clear and accurate account of the typical fauna that formerly inhabited the Saharan—elephants, rhinoceri, hippopotami, raffes, *Hippocervidae*, gazelles, aardvarks, oryx, wild asses, ostriches, fish, and unidentified guines. Such an abundance of wildlife implies the existence of a very damp climate and rich pastures—which is further proved by a fresco of hippopotami being chased by men in a canoe. Both beasts and men are shown grouped as if in life. One sees human figures in the midst of an oval that seems to represent the ground plan of an oblong hut: the door indicates clearly the materials used for its construction—straw or esparto. In fact, just the same sort of hut—made of vegetable matter and standing on a foundation of pottery—is to be found today in all the French Sudan. In other paintings one may see women standing before their cooking pots, men with axes in their hands ready to split wood, children lying under a coverlet, people sitting in a circle, conversing, and many other scenes that reveal the material life of these pastoralists, who, moreover, must already have practiced some sort of agriculture, as is indicated by a group of women tilling a field.

The origin of these pastoralists would have been mysterious enough had we not discovered decisive evidence that they came from the Upper Nile. Indeed, in six different sites we found Bovidian pictures in which were representations of typical Egyptian boats with the standards of the nemes—the ancient provinces of Egypt—at the prow. The really extraordinary fact that such characteristic paintings exist on the Tassili rocks proves that these pastoralists had, at one time, contacts with the Valley of the Nile and that, in all probability, they came from the east.

Such, then, as I see it from my first attempts at interpretation, are the main art phases that can be distinguished in the Tassili frescoes. But there are other paintings that we have not yet been able to place chronologically.

One of the most unexpected of our discov-
Strong Egyptian influence is apparent in the painting, below, at Sefar. Gray-blue, red ochre, and white pigments, now worn by the elements, resemble those used at Jabbaren.

Jabbaren fresco, above, was on unsheltered cliffs. Again, Egyptian influence is obvious. The headdress of the man's loincloth, and the skirts of the women are...
of the Eighteenth Dynasty, while the conical are similar to those of Predynastic Egypt. The ritual left, is like those found in Upper Nile area.

Archer of “Evolved Round-head” period, below, is detail from gigantic fresco. Figure, rendered in light yellow ochre, shows possible feather headdress and heavy bracelet.

Great Libyan nation, the Garamantes (whose and lay in what is now the Fezzan), saying they used in war two-wheeled chariots drawn by two four horses. With these vehicles the Garamantes pursued another Saharan people, the "troglodytes," who lived in caverns and rock shelters. Since Herodotus died about 425 B.C., the events he related would have occurred in the 7th century before our era.

The Saharan chariot pictures were thus, first all, attributed to the Garamantes of Herodotus. But a careful examination of the paintings as made by such experts as Dussaud and Salomon Reinach, who concluded that the very peculiar style of the horses—galloping with outstretched legs (illustration, page 37)—was one early related to the “flying gallop” convention the Mycenaean art of Crete. Now, it is certain that, about 1200 B.C., immigrants from Crete landed in Cyrenaica with the object of conquering Egypt, and that these people mingled with the Libyans. So it appeared that the Saharan chariots must be more ancient than has been
supposed and they confirm what historians had called (borrowing words from ancient Egyptian texts) an invasion by the "Peoples of the Sea." It might well be that after the failure of their campaigns against Egypt these invaders of Cretan origin retired toward the Saharan regions, where, sooner or later, the Peoples of the Sea interbred with their Libyan allies.

As well as copying the paintings of the Tassili, we sought for traces that the astonishing populations of artists might have left near their works. We were able to find a considerable number of grinding stones and pestles. In certain shelters, bits of pottery literally covered the ground. I did some digging at the foot of painted rock walls and, in several places, found abundant remains of grain mixed with objects identical with those on the surface—not only the same grinding stones and pestles and the same pottery, but also stone axes, flint projectile points, scrapers, and ornaments such as necklace beads cut out of ostrich eggshell and schist pendants and bracelets.

All these objects had been abandoned, it seems, by the Bovidian populations. Charcoal was recovered from among the ashes. When it has been submitted to radiocarbon tests we shall have a good idea as to the date of the Bovidian paintings. Provisionally, however, they can be assigned to about 3500 B.C. That would be a rough dating for the arrival of the pastoralists, but they must have sojourned long in the Sahara—perhaps thousands of years.

The other pictures—belonging to the various phases of the Round-head type of art—are much more ancient. Their very first stages must be assigned to a Neolithic without grinding stones or pottery, whose principal implements were coarsely chipped stone axes. If we date these paintings to about eight thousand years ago—and thus to the very early Neolithic—I think we shall be within the bounds of reason.

Perhaps in this short summary I have indicated the considerable amount of new information that the Tassili rock paintings add to our knowledge of the Sahara's past. Of course, the close study of our documentary evidence has hardly yet begun. What I have done here is to present somewhat fragmentary data as I collected it on the spot—data that, however, the careful and exact laboratory work of today will, we hope, make more illuminating in the future.
Masterpiece of “Bovidian” period is fresco of roan or sable antelope done in red ochre and white. The small leaping gazelle at bottom is painted in yellow ochre.
Child's-Eye Woodland

What does a woodland mean to most of us? A complex com-\y of plants and animals. A vaca-\ot. An unspoiled area threatened housing development. Exploit-\ees. Perhaps these are its mean-\ to adults: but for a child who has learned to look nature in terms a predatory civilization or a lytical problem, a woodland is what it should be—inviolate, new, fresh in matter for the senses. It can be full of fearful fascinations

—I remember being on the lookout for wolves and more than once hearing owls where they were not!

In these pages, Arline Strong has followed the world of woods and children from early spring on into high summer. Her pictures catch at the unexpected, seize the sensations of sun

Mr. Hay, President of the Cape Cod Junior Museum, here comments on woodland portfolio of Mrs. Strong, photographer of children and nature.

and shade, document experiences of touch and sight, and relate moods of pleasure, solemnity, questioning. Adults may overemphasize or overuse the word “fun” in considering childhood experiences. For youth is also a solemn-faced, serious business. These young investigators of life are gathering material for the future. Each of their encounters leads to others, in the way the season itself progresses from dormancy to active life, from spring’s first few to summer’s abundance.
WHAT does a wood, its clearings, and surrounding fields, provide to children? Trees, water, grass, leaves, insects, nooks and crannies, petals and seeds for games that have to do with tests and wishes, and a home for their feelings. Grass tickles and pleases, or it can be chewed with gusto. Sunlight dancing through an open glade is warm and inviting. They stir up insects as they walk, grasshoppers, leaf hoppers, lacewings. Butterflies dance away from sun spots on a log. Their hearts jump when a rabbit suddenly bounces across a clearing ahead of them, heading for the safety of a thicket. Blue jays scream. A woodland is full of exciting company.
A loosestrife flower in a briar patch must be sniffed.
Does he like butter? Buttercups will prove it.
It's a very lovely toad. Should I take him home?

A little boy stops a minute to look at a skunk cabbage, early in the spring before the great, green leaves unfold. It is in the form of a rosette, or open bud—leathery and colored green with streaks of red. A bit like a tuft of leaves, perhaps. Adults might tell him that this is a “spathe,” which encloses the skunk cabbage's flower, and it also serves as a trap for insects.

Or a boy will find a toad, a strange and cool, pulpy creature whose popeyes stare ahead of him as nobody knows what. He holds it with his hands. Will he decide to take it home in his pocket, or to let it go?
Tent caterpillars have come to live in this wild cherry tree.

Sunbeams, as well as feet, may be trapped in spider webs.

They look. They run on. They wait and see. They pick things up to feel. They touch the hairs on a caterpillar, the silk threads in a spider web. Why the spider doesn't get mixed up and lost in his own home is hard to see. What is this, or that? Children may know only a few names or reasons, but they are nevertheless the freshest witnesses alive.

Boys and girls may be playing their own games when they run off to woods and fields, rather than the game of natural history as it is defined by its students. But what they meet, and what meets them, is part of the same world. Life everywhere, through sun and shadow, in motion and repose, is well received in their own growth.
LAKE MANITOBA, in central Canada, is a great, shallow pool in the bed of the long-vanished Lake Agassiz, of glacial times. Each spring, for countless years, the north winds have whipped across this open expanse of water and thrown broken ice against the shoals of the southern shore lines, casting up a low, narrow ridge of sand. The ridge, now, is covered by a tangle of poplar, maple, ash, and willow. Behind these woods, extending to the south, east, and west, nearly as far as the eye can reach, is a sea of Phragmites — tall, plume-topped, yellow cane — that ends at last by the far-off groves that mark the farm bluffs on the wheatlands of the rich Portage Plains. This sea of yellow cane is what is known as the Delta Marsh.

New, green life comes to the Delta Marsh in early June. Then, the snowdrift has melted from the deep maple clump, and the wooded ridge is alive with greenery. Ice has long gone from the bays, and the dead, brown bulrushes are hidden by new, bright green growth, broken here and there by apple-green patches of cattail. The Phragmites beds are knee-deep.
but the tall yellow canes of the us year will not be hidden by growth until July. Early June is not spring, nor is it yet. It is a brief period of in- en, when the life of the marsh any characteristics of both sea- Traveling over the bays, one still arties of redheads in prenuptial ship, and still finds courting s of gadwalls, blue-winged teal ers, and lesser scaups. The first winged scoters are just starting . A few bands of whistling swans not yet started north.

There have been broods of mallards and pintails afloat for two weeks past; and now one may look for the first canvasback and redhead broods.

Each year, the first canvasback ducks hatch at Delta about the end of the first week in June. One does not find many young then but, by the end of the month, broods are common. Most hatch between mid-June and early July, and newly hatched young continue to appear throughout July.

I have not been able to deduce any fixed schedule for the daily brood-activities of the canvasback. During the heat of the day, they are found frequently in the rushes of island or border growths, but I have seen many broods spending the greater part of hot days in open water, far from shore. Periods of greatest activity come during the hours of twilight—morning and evening. Then all broods are feeding or traveling. They are active in moon-light and, on bright nights, they may be seen in open water. On dark nights, or during stormy weather, I have found broods on dry shores in Phragmites beds, on muskrat houses, or on coot nests. But it takes severe weather to bring them ashore, and I have seen broods in open bays on days too rough for canoe travel.

Newly hatched ducklings are able to dive as soon as their down is dry, but until they are about two weeks old they obtain most of their food on the surface. I have never seen a hen bringing food to her young. Nevertheless,
Canvasback hen feigns injury to draw attention from a newly hatched brood.

Unlike some other species, she ceases this practice as the young grow older, sometimes not returning for an hour or more. There is much individual variation, however, and several times I have seen protective canvasback hens feigning intensely.

When harassed, following the departure of the mother, the ducklings skitter for open water, where they separate and dive, swimming to a considerable distance before bobbing up for air, then going under and away again. Birds two or three weeks old make three or four lengthy dives before showing signs of tiring. When less than a week old, however, they tire easily, soon becoming unable to force themselves under water.

After absences induced by distance, the mother may return to find her brood dispersed and fail to retrieve them all. Or she may find downies from another scattered family have joined hers. Strange young are not always accepted, however. On several occasions I have seen canvasbacks, as well as redhead mothers in the habit of driving away ducklings of their own species, presumably interlopers. Such behavior suggests that, although the hen cannot “count” her brood, she can tell hers from strange ducklings.

In all species of ducks, one parentless brood may on occasion join another in its entirety, and the process may repeat itself until finally a large aggregation results. An extreme case is that of a white-winged scoter I saw with eighty-four young, all under two weeks of age! Lesser scapules are commonly seen with broods of two or more, sometimes with two or three hens attending such combined families. But canvasback and redhead broods of this size are rare at Delta.

Canvasbacks at Delta require nine to eleven weeks to attain flight. The first young are on the wing by the second week in August, and the majority by the first week of September. A belated minority is still learning to fly in late September or early October.

The canvasback brood does not spend the entirety of this period with the mother. The hen abandons her young before they are

Some adults accept young from broods that have been scattered by fright or for other reasons. Sometimes one bird without parents will join another...
The same is true of all other ducks that breed at Delta. The which young canvasesbacks and young diving ducks are abandoned largely upon the date thing. A hen may remain with a brood until it is ready to fly; but the later young often are abandoned by the parent hen, even two or three weeks old, or later. The first week in August, when how immature the young are, is very nearly the latest date by canvasback hens accompany roods. After this, parentless are the rule; hens with broods are exception.

Early abandonment may be induced by the summer molt of the fore she moves south again, a renewal of the wing feathers take place. All of the old flight are lost at the same time and, when ones develop, the hen is for a period of three or four. Apparently the time of the wing is balanced delicately with the reproductive cycle, so that it is not occur until she has completed all duties. Should canvasesbacks remain with their ducklings when they were able to fly, some would be able to complete the molt for autumn migration. The abandonment of the brood, then, is the-hen to molt and renew as well ahead of the freeze-up, the young canvasesbacks are abandoned by their mother, they gather in groups. These are often composed of different ages from several broods, the younger birds following an older duckling as they would the parent hen. In late July or August, it is not uncommon to see a brood of two- or three-week-old birds tagging along behind a four- or five-week-old. This “following” behavior is so strong that these ducklings will sometimes cling to a flightless adult drake of another species: parentless redheads sometimes travel with such bands of canvasesbacks. These bands seem less inclined to wander than broods with hens, and I have seen what was apparently the same band in the same water day after day. Such birds are much less wary than those attended by a mother; sometimes they may be approached to within ten or fifteen feet before showing alarm.

As full development approaches, the young gather in large, loose aggregations in the open waters of the bigger bays. As soon as they are able to fly, there is much movement of young birds between marsh and lake. The downy canvasesback can be mistaken for but one other duckling on the Delta Marsh—the redhead. Day-old birds of the two species are nearly indistinguishable at first glance. Both are predominantly yellow on the sides of the head, neck, breast, and underparts. In both species the crown and back of the neck, as well as the upper parts, are of a darker, olive shade. The only field difference between the two is in the color of the upper parts—the canvasesback is a shade darker. One authority, marking this color difference, described the upper parts of the canvasesback as varying from “sepia” to “buffy olive,” and the upper parts of the redhead as being “light brownish olive” in tone.

The plumage development of young canvasesback is not rapid. The first juvenile feathers do not appear until the bird is about three weeks old. Then true feathers begin to replace the natal down. It is not until the contour plumage is completely developed that the
Feathers of the wing are fully grown, so young birds cannot fly until juvenile plumage is complete. Plume development, as obtained in large numbers of young canvasbacks reared in the Delta Hatchery, is discussed on pp. 60-61. Field observations indicate that the development of the plumage of wild birds is closely matched by that of birds reared in captivity. In captives, there is a variation of about two weeks in the period required to reach the flying stage; a similar variation has been noted in the wild.

Juvenile plumage is worn for a short period only, as the molt to the first breeding plumage begins before the birds are twelve to sixteen weeks old. In the male, the eye color changes from olive-yellow to Vermilion at ten or twelve weeks. By this time the birds are nine or twenty weeks old, they are in their breeding plumage, but are not in full plumage until January or February. The juvenile wing is retained until the bird is about four months old, and is changed in the nuptial molt.

Plumage development of canvasbacks at Delta may not be the same as in the same locality reared in other latitudes. In the north, the greater amount of light in the northern breeding areas may cause more rapid development of plumage. Each October during the post-breeding period, birds through the region—canvases, canvasbacks, and hunters' bags are more abundant in the development of the nuptial plumage than in the localities. Many of these, identified as birds from other latitudes, have brown stainings on the breast which are not present in local species.

Molting hen has abandoned her brood by early August, no matter how young they are. Her wing plumage must be complete in time for autumn migration.

In the bays of Delta, diving ducks rear their young largely in open water. They do not shun the cover of emergent growths, but daily activities take place more in the open than at the marsh edges. River ducks, on the other hand, usually rear their families in the dense cover of the edges.

To be sure, they move and feed in open water, particularly in twilight hours, but far less so than the diving ducks. When one intrudes upon a brood of river ducks in open water, the young usually make haste for the nearest cover. Diving ducks, however, often seek sanctuary in open water, where they escape by diving.

Young redheads or canvasesbacks, however, have been observed to make themselves known to me by a frantic rush for open water as I passed by.

There is much variation in the behavior of brood females, particularly in their reaction to the intrusion of man. At Delta, feigning-behavior is most intense in the pintail and blue-winged teal. A mother pintail will give a show of feigned injury that would put any killdeer to shame. Redheads, like canvasesbacks, will feign with a newly hatched brood, but the feigning seldom is well acted.

Local guides insist that a mother duck has a vocabulary of calls and signals by which she directs her young, particularly in moments of impending danger. Students of bird behavior have shown that birds do have, in their innate behavior pattern, a code of movements and utterances that, when given expression by one member of a group, affects a response in other members. When I approach a brood of teal in the open marsh, the hen's first reaction to my presence is evasion. She stops feeding and swims away...
Me. Hochbaum, who illustrated his text especially for this magazine, is Director of the Delta Waterfowl Research Station in Manitoba. The article is excerpted from his book, *The Canvasback on a Prairie Marsh*, published by The Stackpole Company.

From me, the brood following her. As I continue to advance, she increases her speed until she is swimming as fast as the brood can follow. Then, as I continue to keep pace, there occurs a very rapid series of movements, and a change of behavior. Suddenly the hen utters a low, reedy, *whank, whank*, and flaps away from her ducklings in injury-feigning action. At the same moment, the young—which until now have followed their mother’s every move—rush away from her in a pell-mell, water-churning scurry for the cover of the nearest reeds. The special note of the hen, followed by the feigning actions, releases the escape reaction in the young.

Another type of directive signal functions to hold the family together. A mother blue-winged teal, kept for a period in captivity, constantly uttered a soft, low, *pe-tunk, pe-tunk* note. As I watched the family travel through the dense grass of the flying pen, the mother often was three yards or more ahead of her young; yet they accompanied her unerringly through the grass, not following her trail, but “cutting corners” when she changed her course. Apparently her note was a constant signal of identification and position by which the ducklings traced her movements, even though she was out of sight. The young, in turn, kept up a constant soft “peeping” among themselves, which held them together as a brood. Once I scattered them in the grass until they seemed hopelessly lost from each other. After a few moments of silence, stray “peeps” came from every corner of the pen and, shortly, the ten ducklings were again behind their mother.

I have pointed out that parentless young canvasbacks are much less wary than ducklings attended by a mother. Undoubtedly, the role of the hen in directing ducklings through her own responses to danger is an important factor in brood success. I suspect that broods attended by the mother until they reach the flying stage are much more successful than broods abandoned before they attain flight.

**Plumage development of a canvasback** begins with a newly hatched duckling’s yellow down, *A* contrasting with olive of back and crown. The patches fade when duckling is about half as long as hen. Cheek patches appear at another
eeks C and tail is prominent, still persists, D although flank pular feathers become distinct.

When about three-quarters the adult's swim-size, bird is nearly feathered E. Now almost fully grown, F bird's feathers do not quite cover rump. At fifty-six days, feathering is complete. Now, G juvenile may begin flight.
WHEN SUMMER ARRIVES in our Northern Hemisphere, the earth is actually farther away from the sun than at any other time of the year. However, the difference between maximum and minimum distances from the sun produces only a six per cent difference in the radiation received, and this effect is lost amid the other factors that bring about the warm season.

The axis of rotation of the earth is inclined to the plane of its motion around the sun, while its orientation in space remains constant; therefore the North and South Poles are tipped alternately toward the sun as the year progresses. As a result, the sun's apparent yearly course in the sky does not follow the celestial equator, but the path called the ecliptic (curve in illustration, above), which takes it through the successive constellations of the zodiac. From the spring equinox, on March 21, to the autumnal one on September 23, the ecliptic lies north of the celestial equator. On June 21, the sun reaches the northernmost point of its path; that is, its northward progress is stayed as it begins once again to move south. This is the summer solstice, from the Latin solstitium, "sun standing still."

At the summer solstice, in temperate zones, the sun climbs higher in the sky than on any other day of the year, thus its rays fall more directly on the earth's surface, imparting to it more heat proportionately. In addition to this, the summer solstice is also the longest day of the year, and therefore enjoys the most prolonged period of insolation. Yet this is only the first day of summer, preceding the hottest days by several weeks.

The upper layers of the earth's crust absorb and store solar heat. As the intensity of the sun's rays begins to lessen, the stored heat is released gradually into the atmosphere. The atmosphere, however, acts as a sort of blanket, retarding heat dissipation into its upper levels. This effect adds to the normal insolation, causing a temperature increase comparable to the conditions in a greenhouse. As a result, maximum temperatures occur generally in August after which the progressive decrease in solar heat becomes once again the dominating factor.

Seasons are reversed in the Southern Hemisphere so the South Pole is tipped toward the sun from September to March 21, and the summer solstice occurs on Decem...
The Equator and in the tropical regions, seasonal variations are much less pronounced, because the length of day is nearly constant throughout the year, and because there is less variation in the altitude of the midday sun. Poles, on the contrary, insolation is uninterrupted all year round. In fact, the total amount of heat received in a single summer day exceeds by about five per cent the amount received at the Equator, and the effective power of winter snow accumulations, not dissipated until early summer, provides the main reason why polar summers are not the hottest on earth.

The warmest days of summer are often called dog days in common language. The expression refers to an ill period, extending roughly from mid-July to early August. At that time of the year, Sirius (the “Great Dog” of the Romans—see illustration, above) rises in the eastern sky, just before sunrise. This fact had been noted by ancient Egyptians, to whom it heralded not only the heat of sultry days, but also the annual rising of the Nile. So important was the heliacal rising of Sirius to the Egyptians, that they used its recurrence to measure the length of the natural year, in a manner similar to our astronomical use of the spring equinox.

The Greeks and the Romans inherited the Egyptian beliefs concerning the influence of Sirius on the weather. They even thought of a “scientific” explanation for it: it was assumed that, at midsummer, the proximity of Sirius and the sun caused them to mingle their rays and thus produce the added heat. There was no River Nile in Athens or in Rome; the summer season brought only parching skies and pestilence. It is not surprising then to find that Greeks and Romans saw Sirius as a symbol of evil that must be appeased. Homer and Hesiod allude to the nefarious influence of the star, and Ovid, among others, tells of dogs sacrificed to secure its good will.

Somehow, the notion of the Dog Star—and of the summer calamities for which it was held responsible in the ancient world—became confused in the minds of later generations. Thus, the belief that dog days may cause madness in dogs is a fine example of mythology gone awry, and a wholly modern addition to the lengthy list of classical superstitions.
THE SKY IN JUNE AND JULY

From the Almanac:

First Quarter: June 2, 11:02 A.M., EST
Full Moon: June 9, 3:02 A.M., EST
Last Quarter: June 15, 11:36 P.M., EST
New Moon: June 23, 10:27 P.M., EST
First Quarter: July 1, 10:49 P.M., EST
Full Moon: July 8, 2:37 P.M., EST
Last Quarter: July 15, 10:43 A.M., EST
New Moon: July 23, 1:31 P.M., EST
First Quarter: July 31, 7:39 A.M., EST

The solstice will be reached on June 21, at 4:43 A.M., EST, marking the beginning of summer in the Northern Hemisphere. The sun will attain its northernmost declination on that date (see pp. 62-63).

For the visual observer:

Mercury will be at its greatest eastern elongation on June 19, and will be most favorably located—about five degrees south of Pollux—on that date. It will remain in the evening sky throughout the month of June, setting ninety minutes after sunset on June 1, one and three-quarter hours after sunset on June 15, and one hour after sunset on July 1. Approaching the sun gradually during the first half of July, it will be in inferior conjunction on July 16 and will remain poorly placed for observation (in the morning sky) for the remainder of that month.

Venus will be too close to the sun for observation both in June and July. It will be in the morning sky until June 22. On that date it will be in superior conjunction with the sun and will enter the evening sky.

Mars (+1.0 magnitude) will rise in the east at about 2:00 A.M., local standard time on June 1, and will continue rising about two minutes earlier each day in June and July, making it thus approximately 1.00 A.M. on July 1 and midnight on July 31. At the end of July, its magnitude will have brightened somewhat to +0.9, and it will be found south of the Pleiades, looming high in the eastern sky at the onset of dawn.

Jupiter will be located between Sagittarius and Ophiuchus about fifteen degrees east of Antares. It will rise one hour after sunset on June 1, and at sunset on June 15. After that date, and for the rest of June, it will be up in the southeastern sky after dark, passing low in the south near midnight and setting in the southwest shortly before dawn. In July, it will be favorably placed in the evening sky (see map) and will set about forty-five minutes before sunrise on July 1, two hours before sunrise on July 15, and three hours before sunrise on July 31.

Saturn, in Sagittarius, also will be visible in the evening sky. It will rise about two hours after sunset on June 1, one hour after sunset on June 15, and in the evening twilight on July 1. Visible all night throughout the month of July, its brightness (+0.3 mag.) will be nearly two and a half magnitudes fainter than Jupiter’s.

The Delta Aquarid meteor shower is expected on July 29, with a possible maximum rate of twenty per hour. A few Perseids may be seen in late July, although the Perseid shower does not reach its maximum until August.

The former Astronomy Editor for Nature Magazine, Mrs. Gossner, continues in that role for Natural History.
MAGNITUDE SCALE

- 0.1 and brighter
- 0.0 to +0.9
- +1.0 to +1.9
- +2.0 to +2.9
- +3.0 to +3.9
- +4.0 and fainter

TIMETABLE

<table>
<thead>
<tr>
<th>Date</th>
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<tr>
<td>June 1</td>
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<td>June 15</td>
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<td>July 1</td>
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<td>July 15</td>
<td>9:00 P.M.</td>
</tr>
<tr>
<td>July 31</td>
<td>8:00 P.M.</td>
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(Local Standard Time)
Hunting is prohibited in the national parks, as is commercial timber-harvesting. Watershed protection is, of course, inherent in these areas, and recreation is an important use, although protection was and is the primary objective. To the fundamentalists among the multiple-use clan, parks constitute but a single-use, and thus, to them, a waste of resources. A truce, now and then an uneasy one, would no doubt have continued, were it not for two factors. One of these is the strong drive for creation of a Wilderness System, now embodied in legislation known as the Wilderness Act, S.1123. Under this program, certain outstanding primitive areas in the national forests, national parks, and fish and wildlife refuges would be given a protected wilderness classification by national law and would be removed from departmental regulations, so easily changeable at the stroke of a pen.

The other factor that has stirred up the multiple vs. single-use trend has been recent demands for the creation of a number of new national park areas, including Northern Cascades National Park in the State of Washington, and Great Basin National Park in Nevada. Considerable acreage is involved, and most of it would be taken from national forest holdings.

Extensive hearings on the Wilderness Bill and the presentation of the park proposals in specific terms have resulted in much debate over multiple-use and alleged single-use. It remained, however, for Assistant Secretary of Agriculture Ervin L. Peterson to dust off his flintlock and start shooting. Aiming at the national park proposals, he asserted: "I am firmly convinced that action to weaken or dismember the national forest system would be inimical and contrary to the public interest."

Training his sights on the wider idea, Mr. Peterson declared: "True preservation means management of national parks, area by area, to achieve maximum of usable values from a location, and without impairing the future ability of the land area, the resources to keep on producing these values indefinitely."

From his side of the fence, Secret of the Interior Fred A. Seaton returned Peterson fusillade. Taking advantage of a Park Service conference in Williamsburg, Virginia, Mr. Seaton wrote a special letter to Conrad Wirth, Director of the National Park Service. The Secretary paid tribute to those who had brought about the national park system, and pointed out that the frontier is gone and we are now in the midst of a population "explosion. Competition for land is stiff and demands are intensifying. Mr. Seaton declared that: "There is every reason to believe that the next five or ten years constitute critical years if we are to keep what we need to our heritage of scenic historic, and cultural treasures for the use and enjoyment of the greater, largely urbanized population of the future."

"Because of the situation with America confronting in this respect," Secretary continued, "I ask you and your colleagues in the National Park Service to give high priority to a program of studying and identifying such areas which should be preserved for the enjoyment and inspiration of all people of America. These should include seashores, scenic mountains, prairie grasslands, places of national importance in our history, and other areas of significant types in this regard."
intrinsic value for public refreshment, enjoyment, and inspiration be clearly identified, and steps taken to protect and preserve them for this overlying purpose before they are irreparably lost to other uses. Action on that problem I believe to be of transcendent importance."

As the issue is joined. The fending for a dual-use of public land, as derived from the very terms of "single-use and dual-use—black or white," with no gray in between. It would be obvious that no area of public land provides only a single use; that it is a question of values, and a matter of philosophy of land management. Call it primary use, greatest use, basic use, or something else, the area can only be served by a farseeing philosophy of our remaining land assets.

Our Traveling Public

Or that Americans are not content to remain static is found in the 1959 figures of national parks and national forests. The National Park Service reported 62,812,000 visits to the 29 national parks and 151 other areas administered by the Service. This was an increase of 4,315,000 above the 1958 load. The twenty-nine parks received 22,392,000 visits, an increase of 1,671,000, or 3.3 per cent above 1948. Of the national parks, Great Smoky Mountains in North Carolina and the Appalachian Mountains received 3,162,318 visitors. Yellowstone, Sequoia, Yosemite, and the Grand Canyon—some of the more isolated park areas—were all in the 1,500,000-visitor category.

Of course, these figures represent a duplication of visits by Americans who travel more than one park on vacation and therefore leave no doubt of the basic importance of the National Park Service in 66," which seeks to be ready in time. The estimated 80,000,000 visitors by the end of 1966.

The expansion of use of national forests to an all-time high in 1959, with 424,900 visits to these areas, was a 15 per cent increase of nineteen per cent above 1958. The U. S. Forest Service reports that the most popular purpose of forest visits was general aesthetic enjoyment of the forest. Following in order of importance were picnicking, fishing, and hunting in that order. So was the 1959 visitation that the Service found existing facilities in campgrounds and camping-in that order. So was the 1959 visitation that the Service found existing facilities in campgrounds and camping-in that order. So was the 1959 visitation that the Service found existing facilities in campgrounds and camping-in that order. So was the 1959 visitation that the Service found existing facilities in campgrounds and camping-in that order. So was the 1959 visitation that the Service found existing facilities in campgrounds and camping-in that order. So was the 1959 visitation that the Service found existing facilities in campgrounds and camping-in that order. So was the 1959 visitation that the Service found existing facilities in campgrounds and camping-in that order. So was the 1959 visitation that the Service found existing facilities in campgrounds and camping-in that order.
Water Pollution

POLITICAL ammunition in an election year appears to reside in President Eisenhower's veto of the bill to amend the Federal Water Pollution Control Act. This was followed by the action of the House of Representatives, which voted to override the veto by a vote of 249 to 157-22 votes short of the necessary two-thirds. The measure was passed by the House in 1959 by a vote of 255 to 143, and by the Senate, 61 to 27.

Although it is now academic, the measure would have increased grants—from 50 million annually for ten years to 90 million annually for the same period—to municipalities for construction of sewage treatment plants. The ceiling of $250,000 for individual projects would have been raised to $450,000. The measure was approved by the Water Pollution Control Advisory Board and widely supported by conservationists.

The President's veto was on the ground that the primary responsibility is state and local; that "...holding forth the promise of a large-scale program of long-term Federal support, it would tempt municipalities to delay essential water pollution abatement efforts while they waited for Federal funds." He urged a national conference on water pollution [which would be another in a long series] and aid to local governments through research and technical assistance [which has been rendered for some time].

Military Conservation

Although the Army, Air Force, and Navy have been carrying on some conservation activities on lands under their jurisdiction, the Navy is the first to establish a Natural Resources Management Branch, Commander C. R. Zirzow heads the new branch, which has been placed in the Bureau of Yards and Docks, and which will manage natural resources on Navy lands. He will be assisted by three civilian consultants in the areas of forestry, erosion control, fish, and wildlife.

Planting of Trees

More than two billion trees were planted on 2,118,471 acres during 1959, according to information compiled from field reports to the U.S. Forest Service. One third of the trees planted was cropland, placed in Conservation Reserve program under ten-year contracts, provided by the Farm Bank Act. Thus, acreage has been cleared from crop production and turned to conservation purposes, thanks to the incentive extended to farmers through the cost-sharing provisions of the Farm Bank Act.

Secretary of Agriculture Ezra Benson points out, however, that: "...we have a lot of idle forest lands to get full production if we are to have the test products needed in the future. We catch up with areas deforested in past and keep caught up, we will increase to the rate of planting. . . ."

In the present statute, $450,000,000 are allocated for the Conservation Reserve, but only $375,000,000 were appropriated for the past fiscal year. Also, provision for the Conservation Reserve expires December 31, 1960, and if it is extended, as provided in pending bills, no applications for classification of lands in this category can be accepted beyond that date. Applications in the past have been about double the number of contracts granted. This is an entirely voluntary program.

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PROGRESS REPORT ON A NATIVE ANIMAL Wendell G. Swanson
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DEPARTMENTS
REVIEWS IN BRIEF
SKY REPORTER Simone Daro Goss
NATURE IN ROCK AND MINERAL Paul Mason Tilden

COVER: These gulls, busily investigating the food deposited on the shore by the swash of the now gentle Atlantic Ocean, are part of the population of Beach, on the New Jersey coast. This narrow strip of barrier beach lies fifty miles north of Atlantic City, separated from the mainland by Barnegat Bay. It is a slice of virtually undisturbed seaside vegetation, inhabited by birds, mammals, reptiles, and various invertebrates that find the element congenial. The area, of particular interest to naturalists as a reminder of primitive, East Coast shore line, is described in detail beginning on p 348.

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Reviews in Brief

Ilias of Pedro de Cieza de León, translated by Harriete de Onis, edited by Wolfgang von Hagen. University of Chica Press, 1939, $3.95; lxxx+ illus.

Knowledge of the extraordinary story of the Incas comes to us from the writings of Spanish priests, and officials who took the conquest of Peru or lived and died there in the decades that followed. This new translation once again available in English the account of the most careful and credible of all who ever to write about the Incas. Six years after he landed in the New World, Cieza began to write his chronicles. It had already ensnared his mind to set down what he had learned, but modesty about his literary at first deterred him. Later he made this hesitancy, having been largely, he tells us, by the fact that he had taken notice wherever he went, that nobody concerned himself with anything of what was happening. (Page 3).

In 1547, Cieza joined the forces led by Gonzalo Pizarro. For four years he traveled over a considerable part of the country, observing, interrogating, and taking note of much of what he learned. He wrote his histories with a condor’s quill, on pieces of foalscap, often with nothing better for a table than a drumhead. La Crónica del Perú was finished in 1550.

Cieza’s Crónica comprised four parts. Part One, although consisting largely of geographical descriptions, also contained information about the local customs of the inhabitants of the valleys he visited, especially those customs that preceded the Inca conquest. This part of the Chronicle, which was printed in Seville in 1553, was the only one of the four to be published during Cieza’s lifetime. Part Two, which remained in manuscript for more than three hundred years, deals with the Inca Empire, particularly with its achievements in government and religion. Of these first two sections of the Chronicle, the latter is by far the more useful to anyone seeking to learn about Inca culture.

The third and fourth parts deal, respectively, with the conquest of Peru and with the civil wars that arose among the Spaniards thereafter. They are of no particular interest ethnographically, and have been omitted from this edition.

Here, the two hundred-odd chapters comprising Part One and Part Two of the Chronicle have been rearranged, renumbered, and integrated into a single book. Not every chapter from the original Spanish text has been preserved; those dealing with Colombia, and a few considered by the editor to involve excessive duplication, have been deleted. The part and chapter numbers of the original text are given in parentheses after the new chapter numbers, making it possible to locate more or less easily any chapter whose number in the complete Spanish editions is known.

Cieza’s outstanding characteristic as a chronicler is his passion for accuracy. Before any entry was included in his chronicles, he took considerable pains to assure himself that it was as nearly correct as his own interrogations and investigations could make it. In attempting to learn the facts about Inca civilization, Cieza was working at a disadvantage. The empire had been overthrown fifteen years before he arrived in Peru, and to reconstruct the fabric of Inca society he had to rely on informants rather than on direct observation. Someone less punctilious might have recorded the most dramatic version of an important incident without further qualifications, but...
Cieza never disguised the fact that what he portrayed often was only the best approximation to the truth. He tells us that his informants sometimes differed "... on many points, some saying one thing, and some another, and no human mind could put all this in order, but can only take from what they related that which they themselves consider most true..." (pp. 231-32).

Cieza was in general quite sympathetic toward the social system that the Spaniards encountered in Peru and overthrew. He repeatedly expresses admiration for the Inca achievement and, noting the amount of disorganization that prevailed in his time, occasionally upbraids his countrymen for recklessly destroying what the Incas had so carefully built. But one should not expect a complete or balanced account of Inca culture. Cieza himself was most interested in the administrative system by means which the empire was governed, and in Inca history and dynastic succession. In these matters, the information he provides is deep and rich.

There is a wealth of material on the investiture of the Inca, his prescribed marriage to his own sister, his powers and prerogatives, his conquests at the head of his armies, and the like. Cieza was impressed with the honesty, compassion, and justice with which the Inca ruled his subjects, and with the extreme awe and respect in which he was held by them. There is a brief but graphic description of the Inca system of taxation, which, while best known for exacting labor (the corvee), made use of taxation in kind as well. About other subjects, such as agriculture or architecture, the Chronicle teaches us comparatively less.

The present translation, by Harriet de Onis, is excellent. Cieza's meaning is rendered with clarity and fidelity, while at the same time the peculiar flavor of sixteenth-century Spanish is retained. Victor von Hagen has done a thorough job as editor. His introduction is, in all likelihood, the best biographical sketch of Cieza in existence, especially since it makes use of source material unavailable to previous biographers, and the footnotes provide background material that will make Cieza's account infinitely more meaningful to a modern audience.

ROBERT L. CARNEIRO,
The American Museum

Fundamentals of Ornithology
Along with the great increase in numbers of bird watchers, there is an increase in the ranks of serious students who wish to study ornithology in institutions of higher learning. This work is the best text currently available in ornithology at the graduate level.

Some years ago, the late Dr. Jos Van Tyne began a book on the birds of the world, which he eventually did

exaggeration when he calls them "... the field of zoology ... a literary mark of a magnitude not equaled after Cieza in America or the world." Like they are, and one of their chief claims is that of following Mr. Bent, the company of well-known American naturalists of the last generation of which the reader, stylistically, is taking two volumes to has succeeded in preserving this atmosphere and giving us a vignette of each species of the originals, these are as often words of other naturalists as in Bent's own unfulfilled prose.

Surprisingly enough, Bent started an "eggologist," but unlike some of that vice, he largely outgrew it, that he never caught without an egg, and blowpipe in his pocket. When preparing each volume, he would visit The American Museum for moments of eggs not in his collection; the reviewer recalls the trepidation which he approached the task of collecting the eggs of rare hummingbirds, Mr. Bent. All such data Mr. Collis, happily deleted. The photographs, formed a conspicuous feature of the originals, have also disappeared without trace or mention.

Anyone who wishes to enrich his knowledge of American birds by looking through the writings of well-known naturalists will appreciate these volumes.

DEAN AMADON,
The American Museum


The twenty volumes of the Life Histories of North American Birds, by Arthur Cleveland Bent, are a landmark in American ornithology, though Mr. Collins is committing the most flagrant
Reasonable hawk eagle, also from Van Tyne.

The Physiology of Forest Trees, a symposium held at the Harvard Forest, April, 1957; ed. by Kenneth V. Timmann. Ronald, $12.00; 678 pp.

THIRTY-FIVE papers on various aspects of tree physiology, from reproduction to root growth and water movement, are collected in this weighty tome. All are highly specialized, review-type articles of interest chiefly to trained botanists and designed primarily to grace the reference shelves in college libraries and research laboratories. However, other readers will find information of general interest in a few articles, particularly those concerning "The physiology of maple sap flow," "Dew absorption by conifers," and—despite the title—"Photoperiodic control of growth and dormancy in woody plants.

Those who have never attended a scientific conference may find the transcriptions of the discussions by the scientists in attendance at the symposium to be of great interest. However, in most cases the discussions were allowed to wander far from the point and are in the superficial conversational form characteristic of extemperaneous verbal exchanges. Stricter editing of these sections could have reduced the size of the book and, perhaps, its cost without noticeable damage to its content.

Jack McCormick,
The American Museum

Out of Noah's Ark, by Herbert Wendt. Houghton Mifflin, 88.30; 464 pp., illus.

Aurochs, tahts, bndegos, langurs, tapirs, dodoes, muhalus, chequos, and abominable snowmen are only a few of the creatures to which Herbert Wendt devotes himself in what purports to be a summary of zoological exploration. Actually, the material he has assembled has to do largely with the legendary, or at best the possible. It is fortunate that Wendt's style is pleasant and well managed; otherwise, his book might have been a thoroughly turgid catalogue. Still, the mind boggles at times, as the reader finds

(continued on page 58)
An Unspoiled Bit of Atlantic Coast

New Jersey's Island Beach preserves a pre-Colonial landscape

By William E. Martin

Island Beach State Park occupies the last undisturbed stretch of barrier beach in New Jersey, and probably the largest natural area of its kind on the North Atlantic coast. Consisting of a narrow finger of sand reaching from Seaside Heights to historic Barnegat Inlet, Island Beach is separated from the mainland by the quiet waters of Barnegat Bay and pounded on its eastern flank by the Atlantic Ocean. Its ten miles of ocean shore and more than 2,300 acres of dunes, thickets, woodlands, and marshes comprise a unique remnant of the primitive Atlantic coast, which looks today very much as it did to the early settlers.

A peculiar combination of historical circumstances is responsible, at least in part, for the fortunate preservation of this remarkable area. Barnegat Inlet, then unnamed, and the "beach" to the north are mentioned briefly in the log of Hudson's 1609 voyage, and local folklore contains the inevitable dead men, pirate's treasure, and the like. For a short period of recorded history—from 1750 to 1812—Island Beach was truly an island, its northern shore marked by Cranberry Inlet. During the Revolutionary War, various enterprising, but poorly armed, American privateers made use of the inlet to escape from the British, whose larger ships could not navigate the shallow water.

For the bustling port of Toms River, on the New Jersey mainland, it was a gateway to trade. That gateway was closed by a tropical storm, never to be opened again.

As settlements on the Jersey mainland grew into metropolitan areas over the years, resorts spread rapidly over most of the barrier beaches. In this early rash of estate development, Island Beach was spared because property owners preferred to keep their holdings as investments in a possibly even more prosperous future.

Toward the end of the nineteenth century, three Coast Guard stations were built on the dunes, and some of the men stationed at these outposts obtained permission...
AGE POND at extreme southern tip of Island Beach ismer nursery area for terns. Masses of flightless young sit on the sand, leaning into the wind, and wait for their parents, who have caught large minnows, to find them.

SHORE, usually a smooth, sandy incline, is often cut by a heavy northeast blow. Surf fishermen can depend on a good catch when the undertow uncovers a food supply that lures fish into the shallow waters near shore.
Bay shore bank is held against onslaught of waves by the tangled roots of plants and the windrows of cast-up eelgrass.

build cottages nearby. With the precedent established, other cottages and driftwood shacks sprang up among the dunes, and houseboats appeared along the bay shore. Over half a century, the forgotten beach south of Sea Heights was a sort of squatter's paradise, populated mainly by weekend surf fishermen. Then, in 1953, after an attempt to establish an exclusive resort, New Jersey chanced the property for use as a state park.

Before the park was opened to the public in 1959, the northern third of the ten-mile beach was set aside as a botanical preserve. The middle section was designated for recreational development, while the southern portion was reserved for a wildlife sanctuary (with limited recreational facilities) and a marine fisheries research laboratory. In the present time, Island Beach provides an unexpected haven for nature lovers.

Beach heather, left, which helps to control wind erosion, turns brown in drought, becomes green again after a
Dusty miller (Artemisia Stelleriana), an Asian wormwood first introduced as garden plant, now grows wild on dunes.

Dune grass, here growing sparsely, establishes footholds in the sands, stabilizing them against the wind and waves.

With other plants, the Virginia creeper, right, form impenetrable thickets that shelter animal life.
of higher plants representing sixty-six different families. Almost a third of these are weeds, and are found only along the main highway and around building sites. Some are introduced species, but only two are well established. Over half of the native plants are relatively rare. The bulk of the vegetation is composed of about seventy-five abundant species, which combine in various ways to produce many strikingly different kinds of vegetation cover.

The eastern edge of the area is a narrow strip of ocean shore, inhospitable to most plant life. The shifting provide no anchorage for rooted perennials, while the and brightness of the sun—together with the salt-laden breezes—prevent the growth of all but a few hardy als, such as the sea rocket Cakile edentula. While the is thus lacking in vegetation—the primary source of mal food—it supports an abundance of creatures decent, directly or indirectly, upon the sea. One of these mole crab, Hippa talpoida, also known by the local l
RISING WAVES expose crustaceans nearby sandpipers, knots, dowitchers and other shore birds, above, who race ahead of foaming water's edge.

These shellfish washed ashore by past storms sometimes litter the sand, right. Gulls feast until wind-shift cleans sand.
Least terns nest in secluded areas, to which they bring bits of broken shells on which they lay their fragile eggs.

Raccoons seem unlikely inhabitants of the barren dunes, but there is sufficient food to maintain their population.

of sand bug or sand crab. This small crustacean sits ely, half-buried in the sand, and lets the water wash and fro overhead. When threatened by danger, it bur backward and virtually disappears—only its V-shaped tennae show. If the mole crab is stranded by low tide, it digs down three to six inches in the wet sand, and until the water has again invaded its beach.

The ghost crab, *Ocypode quadrata*, whose color and speed make it virtually invisible on the white sand, is another familiar member of the shore community. T and many other small creatures are prey for cr sanderlings, plovers, and other shore birds. The sandlings seem to be playing a game as they flee before swash, then chase the backwash of each breaking wave. Actually, this is maneuvering to catch crustaceans but they can burrow out of sight or “disappear” by sitting perfectly still and blending with their background. Ring gulls, too, haunt the area, eating clams and dead washed up by the sea.

Inland from the shore, above the reach of high and storm waves, is a zone composed of the sand that has been blown there by gentle ocean breezes or by hoop northwesterly gales. This zone is characterized by d and hollows that combine to form an unending varie
The sparse vegetation bordering the dunes is composed primarily of dune grass, or marram Ammophila breviligulata with a sprinkling of other such as beach heather Hudsonia tomentosa, dusty Artemisia Stelleriana, and Virginia creeper Parthenocissus quinquefolia. Dune grass is especially well adapted to this desert-like, unstable habitat. Above ground, its stems and leaves reduce the velocity and carry-away of surface winds and cause the deposition of sand. Below ground, its rhizomes and roots form an intricate, which helps bind the sand into place. Many of the dunes in this zone are composed of successive layers of sand held in place by past generations of dune grass. Farther inland, where sand movement is less prevalent, the low, sprawling cushions of beach heather stabilize the surface.

Small animals that make their homes in these dunes are also well adapted to the special features of their habitat. The pale wolf spider, of the Lycosidae family, for example, sits patiently inside its burrow in the sand, ready to pounce on unwary insects that pass by. Its coloration blends with the environment and, instead of spinning a web, the spider captures its prey by speed and remarkable stealth.

Old breeding mound was selected by black skimmers for a nesting site. From here they patrol bay waters for minnows.

Ghost crab emerges from burrow when tide falls and darts after food. When it stays still, it is perfectly camouflaged.
strength. The seaside locust, *Trimerotropis maritima*, is another dune-dweller that blends with the sand. It feeds on dune grass and other plants in the area.

Farther inland, dune grass and beach heather give way to a vegetation dominated by woody plants, Bayberry, black cherry, beach plum, highbush blueberry, American holly, red cedar, poison ivy, and many other species of shrubs and low trees are intertwined and laced together by Virginia creeper and the thorny greenbriar to form low, impenetrable thickets. Low at their seaward edges and sloping gradually to as high as fifteen feet to landward, these thickets—pruned and sculptured by salt spray—present a distinctive, streamlined appearance.

Taller thickets and woodlands can develop only on sites protected from spray-laden winds by their distance from the shore or by intervening dunes. Woodlands dominated by red cedar *Juniperus virginiana* or pitch pine *Pinus rigida* are primarily confined to the northern part of the park. These have the richest flora and fauna of any of the forty-odd community types represented in the area.

Such thickets and woodlands provide the cover for large populations of rabbits and a variety of bird species. The abundance of rabbits may be attributed, in part, to the scarcity of foxes and other predators. The few foxes that live in the area, as well as marsh hawks and other birds of prey, find it both difficult and hazardous to hunt rabbits in the thorny vegetation they use for cover.

Although it is only half a mile from the ocean, the western shore of Island Beach, facing Barnegat Bay, presents a vastly different countenance from the eastern side. In some places, there are narrow strands of sand strewn with a water-soaked eelgrass *Zostera marina*, the breeding place of countless biting flies. Behind the sand strips are

*Nearly invisible nets are strung across movement routes of birds, which are usually caught during morning feeding.*
Following identification and banding, birds are released unharmed. Mesh holds them gently while bander takes notes.

low, grassy dunes. In other places, the bay shore is bordered by tidal marshes whose vegetation is characterized by salt grass *Spartina patens* and a small, fleshy samphire *Salicornia virginica*, whose Latin name—from “saline”—indicates its adaptability to its environment. On the bay shore and just above the high-tide boundary of some of the tidal marshes are great stands of reed grass *Phragmites communis* that blanket the Jersey flatlands farther north. From late spring to early fall, the air over the marshes swarms with mosquitoes. Ditch banks are riddled with the burrows of fiddler crabs, which fall prey to raccoons, great blue herons, and other shore birds.

Certain factors appear to be especially important in forming each of the five recognizable plant communities on Island Beach. Of these, the distribution of salt spray is one of the most apparent. The intensity of the spray, which is windborne inland and deposited on the exposed parts of plants, is greatest near the ocean shore and decreases farther inland. Dune grass and a few other species are tolerant of salt spray, but most herbaceous and virtually all woody species are severely damaged or killed by exposure to spray in large amounts. Only inland, where spray intensity is reduced, can woody species become established and grow into thickets.

Tree twigs that are exposed to spray are killed and terminal growth is suppressed. Thus, shrubs and trees alike are pruned to about the same height and molded into dense thickets, which grow very slowly and never seem to develop into woodland or forest. In more protected sites, the ground level effect of spray on trees is negligible, but taller trees, especially in open spaces, have deformed crowns that appear to reflect the influence of the salt.

The varied face of Island Beach, by its constant flux, is made even more expressive of the laws of nature. Waves reshape the shore. Winds rearrange the patterns of dunes, and plants modify the work of the wind. Salt shapes the plants into characteristic forms, and plant communities
A great wingspread—as much as six feet—characterizes the osprey, an eagle-sized hawk that patrols the bay shores and inland ponds for fish. When fishing, it flies high, spots its prey, then rockets down to the water to seize.

Change the physiognomy of the landscape. Sometimes the innate forces of nature and the growth of plants combine to change the shape of a piece of land, setting off a chain reaction that completely alters both the physical and the biological characteristics of a habitat. For one example, Barnegat Bay usually freezes over in winter, and the expansion and erosive action of the ice—first freezing and then breaking up in the spring—throws up low ridges of sand mixed with eelgrass and silt. When these ridges are stabilized by the growth of pioneering reed grass, they form effective dams against tidal flooding. If this process occurs along the bayward edge of a tidal marsh, further saline inundation is prevented. The salt already present is slowly leached out by rain, and the soil solution from which the plants draw their water and mineral nutrients gradually changes from salty to brackish to fresh. Even the early stages of this evolution, the changing marsh provide niches for the marsh mallow and various of plants that are unable to grow in highly saline s.

Later, small fresh-water ponds may be inhabited by leopard frogs, which cannot tolerate saline waters. Eventually, these once-salty, grassy marshes may develop thicket or woodland communities with an entirely different combination of plant and animal occupants.

The great diversity and perpetual changing of Island Beach landscape and biota present the professional ecologist and the amateur naturalist with a multitude of lessons, mysteries, and quandaries. Within relatively narrow boundaries are packed a fascinating array of plant and animal communities virtually unaffected by the activities of civilized man. Being thus unique, it is of inestimable value for the enjoyment or study of the myriad forces that have shaped our coastal la.
The tower near ocean shore has been popular nesting places of osprey, which, in the absence of big trees, will take advantage of almost any available support. Young may remain in the nest for as long as six or seven weeks.
Gluttony with
good reason

Some honey ants become living reservoirs

By Ross E. Hutchins

The various ways that animals have solved the manifold problems of life are a source of constant interest to students of nature, and often shed light on the evolution of particular activities. Noteworthy in this respect are the ways of the social insects—the ants, bees, and wasps—whose life patterns reveal some of the most remarkable adaptations in the animal kingdom. Honey ants, which utilize a distinctive method of solving the food storage problem, present a particularly interesting example of such specialized adaptations.

Several species of ants possess well-developed, characteristic methods of storing food. Harvester ants, for instance, gather seeds, which they store in "grain bins" beneath the surface of the soil. But the storing of a liquid food, such as honey, presents difficulties. Bees store their honey supply in cells formed of wax; but honey ants are not endowed with the ability to secrete wax. How, then, can they store such a fluid material? Their solution to this problem is an ingenious one.

The recorded story of the honey ants goes back more than a century—to the year 1832, when the first account of the insects was published by Dr. Pablo de Llave in a Mexican scientific journal. Dr. Llave obtained his information at second hand from a person living in Dolores, a village near Mexico City; but while his information about these ants (known there as busileras) was indirect, he described their activities with surprising accuracy, and in some detail.

The honey ants received occasional notice in scientific journals after their initial description by Dr. Llave, and in the summer of 1879, Henry Christopher McCook, a Presbyterian minister, made a trip to the American West for the purpose of studying the ants in their habitat. Dr. McCook was a prominent contributor to ant lore, having previously made extensive investigations of the harvester ants that populate the Great Plains.

McCook arrived at Manitou, Colorado, in July, 1879, on his way to Santa Fe, New Mexico, where colonies of the honey ants had been reported. By a strange coincidence—and more or less by accident—he found honey ant colonies sooner than he had expected, in the area known as the Garden of the Gods, in the vicinity of Manitou—now a suburb of Colorado Springs. This area, which lies on the slopes of Pikes Peak at an elevation of slightly more than 6,000 feet, consists of numerous exposed slabs of red sandstone thrusting skyward; the slabs have been weathered into various weird shapes, thought by some to resemble heathen deities, and from the region takes its name.

Honey ants exist under very special ecological conditions, such as prevail at this locality: the soil is sandy, firm enough to allow the ants to excavate relatively broad underground galleries, with arched ceilings. Here Dr. McCook found the ant colonies scattered along sandy ridges among the sandstone slabs.

Having thus located his quarry, McCook erected his tent in the valley below the junction of Adams and Hagen ridges in order to study the insects and record their story. His investigations resulted in a class account of the habits of honey ants, which was published in 1882. Within the next 15 years, the present writer visited the Garden of the Gods area to take photographs on these pages, he found the locality little changed from its condition of 1879. In fact, it was po
to locate, within a few yards, the site of Dr. McCook’s camp, made some eighty years before.

Growing on the sandy slopes of the Garden of the Gods are numerous scrub oaks that support large numbers of galls, formed through the activity of certain tiny gall wasps. During the summer these galls, which resemble small marbles, secrete honeydew upon their outer surfaces. The honeydew is secreted mostly at night, and it is then that the yellow ants stream forth from their underground tunnels and imbibe the sweet drops of moisture.

The worker ants leave their nests at about seven-thirty in the evening—which, during summer, is approximately the time of sunset—and the return trip toward the nests begins at about midnight. By dawn, almost all the foragers are safely back in their subterranean nests. When they leave the nests in the evening, the workers have abdomens of normal size, but on the homeward journey their abdomens are distended with loads of the amber-colored gall nectar.

Arriving at the nests, the loaded worker ants “feed” their nectar to certain individual worker ants that serve as “storage tanks” for the colony’s food supply. As the nectar-harvesting season progresses, the abdomens of these individuals become so distended that the insects can no longer walk about normally, but hang suspended by their legs from the ceilings of the galleries that form their nests.

As these ants’ abdomens slowly expand with nectar, the membranes between the segments stretch until the sclerites (the plates covering the abdomen) become reduced to mere ovoid islets on a spherical surface. The engorged ants cling to the arched ceilings of the tunnels, and it is said that if one falls, it is helpless, being unable to regain its suspended position. This, however, is not an established fact; the writer observed that the sister workers of such ants appeared to make an effort to help them recover. Further study is needed on this point.

The engorged individuals are called “repletes.” If one is dropped as far as two inches, its abdomen may burst. In the nest, however, this does not often occur, since the fall is seldom more than half an inch or so. Dr. McCook weighed a number of the normal workers, and found their average weight to be 0.043 grams. He also weighed the honey from the repletes’ abdomens, and found that it averaged 0.3942 grams. Thus, the store of honey in an engorged specimen averaged about eight times the ant’s weight.

The storage of honey or nectar in the abdomens of various species of ants seems a logical solution to a storage problem: the safe storage of a liquid food over a long period of time. Accordingly, it is not surprising that we find many sorts of honey ants in other parts of the world—Australia, for example. It seems to have been a generally accepted practice for ants to have these extraordinary capabilities. Some of these ants are known as “honey hunters,” and others as “honey stomachs.”

Golden-yellow worker ants of normal size, above and at right, mingle with repletes. Some of latter have fallen to floor because of nest disturbance.
Aca, for example. They are not, however, as spectacular in their honey-storing habits as those of the American Southwest and Mexico; and it is worth noting that the honey-storing ants elsewhere in the world are not closely related to our own.

In the United States, itself, there is another quite widely distributed ant— the genus *Prenolepis*—that also possesses the honey-storage habit, but in a lesser degree. *Prenolepis* workers are often seen crawling about with their stomachs considerably distended with honeydew gathered from aphids or soft scale. These workers, however, do not imbibe sufficiently to render them incapable of movement, as is the case with many of the workers in every well-established colony of *Myrmeco-cystus horti-deorum*, as the Garden of the Gods honey ant is known under its scientific name.

It has never been established how certain workers happen to become repletes, rather than foragers, but it is a fact that there may be up to three hundred of them in the nest galleries. Here, in the darkness, the repletes hang month after month through late fall, winter, and early summer. Now and then other ants visit them and receive regurgitated honey from their mouths; but otherwise their lives are without incident. After assuming their roles as living tanks, they never again see the light of day.

Indeed, the repletes are the ant colony's sole source of nourishment during much of the year—for the region is without sufficient moisture to produce nectar-bearing flowers, and the oak galls do not produce honeydew until midsummer. Except during this one brief period, then, workers, queen, and young must all look to the repletes for their sustenance. During winter, the colony is dormant; and the repletes, deep in their galleries, remain safe from the frost.

The southwestern United States is an exacting environment, providing extremes of temperature as well as of drought. Among the creatures to be found in this harsh region, few can be better adapted than the honey ants.
Children of the Forest

Thus the Pygmys aptly name themselves

By Colin M. Turnbull

Just to the west of Africa's Ruwenzori Mountains lie the many thousand square miles of the Ituri Forest, a tropical rain forest that covers much of the northeast corner of the Belgian Congo. Here, throughout the year, the climate is even: temperatures range between 70° and 90° F., although an average relative humidity of 95 per cent makes the nights and early mornings seem chilly and at times almost bitter. Rain comes in torrential downpours that last only an hour or two, usually in the afternoon or evening. Such cloudbursts can be expected at any time of the year, although December and January tend to be less rainy than the other ten months.

The terrain is gently undulating under its cover of dense, primeval forest. The branches of the tall trees meet high overhead and shut out the heat and glare of the sun. Toward the east, the country actually becomes mountainous, but it is possible to go everywhere on foot with relative ease. The larger rivers that meander through the forest form natural boundaries both for the wild game and for the nomadic hunting groups—the African Pygmies, known locally as BaMbuti—that wander around the vast preserve, each group in its own area, following the game and gathering the wild fruits of the forest.

The Pygmies of Africa refer to themselves as Children of the Forest, and this is not casual, primitive poetry but a very realistic self-appraisal. A child is dependent on his parents for all the necessities of life—food, warmth, shelter, clothing, protection. The BaMbuti are conscious of exactly this dependence on their forest home. They sing to it, talk to it, dance to it; refer to it as Mother or Father or Friend. One night, as an example, I heard a noise from a clearing just behind the BaMbuti hunting camp where I was living. I went to see who it was because usually, at night, the Pygmies do not leave their huts. The sound was being made by a young friend of mine, a youth called Kenge; he was dancing in the moonlight all by himself, with a flower stuck in his hair, singing his heart out. Kenge was one of the most incorrigible flirts I knew, so I jokingly asked him why he was dancing alone. He looked at me in surprise: to him this must have seemed an exceptionally stupid question. He answered: "But I'm not dancing alone... I'm dancing with the Forest, I'm dancing with the Moon."

This Pygmy feeling of closeness to the forest and intense affection for it, mingled with a sense of dependence, can best be understood by a look at the way these people live their daily lives and how they are influenced, if not governed, by their environment. Perhaps the forest's most powerful influence, and the way in which it is most strictly limiting, derives from its very self-sufficiency. The endless miles of the Ituri offer the Pygmies everything they need—at a simple but fully satisfactory level. The forest is a world of its own, sufficient and complete; a static world, yet an extraordinarily vital one. Its people—nomadic hunters and gatherers—live one of the earliest forms of life known to man.

Me Turnbull has spent considerable time documenting the Pygmies on film and on records. He studied at Oxford and London Universities, and is on the staff of The American Museum.

There are isolated groups of Pygmies and Pygmoids today in different parts of Africa's great equatorial forest belt from the Ruwenzori Mountains right across to the west coast, a span of about 1,500 miles. The Pygmies, the BaMbuti, which of these groups seem to have resisted any change or acculturation process most successfully, today number about 40,000. A BaMbuti family feeds itself simply by setting off in
TO HUNTING SITE, vigorous, middle-aged men carry men and children are armed with bows and arrows.

Nets are laid end to end, joined with those of other units of the group. When catch is made, all converge for the kill.

...the father, helped perhaps the mother and young girls to do the odd chores that gradually accumulate—the making of new bows and arrows, or the repair or lengthening of hunting nets, where these are used.

One almost constant activity is the making of bark cloth, and any hunting camp can be detected from a great distance by the sharp sound of hammering as bark is flattened out against a fallen tree trunk with an ivory beater. The whole bark is first stripped from a tree, the outer bark removed, and the inner bark then softened either by soaking it overnight in a stream or by smoking it over a fire. Sometimes the inner bark is left in a special mud that dyes the material blue. When beaten with a mallet—usually made from the butt of an ele-
phant tusk but sometimes from wood—the fibers spread out to form a soft cloth that, after drying, is either worn as it is or decorated with simple dye patterns drawn with the finger.

Most of the BaMbuti hunters on the eastern edge of the Ituri Forest use bow and arrow or spear, not nets. The men go out in groups of two or three—sometimes they stay together, sometimes they split up, each following his own trail. A common technique is simply to climb a tree early in the morning and wait for an antelope to pass by. Most Pygmies are well able to imitate the sounds of the various antelope, and can call the animals within range. Some use hunting dogs, particularly for wild pig. Spears are used for protection against larger animals, such as buffalo, and for hunting elephant.

But elephant hunting is a relatively rare occurrence, and perhaps satisfies a psychological need as much as a physical one. Any BaMbuti group that wishes, because of its size or a desire for an excess of meat to barter with non-forest tribes, can get a regular abundance of meat by the use of hunting nets. In net-hunting groups, which may number as many as twenty-five families, each married man owns such a net, anything from one hundred to three hundred feet long and about four feet high, made from a local vine that has been dried, shredded, and rolled on the thigh into a strong cord.

Food is man’s primary need; if the forest had denied the BaMbuti a sufficiency of food, they would either have died out or developed new techniques for food-gathering, perhaps including the principles of cultivation. But the forest did not, and they are still nomadic. Their own particular economy, at least favored if not ordained by their environment, has influenced them further in a kind of chain reaction—starting with the forest itself, and always referring back to the all-providing forest.

After a month’s hunting from one camp, not only are the animals reluctant to come within easy hunting distance, but the local supply of vegetables and fruits will all have been gathered by the women. Daily, the food-gatherers will have to wander farther and farther with diminishing results. In addition, with no effort toward garbage disposal and little idea of sanitation, a Pygmy camp becomes mildly unpleasant to live in after a month, even for a Pygmy. One can then, seldom lasts more than a month. A decision is made to move and early the next morning the women pack their few belongings into a basket and carefully wrap a glowing ember from their hearth in a heart-fire-resistant leaf. The men, with spears and bows and arrows at the ready, carrying their hunting nets if they have them, lead off, others staying behind as rear guard.

In deciding how far and in what direction to go, the Pygmies are influenced by their knowledge of game and its migratory tendencies. They are also limited by natural boundaries, particularly those formed by the larger rivers, which they have no means of bridging. It is an integral part of Pygmy life that he recognizes and accepts the boundaries that nature has set on him and on the game he follows through his territory.

This nomadism in turn has its effects, necessitating, as it does, a minimum of permanent possessions that will have to be carried from camp to camp. Pygmy material o
are mashed in large wooden mortars with greens, herbs, and are then wrapped in edible leaves and roasted. In the forest, other fruits are substituted for bananas, which grow only in clearings near Negro villages.
ture is minimal; many items are abandoned at each old camp and made anew at the next. Huts are built quickly and easily, using saplings bent over and twisted together to form a beehive-shaped frame, on which large phrynium leaves are hung like tiles, making the hut waterproof, yet allowing smoke to escape from inside. Beds and chairs are made equally easily from light wood, either fastened by vines to a frame or simply laid on the ground. Food is mostly roasted in or over an open fire, water is carried and drunk from leaf cups.

The simple economy of the Pygmies and their necessary nomadism naturally influence their social organization. Take, for instance, the size of the hunting groups. Regardless of whether they are net-hunters or archers, a considerable amount of co-operation is called for both on the hunt and in the general run of camp life. For both archers and net-hunters there is a minimum number of adults below which hunting becomes ineffective, and there is equally a maximum limit beyond which the group becomes unwieldy.

The BaMbuti have no system of chiefs or councils of elders who make vital decisions for all. The lead is taken by the great hunters, the younger- or older-aged men, and the older bachelors but nothing is done without general consent. When a dispute reaches an omnivocal stage, it has become so noisy—everyone taking one side or the other, all shouting at once, that one of the older men, or sometimes even a woman, will slowly wander in the middle of the fray, quite unconcernedly. If people do not quiet down he will give a long whistle, as is sometimes done on the hunt to call for silence. Then he says, quietly, "must stop the noise [i.e., dispute], they are killing the Forest." This argument is, in fact, a cogent one because there is always the danger that excess noise will scare away the game. The dispute is then abandoned, with some grumbling, and will be patched up as soon as possible over the next day or so.

This force toward law and order is strong and evident enough for the BaMbuti to exist without the formal systems of leadership and authority found in more complex tribes.
covered with banana leaves—a foliage the Pygmies use when they have made camp near a Negro settlement.

IN FOREST, mongongo leaf stems are slit, above, hooked together and made into thatch that effectively covers huts.

...tion between law and order and a full stomach is obvious.

The internal organization of a BaMbuti hunting group is, at first sight, haphazard. No chiefs, no leaders, no councils: everybody, young and old, man and woman, have an equal say in any decision problem. There is no obvious authority before which all Pygmies bow, and in the face of which they all know how they should behave in any situation. That authority is the forest and the way of life it taught them—the only way they have that makes it possible to survive the conditions it imposes on them. It is hardly surprising that within this authority the central theme of my religious thought.

The self-sufficiency of each hunting group within its own area makes political relationships between neighboring groups unnecessary; here, kinship does play a role, although again in an unformalized way. Among the BaMbuti, it is customary to “marry far”; if pressed for an explanation, the Pygmy will often speak in terms of spatial rather than kinship distance. The basis of most hunting groups is a number of related males and their families. Yet any Pygmy group, for one reason or another, is likely to attract strangers, who become “kin” by adoption, and the group may grow in size and complexity until it is a composite rather than a patrilineal band. At this stage, of course, marriage within the group becomes permissible.

But the general pattern and preference is still for “marrying far,” and the young males will seek their wives among neighboring hunting groups. There is a series of exchange visits, first by the youngsters, then by their parents. The marriage itself, if it takes place in the forest, is an informal affair, the decision being marked by a token exchange of gifts, such as bows and arrows. More important is the fact that it lays an obligation on the group to which the groom belongs to provide a suitable girl—at some later date, if not immediately—for one of the unmarried boys in the...
Boy helps older brother string a net. If proved worthy, he will have his own.

Net, being played out through brush, is as much as three hundred feet long.

If a small animal is caught in the net, and a shout brings out hunting parties to help at the kill. If dangerous, ani

bride’s group. This is often called “sister exchange,” a term that is only barely correct if “sister” is understood in its widest classificatory sense.

The result is that neighboring groups become interrelated through marriage. This supplies what little basis is needed for formal, intergroup contact. There is a constant interchange of visits by in-laws, establishing bonds of friendship and mutual obligation that make for a relatively easy and peaceful settlement in the event of any dispute. Such disputes as there are usually arise over trespass while hunting or gathering, and there is (or has been until lately) little occasion for trouble owing to the wide extent of Pygmies’ forest environment.

Let us look at some of the other ways in which the BaMbuti make use of their vast forest world. We have seen something of its general effect on their social organization. What about everyday life? This level, it can be seen that the forest does not merely make it possible for the BaMbuti to live a simple, bar
ired from a distance. Small boys on “side lines” seize animals that manage to escape through mesh of the net.

The necessities of life are not unduly hard to come by; both hunting and gathering can be strenuous, but this is no subject for complaint by the tough little Pygmies. And on good days they have all they need and are back in the camp by midday.

Although in the night and after heavy rains the cold feels intense, the forest is full of deadwood and there is never any shortage of fuel. The BaMbuti, incidentally, claim no knowledge of how to make a fire. They say that fire was given them by the forest, and they keep it burning perpetually, lighting fire from fire, always carrying embers with them, even for the shortest distance.

Most important, however, is the fact that the forest allows the Pygmy both time for leisure and the opportunity for making something of it. The children make toys for themselves: many of these are in imitation of adult activities, but others have no such significance—spinning tops made from nuts, whistles from dried fruits, and floating darts from leaves. They

Net’s owner directs the cutting and dividing of meat at the capture site.
Bow and arrows are always carried by lead Pygmy in a net hunting party, who acts as the "bodyguard" for rest of the group. Another duty of the bowmen is to shoot wild low monkeys in the event hunt for bigger game is unsucces
make a variety of swings from many vines, and there is always a by stream in which they can play. Adolescent youths generally are more serious in their games, out of which serve to develop the skill they will need in the hunt.

Older men and women find their amusement mainly in mime, dance, or song. Every Pygmy camp has its men who can re-enact some trivial incident of the day with such exaggerated posturing that he holds the attention of the entire group. Others join in, and a dance will follow.

But whether it be mime or dance or song, the subject matter is always the same—the forest around him. If someone managed to make of himself on the hunt, this be made a subject for good-natured ridicule; but far more often the Pygmies will dance or sing about some imaginary hunt where a great hunter killed a hundred elephants. Or they will simply dance the role of a leopard, an antelope, or a wild pig, imitating to perfection each animal’s movements and characteristics. They might imitate the bees that they rob for honey—perhaps the most highly prized of all the forest foods.

Honey season marks the height of Pygmy relaxation and merrymaking. It is then that one can best see the Pygmy’s sharp consciousness of the world around him and his great affection for it. It was while I was with the Bambuti during one honey season that I suddenly felt I was beginning to understand the Pygmies; that I began to know, as they knew, what their life was all about.

LIFE, for the Pygmy, is meant to be enjoyed. The forest gives him an opportunity to satisfy his needs simply; in his leisure hours he can give himself over to whatever form of recreation takes his fancy. The honey season is a time when food is particularly plentiful, and the main bulk of nourishment comes from the various kinds of honey that fill the holes in a myriad of forest trees.

Now, hunting is almost completely abandoned; all day long and far into the night the forest is filled with song and the camps are alive with dancing Pygmies. Both activities are expressions of pure joy, and even such dances as might be said to have magical significance—trying to lure the bees to bring more and more honey—are joyful because the performers know perfectly well that their magic

ARROWS are preferred by Pygmies, as small game can be even if only slightly grazed. Bowmen always hold arrows in bow hand to enable quick re-notching as string is released. The large wrist protector is made of monkey skin.
is almost infallible. The songs say, quite simply, “The Forest is good, the Forest is kind.”

Down in the Negro villages, the Bantu get drunk when they have a holiday. That is their way of enjoying themselves. Their dances are not dances of joy. When something goes wrong in the Bantu village, the sorcerer is called to cast his spells, and hardly a day passes without his being summoned. Theirs is a hard world and full of evil. The forest is hostile and makes life painfully harsh for the plains-loving Bantu.

Deep in the forest—if life goes well and easily, as it usually does—the Pygmy sings his joy. If something does go wrong, he sings his faith, an unshakable faith, that the great god, the Forest, will soon put it right. And the Forest always does.

(To be concluded in October.)

Honey is staple of Pygmy diet. Here honey adz is used to widen hole, thus facilitating removal of comb. Bees are smoked out by coals wrapped in leaf. Handfuls of honey are pulled from hole after bees are smoked out. When hole is high in tree, one Pygmy removes honey, eats a bit, and throws rest to his friends, who are below. Leftovers are leaf-wrapped and taken back to camp.
Fry is usually eaten fresh, comb and all. However, if full of foreign matter, comb is put in a leaf, soaked in water, and the water drunk eagerly. If there are white, fat larvae in the comb, it is especially prized by Pygmies.
The variable star called Algol, in the constellation of Perseus, is as much a linguistic puzzle as it is an astronomical one. In the illustration, left, it is the left eye Medusa, but this picture has been drawn as it would appear on a celestial globe. In the sky, which is seen from the imaginary celestial sphere, Algol appears, as Medusa's right eye.

Theologically, the name of Algol is derived from the Arabic al-ghul, a female demon. The association of this with the fearful Gorgon of the Greeks and the no-listening ghoul of the Arabs has led many historians of astronomy to believe that Algol's variability was already known to Ptolemy and his predecessors. This is open to considerable doubt. There are no records of any kind, in Ptolemy's Almagest or elsewhere, that a change in Algol's brightness had ever been noted. It has also been suggested that the star's location in the head of Medusa was a mere coincidence and that al-ghul was the nearest equivalent Medusa in Arab folklore. Disappointing as it may be, explanation is the most plausible one.

The first observation of the variability of Algol (known as Beta Persei) is credited to the Italian astronomer Tanari, who published a pamphlet on this subject in 1610. On the other hand, the periodic nature of the phenomenon eluded him—and his successors—for more than a century. On November 12, 1782, an eighteen-year-old schoolboy, John Goodricke, observed the first minimum of the star's brightness. The boy was a deaf-mute who had developed a genuine skill in astronomical observation. In course of the next six months, he kept a fastidious record of the fluctuations in Algol's magnitude and noted complete regularity. He communicated his findings to the Royal Society with the comment that, in his view, periodicity of the light-curve might be caused "... by interposition of a large body revolving around Algol,"

The possibility of a physical connection between the components of certain double stars had been already noted by the Rev. John Mitchell in 1767. Nevertheless, Goodricke's interpretation met with considerable resistance at first. William Herschel, in particular, could not be convinced that Algol might be a double star—he had seen it thus in his seven-foot telescope.

The century elapsed before the duplicity of the star was finally established, by means of the spectroscope. Any excursion of a light source in the line of sight is accommodated by a corresponding shift in the lines of its spectrum (rainbow pattern obtained by dispersing its light through a prism)—toward the red if the source is receding toward the violet if it is approaching. In the case of stars revolving around each other in a plane tilted to the line of sight, each component would alternately recede from and then approach the observer, with the attendant oscillation in the position of its spectral lines. In the case of Algol, this effect was observed by H. C. Vogel in 1889. Such systems, in which the two stars are too close to each other to be separated by the telescope, but which reveal their dual nature in the behavior of their spectrum, are known as spectroscopic binaries.

Periodic fluctuations in the brightness of Algol are caused simply by the fact that, as the two stars revolve around each other (it would be more accurate to say that they both revolve around the center of mass of the system), each one, in turn, eclipses the other. When they are side by side, the observed magnitude reflects their combined brightness. But, whenever one is eclipsed, the brightness of the other alone is seen. In actual practice, the phenomenon is somewhat more complex, because the plane of motion of the two stars is tilted to the line of sight and their eclipses are only partial.

All that is known about Algol has been inferred from elaborate studies of its light-curve and spectrum, and from a knowledge of its distance from earth. These two eclipsing stars are quite dissimilar, one being about thirty times as bright as the other. The mass of the fainter one is equal to that of the sun, and its radius is 3.8 times the solar radius. The other is more than five times as massive, but its radius is slightly smaller than that of its companion. Their mutual distance is less than a tenth of the earth's distance to the sun. Such proximity induces strong tidal effects which distort their shapes. Their period of revolution is 2.867 days: in view of their closeness, this is believed to be also their individual period of rotation. There is no doubt that such fast rotation causes a certain amount of flattening in both stars.

Algol's binary system does not account fully for all observed data. Certain irregularities in the period of the light-curve can be explained only by assuming strong perturbations by a massive but invisible third body, having a revolution period of 1,873 years. Yet we encounter a contradiction. The length of this revolution period implies an angular separation of the third body from the rest of the system large enough to be resolved by existing telescopes. But no third body has ever been seen, in spite of the fact that a star sufficiently massive to cause the observed perturbations should, in general, be bright enough to be visible from the earth. The only assumption fulfilling both conditions is that the third star in the Algol system is a white dwarf, one of the tiny but very massive stars to which class Sirius' companion also belongs.

Only one puzzle remains in the story of Algol and other systems of its type. Current theories on the formation of stars indicate that close binaries were probably born at the same time, in the same way. How then could Algol's components have evolved into such dissimilar objects?
**THE SKY IN AUGUST AND SEPTEMBER**

*From the Almanac:*

<table>
<thead>
<tr>
<th>Event</th>
<th>Dates</th>
<th>Times</th>
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<tbody>
<tr>
<td>Full Moon</td>
<td>August 6</td>
<td>9:41 P.M., EST</td>
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<tr>
<td>Last Quarter</td>
<td>August 14</td>
<td>12:37 A.M., EST</td>
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<tr>
<td>New Moon</td>
<td>August 22</td>
<td>4:16 A.M., EST</td>
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<tr>
<td>First Quarter</td>
<td>August 29</td>
<td>2:23 P.M., EST</td>
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<tr>
<td>Full Moon</td>
<td>September 5</td>
<td>6:19 A.M., EST</td>
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<tr>
<td>Last Quarter</td>
<td>September 12</td>
<td>5:20 P.M., EST</td>
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<tr>
<td>New Moon</td>
<td>September 20</td>
<td>6:13 P.M., EST</td>
</tr>
<tr>
<td>First Quarter</td>
<td>September 27</td>
<td>8:13 P.M., EST</td>
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The autumnal equinox will occur on September 22 at 3:00 P.M., EST. At that instant, the sun will cross the celestial equator on its southward journey.

*For the visual observer:*

Mercury's greatest western elongation on August 5 will place it very suitably for observation in the early part of August. During that period, it will rise nearly ninety minutes before the sun and will be seen low over the eastern horizon. In the following weeks it will be gradually less favorable. At superior conjunction on August 30, it will remain poorly placed throughout September.

Venus, very low in the west at dusk, will be difficult to see in August and most of September. On September 30, it will set one hour and a quarter after the sun.

Mars will rise in the east at midnight, local standard time, on August 1, 11:00 P.M. on September 1, 10:00 P.M. on September 30. It will be overhead at dawn during all of September. Located in Taurus, south of the Pleiades on August 1, it will pass five degrees north of Aldebaran on August 17, and will enter Gemini in September.

Jupiter will be in the southern sky in early evening, setting at 1:30 A.M., local standard time, on August 1, 11:30 P.M. on September 1, 9:45 P.M. on September 30.

Saturn, in Sagittarius, will be twenty degrees east of Jupiter. It will set at 3:00 A.M., standard time, on August 1, 1:00 A.M. on September 1, 11:00 P.M. on September 30.

The Perseid meteor shower (July 27-August 17) will reach its maximum on August 11, but a gibbous moon on that date will interfere with observations.

**Eclipses:**

A total eclipse of the moon, visible in the United States, will take place in the early morning hours of September 5. The partial phase will begin at 4:35.6 A.M., EST, and end at 8:07.0 A.M., EST. The eclipse will be total between 5:37.6 and 7:05.1 A.M., EST. On the East Coast, the time of moonset will coincide nearly with the beginning of totality, but observers on the Pacific coast will be able to see the entire phenomenon. The magnitude of the eclipse will be 1.43I, indicating that it might be a rather dark one.

The East Coast of North America will be deprived also of seeing any part of the partial eclipse of the sun on September 20. The sun will set partially eclipsed over the Central United States, but, barring inclement weather, anyone located west of the Rockies will see the entire eclipse. Maximum enclosure of the moon over the disk of the sun will be only six-tenths of the solar diameter. Observers are reminded, as usual, not to look directly at the sun except through a very dark filter, and, most of all, never to view it through a telescope or binoculars.

Mrs. Gossner, a Belgian-born astronomer who studied at Harvard, regularly prepares the *Sky Reporter* column.
MAGNITUDE SCALE
* -0.1 and brighter
+ 0.0 to +0.9
+ 1.0 to +1.9
+ 2.0 to +2.9
+ 3.0 to +3.9
+ 4.0 and fainter

TIMETABLE
August 1  Midnight
August 15  11:00 P.M.
September 1  10:00 P.M.
September 15  9:00 P.M.
September 30  8:00 P.M.
(Local Standard Time)
Progress report on a

Modern techniques of herd management are used to insure that

BY WENDELL G. SWANK

When Lewis and Clark returned in 1806 from their history-making overland expedition to the Pacific coast, they brought with them an animal whose habits had been described, but which had never before been examined by eastern zoologists. It was remarkably fleet, the descriptions had said. It was rather like a deer, but smaller. It was buff-colored, with a white rump patch. It was inordinately curious. It roamed the West in millions. The animal was the pronghorn, or pronghorn antelope—which is really not an antelope at all. It is the only living representative of the Antilocapridae, the fossil forms of which indicate that it has ranged widely west of the Mississippi since late in the Tertiary period.

The Antilocapridae probably had the same ancestors as the Bovidae, which include our familiar cattle, the bison, eland, yak, African antelope and similar species—all of which evolved in the Old World.

In pioneer days, an estimate of twenty to forty million pronghorns ranged the western grassland from Mexico to Canada. By 1907 on about seventeen thousand remained. Extensive hunting, the inroads of civilization, and overgrazing gradually

Biologists observe doe's movements, above, showing location of her fawns. Rosettes of white rump hair, right, act as signals of alarm for pronghorn herd.
Longhorns will continue to roam the West

...them to wooded areas for pro-

Now the herd

...ing on some 900,000 square

...in the West, and special pro-

...rope to save and strengthen the herd

...been set up throughout the

...including about 3,000 square

...in Arizona, where the photo-

...these swiftest of all North Amer-

...quadrupeds are smaller than

...most deer. The cinnamon-buff bodies

...and white bellies, and the sharply

...contrasting black and white faces

...vary in color with the seasons. Hair-

...shedding is continuous, and the coat

...is of true hair, containing large air

...cells that protect from both heat and

...cold. This is of vital importance to

...the pronghorn, whose range tempe-

...ratures in Arizona alone vary from

...twenty-eight degrees below zero to

...Young buck's horns are about an inch

...long, barely showing above hair tufts.
The pronghorn's eyes are remarkably large in proportion to its head and give it a broad field of vision. This, together with the animal's speed, is its principal method of protection. The pronghorn is magnificent in motion. It is gaited—it walks, trots, leaps, gallops, and lopes. Perhaps it is most striking at high speeds. Bucks run with their noses pointed slightly toward the ground, while the does hold their heads a bit higher—a distinction that aids in field identification. When a herd is running, the does are in the lead, and the bucks protectively bring up the rear. Although they have some trouble in hurdling high obstacles, they will not break their gait on ordinary rocky terrain. They are equipped with large windpipes and lungs, which provide extra oxygen for exertion and speed, and they race with their mouths open for the greatest possible intake of breath. Their fastest prolonged rate of speed has been placed at about thirty-eight miles an hour, although there have been claims that they can run fifty miles an hour in spurts. On migrations, or when they are being hunted, it is not unusual for them to travel twenty miles a day.

Dr. Swank, the Assistant Director of Arizona's Fish and Game Department, works on herd management problems.

Newborn twins (not unusual among pronghorns) lie flat on the ground, becoming nearly invisible against surrounding vegetation. While wobbly on their legs the first day, they can outstrip most pursuers by the time they are a week
the pronghorn will circle it, hairs erect, and apparently attempt to make itself as visible as possible. At the first start of this terror, others of the herd begin running frantically in various directions apparently in a panic. There is a tendency to believe, however, that the performance serves the purpose of confusing predators.

One of the greatest charms of the pronghorn lies in its curiosity, which is attracted, sometimes fatally, by anything that moves. It inspects and investigate, blowing in the wind, little birds, men, and, it is said, even territory. It will investigate goats, horses, or dogs, all with the same restlessness.

This restlessness carries over into habits. The pronghorn sleeps only both day and night, but short periods at a time. Even if it appears to be asleep, it will quickly to a strange scent, leap its feet and bounding away. Its eating habits, too, mirror its quick behavior. Pronghorns browse on a large variety of plants, being quickly from one to another and with impartiality. If it can get cultivated crops, it takes advantage of opportunity. This eclecticism is so that no single plant need be planted to provide the pronghorn with good pasturage. In some parts of the range there is only one plant per square yard, but the animal adjusts easily to the available supply.

Pronghorns are gregarious. The herds live together in harmony during the major portion of the year. In August, however, the bucks begin to show a certain restlessness beyond normal behavior patterns. Rump patches appear whiter, with each hair standing erect. The mane hairs also bristle occasionally. The bucks strike odd poses, dance skittishly, as if they were side-stepping snakes, and have even been described as looking “melancholy.” When one buck begins to skip, the others stand watching as if with absorbed interest. This behavior is a prelude to harem-collecting.

Most pronghorns breed when they are something over a year old. When
number of two-man teams, equipped with binoculars, ride over the range in pickup trucks, watching the behavior of the does. If the female has a fawn hidden in the grass, her invariable first reaction is to look hastily in its direction. If the fawn is in no immediate danger, she quickly looks back at the oncoming vehicle. It is imperative that the tagging crews catch that one apprehensive glance toward the fawn if they are to save themselves hours of search. By lining up reference points with their scopes, the taggers can stalk the quarry from long distances and pinpoint them with surprising accuracy.

At first the tagging operations, which began in 1953 in the Anderson Mesa country—about thirty-five miles southeast of Flagstaff—and have since included other areas, hit a number of snags. Foremost among these was the ability of fawns older than four days to outdistance the men pursuing them. Now taggers use a net on the end of a ten-foot pole. One man distracts the fawn from the front, while the second man creeps up and nets it from behind. Twins continue to present a problem. A fawn will bleat piteously when the net goes over its head, and the alarmed twin takes to its heels.

Once a fawn is safely in the net, it is weighed, tooth eruptions are examined, sex is noted, and the site of the catch is plotted on a map. Then a cattle tag is affixed to the upper part of one ear—a painless procedure, apparently—and the fawn is released. Throughout the operation, the men wear rubber gloves, as too concentrated a human scent might cause the doe to abandon her young.

When released, fawns exhibit different behavior patterns. Some of the older ones leap away and run. Others lie motionless in the position they have been put in by the crew. Young ones often show a trait frequently found in newborn animals: they follow the biologists, and it is virtually impossible to get them to remain at the site where they were tagged.

Knowledge gained through this pronghorn program is manifold. Herd movement can be observed; dispersal from the fawning grounds and any homing tendency can be followed.

Tagging such animals of a known age and then releasing them into a herd has given biologists a tool to determine the aging of all herd individuals. For instance, aging tables devised by correlating the molting of tagged animals taken by hunters against that of non-tagged animals.

The productivity of a wild population is measured in the number of years in ratio to the number of adult animals in the herd—is the most reliable indication of the success of management. If a high proportion of the pronghorn population, either fawns, is made up of yearlings, management is good. Too many yearlings, however, indicate that productivity has slowed—perhaps due to infertility or to high fawn mortality. In either case, such a composition suggests that remedial measures are impor-tant to bring the herd into balance.

In this same connection, the year of which does breed has importance. Yearling does in the neighborhood of eight months old, for example, are not dangerous to the herd if the animals breed as yearlings rather than in their second year.

Probably the life span of the pronghorn is relatively short. Author Einarson, in his book The Antelope, suggests that in the neighborhood of eight to twelve months. Predators account for a number of animals each year. Most dangerous, perhaps, are coyotes, which attack any age group. Coyotes are not, however, is most dangerous to the pronghorn fawn during the first few weeks of its life. When the doe move in on the young, does will attack viciously with their forepaws. Then, frequently, the doe and her young panic-stricken and runs away, and are often killed by sharp from pointed hoofs. Fawns are times endangered, too, by hawks, eagles, and ravens have been known to attack their eyes. Bobcats attack even a full-grown buck, perhaps the biggest predation danger. The herd today lies in the fast-of-the-road automobiles on western highways.

Storms, too, inevitably take their toll, perhaps more so today than in the times before cattle and small farms usurped the lowlands that served as their wintering quarters for pronghorns.

At an estimate, there are now over 100,000 pronghorns roaming the West. While the herds will again number into the million programs as that being carried on in Arizona will at least insure the continued existence of this unique and handsome native American mammal.
Tag is affixed to the fawn's ear. Handlers take care to use rubber gloves, as a concentrated scent of man can cause a doe to abandon her young. After being tagged, the fawn is left where it was caught, so the mother can easily find it. After being tagged, it is left where it was caught, so the mother can easily find it.
Egrets, having bridged the Atlantic, are now established in the Americas.

For many reasons, man has introduced all sorts of animals to new lands far distant from their native homes. Some of these introductions have proved beneficial—the ladybird beetle in the United States, for example—while others have become serious pests like the mongoose in the islands of the Caribbean. But natural colonization of new areas and new habitats is a fundamental part of the history of any successful species, including our own. Such natural extensions of the range are not everyday occurrences, however, and today's biologists have been able to study these events in only a few species. When such an opportunity presents itself, the biologist should certainly seize it quickly and with delight.

Just such an opportunity now exists in our own backyards or, more properly, in our own back pastures, in the form of a small white heron. The cattle egret, *Bubulcus ibis*, a species widely distributed in the Old World, has recently gone far beyond the stage of minor increments in range expansion. This bird has bridged the Atlantic and now has an entire new hemisphere at its command—an evolutionary prospect full of potentials both for bird and bird watcher.

We cannot state with certainty when and where the pioneer cattle egret population landed, how they crossed the Atlantic, or how many made up the original nucleus or nuclei. But we are sure of several facts. First, South America was the area of original invasion into the New World. Perhaps the earliest written records of the bird's presence were made by a Surinam collector between 1877 and 1882. Second, cattle egrets have spread from that initial “beachhead” to much of northern South America, to many islands in the Caribbean, and through a great area in the eastern United States. Finally, large numbers of cattle egrets are now breeding in many places on both continents. With every passing year, new distributional data, new breeding sites, and other new facts are being recorded about the New World's most exciting heron.

In 1959, I had an opportunity to study the cattle egrets in Florida, where the bird is now a common roadside sight. I began field work in the Florida Keys, the long chain of mangrove-covered islands that extends southwestward from the tip of peninsular Florida. Little is known about the migratory habits of these birds, but it is obvious that they use the Keys to enter the mainland from some unknown region to the south.

Cattle egrets typically move about in flocks, small or large, and this social behavior was evident in the migrating groups I saw in the Keys. Such behavior is, itself, a mechanism favoring overseas dispersal. It was probably as a small flock that the birds first crossed the Atlantic. On February 19, for example, I saw a flock of three cattle egrets on Greyhound Key; on February 20, a flock of nine on Plantation Key; on February 21, flocks of two, ten, seventeen, ten, and thirty from Crawl Key to Lower Matecumbe Key. On these and other dates, I noted that the flocks fed from a few minutes to several hours in grassy areas bordering Route 1, the main road through the Keys. Then, without exception, these flocks took off and flew northeast toward the mainland of Florida. Were they coming from Cuba, Quintana Roo, or Yucatan? We don't know.

Some populations of these egrets winter in southern Florida, and this fact may account for the six or fewer egrets I saw on Payne's Prairie, near Gainesville, on February 11, of the week before I noted migratory birds in the Keys. Furthermore, cattle egrets were courting and building nests on Greyold's Park, North Miami Beach, on February 13, the day before I saw the first migrants to the south. These birds may have come from populations wintering in Florida, but where were the migrants coming from? What regular migratory routes, if any, are they using? These are a few of the many questions still awaiting answers.

Cattle egrets do not breed in the Florida Keys, so after my renaissance there I headed toward birds' stronghold in the Lake Okeechobee area. Despite heavy, continuous rains I was able to make detailed observations on the birds' fascinating feeding behavior. As its common name suggests, this species regularly associates with cattle, and this association is of definite advantage to the bird. While grazing cattle slowly over their pasture land, the egrets are accompanied by one or, more typically, two egrets, which station themselves alongside the heads of the rumbling beasts. The pasture is stirred up by the movements of the cattle, are seized and eaten by watchful egrets. In effect, the egrets act as unwitting beaters for the birds.

Is this relationship one-sided? The point is in dispute. Cattle are infested with ticks, and stomach...
of a Pioneering Bird

New World provides a matchless chance for biological studies

Typical position for egret is at the head of grazing cattle. Insects stirred up by animal’s movement are eaten by birds.
yses show that cattle egrets do eat ticks. If the egrets picked these ticks from the hides of the cattle, we would have a classic example of symbiosis—the egrets help the cattle by removing and eating parasites, while the cattle stir up food for the birds. This would be a neat demonstration, but we have no proof of it! It is true that the birds eat ticks—indeed, in some parts of the world they are called "herons"—but apparently they pick them up from the ground. Furthermore, these ticks make up only a minor part of the egrets' diet.

Symbiosis can involve more than one relationship between species, however. It may be true, for example, that the always alert egrets view their hoofed partners as potential enemies. A similar relationship exists between the ostrich, and wildbeests and zebras. The bird feeds on insects flushed by the animals, and his head, high above the tall grass, serves as a periscope. Any sign of fright on the part of the bird immediately sets the mammals running for safety. The egrets are conspicuously white, attentive, and highly social: their sudden flights and warning calls can scarcely go unnoticed by the cattle.

**Any hoofed animal** is followed by the egrets. In the Old World, the birds' associates include elephants, rhinos, zebras, antelope, and, often, buffalo.

**True symbiotic relationship**, in which birds eat ticks on cattle's hide and the cattle stir up insects for the birds, has not been established in the case of egrets. Although they eat some ticks, they form only a minor part of their diet.
possible service may have value in the case of the egrets' mammalian associates in Africa—antelope, zebras, elephants, and the like. However, with respect to domestic animals, the service seems valueless. A cattle-in herd, destined for the slaughterhouse, would benefit little from any agitation of the egrets. Nevertheless, in the original, wild situation, such a relationship would benefit both bird and herd.

In most situations, I believe, this situation is a one-sided affair—the egrets are opportunistic, following whatever beast will beat for them. There the birds obliged to associate predominantly with cattle. Around Lake Okeechobee, I saw cattle egrets also following horses, sheep, goats, and while in other parts of the world the egrets follow many other species of mammals.

I knew one non-mammalian species that served as a beater for the egrets—an observation that has not been previously recorded. Around Lake Okeechobee, the Florida crane tends to frequent in wet, marshy areas—terrain particularly to the liking of the egrets. On several occasions, however, when the cranes moved onto

Sheep can also be feeding associates of the egrets, although birds can and do feed alone. Occasionally they will perch on fence posts and snatch flying insects.

The Florida bird not only takes advantage of food stirred up by the hog, above; when feeding near shallow ponds it may vary its diet by eating small fish, which bird catches in a manner typical of the many herons to which it is related.
drier ground, I saw flocks of up to 150 egrets land near the cranes and begin to follow them. Here was an interesting example of competition. Both the cranes and the egrets were after the same prey—insects (mainly grasshoppers)—but the egrets were letting the cranes do most of the work. This association with another bird, feeding on the same prey in the same area, was successful. I saw the egrets make innumerable kills. By artful dodging, the smaller species was able to take advantage of the larger birds’ bulk in scaring up food enough for both of them.

Whenever the egrets got too close to a feeding crane, the larger bird would threaten the smaller species briefly and drive it away. A simple turning of the crane’s head was usually sufficient but, if this did not deter the egret, the crane would lower its head and make a short strike. This thrust always worked.

A re cattle egrets obliged to follow other animals in order to get a daily ration? Although this predilection for hoofed and other associates is typical of the egrets’ feeding behavior, they can and do feed by themselves. The migratory flock observed in the Keys fed along grassy areas a few feet from the shore. Around Lake Okeechobee on occasions, I saw single birds, as small as to large flocks, feeding pastures when no cattle or large animals were in sight. Sometimes an egret would perch on a post in a field or on the roof chicken coop and snatch flying insects. I have also often seen egrets, perched on the backs of snapper, snapping up flies that buzzed ahead the resting cows. True, the flies undoubtedly attracted to the

"Leapfrog" feeding is an unusual behavior pattern of the egrets. A flock of birds land in field and one or two make short runs forward to seize grasshoppers, thus stirring other insects. Bird at back of flock then flies up.
The latter's role in helping the large waders was passive. Twice I saw single large waders wade in shallow ponds and feed on small fish in typical heron manner. Twice I observed among the cattle egrets in Florida is what I call "leap-feeding" (illustration, below).

Here is a typical observation: a dozen egrets land in an empty stubble. At first the birds content themselves with looking about, or flying for position in the flock, or working a few flight feathers. Then two birds at the edge of the group begin to peer carefully at the stubble, stretching and weaving their slender necks back and forth. One makes a short, chicken-like run forward and snaps up a grasshopper. This commotion stirs a few insects to flight. A second egret in the rather compact flock runs toward the food source and stirs a few more insects from the grass. Now the flock begins to mill about; a bird from the rear flies up and over the flock, landing just in front of the foraging egrets. As it lands, it seizes an insect disturbed by its flight actions. Two more egrets fly up from the standing group, over the feeding birds, and land in front of them. They begin to peer, to weave, to strike at their prey. The remaining birds in the flock now fly up en masse and leap over the backs of their actively feeding flock partners. By this time, the bird or birds that began to forage first are at the rear of the feeding group. As their food supply is temporarily exhausted or has escaped, they now leap over the feeding egrets, to land at the front of the group and stir up new prey as they alight. In this way, the members of the flock, working as a team, make their way across the field, each taking his turn.
Establishment of territory by male begins courtship. Before finding mate, male starts to build the nest, often breaking fresh twigs for the purpose.

as beater, then forager, then feeder and, finally—by “leapfrogging”—as beater once more.

The scene is not always played in an empty pasture. I have watched the birds following cattle in the usual manner until a light rain began to fall; then the cattle stopped grazing or even took shelter. The egrets would huddle in one group, hunched over, with necks withdrawn and feathers fluffed out. One or more birds at the edge of the flock would start to forage and, in a matter of a few minutes, the entire group would be “leapfrog” feeding in the rain while their former animal associates contentedly chewed their cuds and rested in the shelter of a nearby pine grove.

The pattern of following other animals, however, serves cattle egrets admirably. They occupy a niche—that is, they play a specific role in the community of living things—without serious competition. True, snowy egrets and a few other heron species follow cattle and other animals for the same purpose, but the cattle egrets ply their selected trade masterfully. What will happen when, inevitably, the birds reach the Great Plains of North America and the vast pampas of South America? Biologists should and must be there, watching them, when they do. The great herds of domestic cattle in these areas are ripe for exploitation by cattle egrets.

What form, we may wonder, will impending exploitation take?

Leaving the Okeechobee county headed north for Lake Alice, the University of Florida camp, Gainesville. This was my last chance to see the courtship of the species, part of their general biology that is completely unknown. Lake Alice is actually a freshwater swamp, is a paradise for a heron enthusiast. Breeding there in 1959 were white and green ibises, anhingas, Florida and pink gallinules, Louisiana and little blue herons, snowy egrets, and, unfortunately, cattle egrets. All of these were nesting in the same colony, in red maples, willows, and blackthorns, no one of which contained more than three cattle egrets. However, there are records of hundreds of nests being found together in a single tree.

I took a comfortable, fully equipped observation post in a rise at the edge of the breeding colony, and was able to watch the courtship of the cattle egret from the start. It had been raining heavily for the several weeks before my arrival at Lake Alice, and it was still raining when I started my observation. On that first day, all of the egrets left their nesting area, which they had been using as a roost, and foraged during the day on Payne’s Prairie, a mixed wet prairie and marsh area, mainly as a cattle pasture. To catch their cuds, the egrets began to trickle toward their roosts in small flocks.

Display gestures on his territory interrupted by male, preening feathers.
In the morning, however, the rains had ceased, the sky was bright and clear, and the nesting area was alive with nesting herons and egrets.

Two things stood out as indicators of the start of the egrets' breeding season. First, many of them remained in the nesting area and did not leave until morning at all during the day. Second, all the birds that stayed showed noticeable changes in the color of soft parts—bill, lores, orbital lores, legs, and feet. During the non-breeding season, cattle egrets have yellow or pale orange bills; the coloration of the lores and orbital lores is variable, but typically flesh-colored or dull yellowish-green; the legs and feet tend to be dull yellowish-green, with the rear part of the legs that are blackish, as are the toes. Pugnacity of non-breeding birds is also with a very pale, buffy wash on the neck, lower throat, and back. On their first day of frenzied activity, however, the cattle egrets at Lake Alice had a very different complexion. The bills of most were a brilliant ruby, with a contrasting, bright red tip. I immediately thought of the pattern of Halloween candy corn. Some birds, however, had bills that were scarlet or ruby throughout. Others had scarlet lores and orbital lores, while others had these areas colbalt blue or magenta. The legs and feet were either dark magenta or dark maroon. There was great variation in the color of the iris; typically straw yellow in non-breeding birds, it now ranged from pink to ruby. All had conspicuous, buff-colored plumes on the crown, lower throat, and back. In short, the cow-followers had lost their plain appearance and were now resplendent in nuptial dress.

Although all were bright, some of the egrets seemed duller than others. The more lustrous ones soon proved to be males. These were highly agitated, moving restlessly about the branches of a tree, making short flights to nearby trees and, more significantly, threatening, chasing, and fighting any other cattle egrets that came too close. This random behavior, however, quickly became localized in one small section of the nesting area: the males had started to establish and defend a territory.

The initial size of this area varied from male to male but, in general, it consisted of a space roughly circular in shape, with a radius of about five yards. The center of the circle was the most important part of the male's territory—his display post. From this spot, the male began to advertise his presence in the nesting area by performing a series of vigorously executed displays.

The most common gesture used at the start is what I call the "Snap Display." The male, perched on a branch, suddenly extends his head and neck fully out and down, clicks...
Egrets nest in colonies, often with such other birds as ibises, gallinules, herons, and snowy egrets, and there are records of hundreds of cattle egret nests being found on a single tree. Here a bird is adjusting one of its four eggs.

his mandibles together, retracts his head and neck to the normal posture for a moment, then extends them fully—either horizontally or slightly upward. Then he seizes a twig and wrestles with it a moment or two before reverting to the normal perched posture. Males that are “snapping” are approached quickly by one or more females, but at this stage the females are forced to leave the male’s territory by his aggressive posturing. The male crouches low at the approach of a female, then walks stiffly toward her, with crest, neck, and back plumes fully erect. Then the bristling male lashes out at the female with his bill and utters a rasping “kowwh-kowwh.” Normally she is quick to retreat: if not, the male drives her from his domain by a direct attack. If a male has temporarily vacated his territory (to gather nest twigs, for example) and finds a female there on his return, he forces her to withdraw by using threat displays of the same or a similar nature. If the intruder is a rival male, the territory owner undertakes the same displays he uses to intimidate females. Males, however, tend only to threaten females, while they will attack other males.

On the first or second day of territorial advertising, the males showed their first “Stretch Displays.” From a standing position on or near the partly built nest, the male suddenly bends forward to a low crouch, at the same time rapidly moving his legs up and down in a dancing motion. He then quickly loops his neck down in one vigorous pump, then proceeds to swing his vertically aligned bill and neck in a circular or elliptical path. The male may rock his head and neck from one to two times; during the swaying part of the display, he usually erects his crest, breast, and back plumes. During the display, one or more females come to watch the male’s performance. They are stimulated to be next to him, but again he repulses such attempts. I noted, however, that such hostility on the part of the males was much less intense after a Stretch Display than after a Snap Displa...
OF NESTING AREAS indicates the success of the bird acting to a range in which it was unknown only a few years ago. Unkempt appearance of the egret above is owing to its fluffing out feathers that have been dampened by rain.

A heron species that I have studied, this period of male display, approach, and threatening calling by the male may go on week or more, with a gradual decrease in male aggressiveness. But for the cattle egret—on the first or third day, the female has enough and forces the issue by sitting squarely next to the male in the newly built nest. A particularly live male may still succeed in driving away the brash female away, but usually he does not. Then the pair enter a billing, feather-nibbling, and building—with the male acting usually as gatherer while the female does most of the building. A rather quiet betrothal period is followed by copulation—which usu-
ally takes place on the nest or a few feet from it—and egg-laying. The pair then enters the uneventful, parental part of the nesting cycle.

I left Lake Alice when most of the cattle egrets were sitting quietly on their eggs. I was fortunate in all the new information I had been able to gather about these birds, but I also realized how important this species can and should become to biologists in general. Here is an eminently successful animal: it has crossed the Atlantic Ocean on its own, spread throughout an entirely new range, and is now breeding commonly in regions where cattle egrets were unknown only a few years ago.

What is biological success? Invasion of distant lands, rapid range expansion in the new areas, population build-up at a great rate, further spread from established breeding sites—certainly these can be considered attributes of success. What about the cattle egret’s peculiar feeding behavior? Surely this is important to the continued welfare of the species, but is it crucial?

North and South America have many other well-established heron species and many of these are expanding their ranges, too. But they are being outstripped in this respect by the newcomer. Why? Will several major supply pools form in the cattle egret’s new range, centers of abundance that will feed the outlying districts with new and better adaptive characteristics? When the cattle egrets reach and conquer the Great Plains of North America—where the feeding niche is vacant and waiting throughout a vast range largely cleared by man—will they move south through Mexico, or will they cross the Gulf of Mexico in order to reach a winter habitat?

We can, of course, make guesses, advance theories, or propose schemes based on a few shreds of evidence. But, more importantly, we are now in a position, if programmed cattle egret observations are undertaken, to make concrete many of our rather vague ideas about biological success.
**REVIEWS** (continued from page 2)

It hard to separate myth from reality, the fanciful from the proved. *Out of Noah's Ark* is good reading, but one persists in the nagging feeling that there is too much of it.

**Birds of Martha's Vineyard**, by Ludlow Griscom and Guy Emerson. Privately printed; sponsored by the Massachusetts Audubon Society. $4.50; 164 pp., illus.

**HERE is an excellent book, a labor of love and intelligence, which will appeal to the amateur as well as the professional. The check list includes 312 species. Some attention is paid to history and topography, and a map is provided.**


**THERE are many more anthologies of poetry than of science, perhaps because poets are, *ipso facto*, articulate; so this volume may fill a need. In fact, it contains its share of poems, along with specimens of science fiction, philosophy, social history, ancient and modern natural history, anthropology, and a host of related and interrelated fields of knowledge. Its very diversity may be one of its drawbacks. All the same, if you like samples, you may like this book.**

**This Land of Ours**, by Alice Harvey Hubbard. Macmillan, $4.95; 272 pp.

**BECAUSE of her experience in garden club work and community improvement campaigns, Alice Harvey Hubbard has written a book on conservation that will be of interest and practical importance to many local planners. She discusses over 150 specific projects, and generally offers a patchwork quilt of information. Much of it will be valuable to workers in this area, whether they are interested in community forests, window boxes to beautify their towns, flower festivals, or all projects, or in the larger aspects of soil and water conservation. And it is encouraging to find that so much is being done at the community level.**

**Tukani, by Helmut Sick. Eriksson-Tuplinger, $5.00; 240 pp., illus.**

**HERE is an account of the Roncador-Xingu expedition into Central Brazil, whose primary purpose was to break open the wilderness and make it "fit for human exploitation." Although the scientists who went along did not find as many surprises in the interior as they had wished for, they were able to get a great deal of new data with respect to natural history. Dr. Sick's book is primarily of interest in its very complete account of the fauna, and to a lesser extent of the plants, the weather, and the Indians they encountered during the expedition's seven years.**

**Desert Plants (Cacti and Succulents)**, by Oliver and Margaret Lee. W.H. & L. Collingridge, London, 3 net; and Transatlantic Arts, Florida $7.50; 220 pp., illus.

As specialists in cacti and succulents, Sir Oliver and Lady Lee have, through the course of a lifetime, gathered a vast array of knowledge and experience. Their book is the result of those years of study, and is a valuable resource for anyone interested in the subject. The book is not only informative, but also beautifully illustrated, with numerous photographs and diagrams. It is a must-read for anyone with an interest in desert plants.

**Gemstones of North America**, by J. Sinkankas. Van Nostrand, $15.00; pp., illus.

*The book Gemstones of North America is a book by a knowledgeable and enthusiastic amateur and is valuable chiefly for its extensive information on the localities where gemstones are found. Since this is a large, expensive, and handsome bo*
but seem superfluous to suggest that more color plates would not have been miss; but the layman color is more of great value in identification.

Furthermore, this criticism is not intended to reflect from a book which provides important historical and descriptive information, as well as a great quantity of data about the location of gems.

INDOOR PLANTS, by A.C. Muller. Emerson Books, $2.95; 114 pp.

The 100 plants included in this little guide are a good, representative collection, and the photographs that accompany their description and advice as to care are well chosen. The book is not only accurately written, and it will be very useful for the tyro who plants in the house or apartment but needs a professional to help him.


This is a book for young readers that does not succumb to the temptation to dumb down or over-simplifying. Exposition of ornithological material is presented in a well-written, substantial text. Precise definitions of the physical characteristics of birds in general and, more particularly, the relationship of many species to their environment is the further exploration by the watchful reader or the student of biology.

SALT WATER AQUARIUM IN THE HOME, by Robert P. L. Straughan. A. S. Barnes & Co., $7.50; 252 pp., illus.

Those who have long hesitated to start a salt water aquarium in the face of seemingly insurmountable odds will be reassured by this book. It can be done—but not without painstaking attention. Mr. Straughan, an experienced aquarist and marine collector, makes the successful marine aquarium no more possible than it used to be. The book is a little expensive, but profusely illustrated.

LEY'S EXOTIC ZOOLOGY, by Willy Ley. King, $4.95; 468 pp., illus.

The word "exotic" is a teaser, bringing to mind the serpents and dragons which Mr. Ley's book abounds. Ley is an antiquarian than a scientist; he offers facts as well as the dredges in the muddy waters with a will, while presenting findings at the same time. Moas, pterodactyls, animals vegetable, animals animal-like, and even animals real—a potpourri of the amazing and the common. It makes for strangely unexciting reading—perhaps because of a wooden style—rather because the problems that
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ADVENTUROUS ALLIANCE, The Story of the Agassiz Family of Boston, by Louise Hall Tharp. Little, Brown, $5.00; 354 pp., illus.

LOUISE HALL THARP has set out to write a domestic narrative. It is well told, from beginning to end, but if the period is re-created and brought close to contemporary readers, Agassiz himself remains intangible. Not that information is lacking about his life and fortunes: much is said about his personal force and his intellectual influence on American society. But the background is clearer than the man who stands in front of it.

THE CARE AND CULTIVATION OF INDOOR PLANTS, by Violet Stevenson. Philosophical Library, $4.75; 139 pp., illus.

A USEFUL, sturdily written little book designed to help the home owner see his favorite pot plants through the year. It gives thorough details as to proper treatment and placement, as well as advice on soil conditions and care of the sick. The photographs, regrettably, are uninspired.

SOUTHWEST GARDENING, by Rosalie Doolittle, in collaboration with Harriet Tiedebohl. University of New Mexico Press, $5.00; 222 pp., illus.

THIS BOOK WON A PRIZE FROM THE NATIONAL COUNCIL OF GARDEN CLUBS, and in fact it is well printed and presented. However, the author introduces her subject with an irritating "flowers-are-pets" angle, goes on to assume a frequently hussy authority about the do's and don'ts of the business, and rather neglects the soil and weather conditions of the Southwest, although this is specifically a regional book. But all in all, what can be done with landscaping and gardening under the prevailing conditions is simply explained, and the culture of individual plants examined in some detail. A useful volume for those about to dig in at Tucson or Taos.

THE STORY OF EARTH SCIENCE, by Horace G. Richards. Lippincott, $3.169 pp., illus.

THE AUTHOR IS A GEOLOGIST WHOSE EXRESSED INTENTION WAS TO WRITE ABOUT EARTH SCIENCE NOT SO MUCH FOR THE YOUNG AS FOR THE "SLIGHTLY ADVANCED," is a beginner's book, then, but one which might be read with profit by an untutored adult. Useful guides are provided for the identification of common rocks, fossils and minerals, and their general characteristics are clearly and simply described.

HIDDEN AMERICA, by Roland Wells Robbins and Evan Jones. Knopf, $5.00; 216 pp., illus.

A MATURE ARCHAEOLOGY ON A HIGH LEVEL, Roland Wells Robbins, who has written this book in collaboration with Evan Jones, was the discoverer of the site of Thoreau's cabin on the shores of Walden Pond. He also directed the excavation of the colonial ironworks at Saugus, Massachusetts, and has sunk his probing rods into the soil over many other historic and prehistoric sites in this country. His book is honest and pretentious, makes no unsubstantiated claims, and as with the supposed tales of the Viking occupancy of Cape Cod, retains an intelligent skepticism. The photographs are well chosen.

SCIENCE IN PROGRESS, Eleventh Series edited by Hugh Taylor. Yale University Press, 75.50; 379 pp.

THE LATEST IN A VERY EXCELLENT SERIES, whose contributions are based on Sigma Xi lectures for 1957 and 1958, particular note in the present book are chapters on mountain building, Armand J. Eardley: continental growth by J. Tuzo Wilson; cosmic radiation, Serge A. Korff; smoking and deposits, by E. Cuyler Hammond; and viruses and cancer, by J. W. Beard.
Two hundred and sixty years ago a group of traders from the island of Ceylon arrived in Holland, bringing with them other merchandising a small hoard of semiprecious gemstones. The traders called "toramali"—not particularly significant word mineralogically, since Singhalese traders of the period used the same word in referring to a number of other precious stones found in Ceylon's gem-rich gravels.

The particular "toramali" were neither so apparently of much interest to the local gem-cutters, who had marketed a similar mineral from Brazil in considerable amount and much more salable color, nor was it the seventeenth century gem's name of "Brazilian emerald." Exciting brown stones were tossed about as playthings for the local street children, so it was said; but these Singhalese traders, nameless in history, left behind their unwanted stones a name for one of the most remarkable of the two-odd minerals that, in greater or lesser amount, constitute the crust of the earth. From the "toramali" of Ceylon, the first of the eighteenth-century English minerologists "tumbled," and the later "tourmalin," a modern word "tourmaline," a name for a mineral that is both a delight to the collector and, in certain of its peculiarities, a challenge to the mineralogist.

All field guides and handbooks on minerals describe tourmaline as "complex silicate," or a "complex of silicate compounds." Such designations have both the merit of being accurate and being conservative of paper. In the latter's time—a fuller account of chemical and physical complexities of a mineral would burden a simple guide with an intolerable number of pages. Indeed, tourmaline has been frequently characterized as "the trash of the world of minerals." After all the other minerals were allotted their quotas of elements, say the mineralogists with tongue in cheek, tourmaline received what was left over. At least twenty-one of the eighty-eight natural elements have been positively identified in analyses of this mineral.

Tourmaline is essentially a borosilicate of the metal aluminum, containing also the elements sodium, magnesium, and hydrogen. The structure of the mineral, however, seems to allow to a remarkable degree the substitution of one element for another within its atomic framework. This characteristic, as might be imagined, is subject to certain limitations. Human feet may be shod with shoes of many different colors and styles, provided that the shoes fit the feet. Similarly, the elements, or groups of elements, that can make substitutions in the composition of tourmaline must "fit" the mineral's basic structure. It is such element substitutions that give rise to the several distinct series—and innumerable variations within the series—that make tourmaline such an attractive item for the mineral collector.

For example, the presence of a substantial amount of iron produces the coal-black tourmaline commonly known as "schorl." Where magnesium is the replacing element, the mineral occurs as the brown or greenish-brown "dravite," commonly found in metamorphosed limestones. The presence of relatively large amounts of the light, alkali metal lithium, either with or without its usual companion, cesium, gives rise to the lithium or "colored" tourmaline, the eccentricities of which have been the subject of much speculation.

The black, iron-rich variety of tourmaline is a rather common mineral wherever granite has eaten or shouldered its way into rocks that are now exposed by erosion, and fine specimens are seldom missing from the most rudimentary mineral collections. In its massive form, black tourmaline has a superficial resemblance to anthracite coal—and apparently was mistaken for that substance by more than one of the earlier settlers of this country. Charles T. Jackson, American geologist, doctor of medicine, and agricultural reformer of an earlier day, noted in 1844 that tourmaline "...abounds in the primary rocks, and is sometimes mistaken for coal, on account of its apparent resemblance to anthracite." The Doctor dryly added, however, that "...the want of combustibility is...sufficient to distinguish it from that substance."

In using the term "primary," Dr. Jackson was referring to rocks like the granites and gneisses, at that time thought to be the original stuff of the earth's crust. While this term has long since disappeared from the language of geology, it is in granite, especially, that the mineral tourmaline "abounds" and reaches both its perfection of form and its greatest crystal size. Granitic intrusions that exhibit the coarsely crystallized, dikelike or pod-shaped bodies called pegmatites, or "giant granites," may yield crystals of the black variety of tourmaline, the dimensions of which are sometimes measurable in feet.

There is a special class of granitic pegmatite—constituting, perhaps, one per cent of the total—in which, through a complex and not wholly understood process of mineral replacement, there may occur an assemblage of lithium- and phosphorus-bearing minerals. Among these are likely to be such collectibles as spodumene, lepidolite, amblygonite, or petalite—accompanied, perhaps, by cassiterite, columbite, the rare cesium mineral pollucite, and an assortment of lithium, iron, and manganese phosphates such as triphyllite, hettorite, vivianite, and a host of others, some of which have yet to be classified and named. It is also this one per cent of pegmatites that furnishes the colorful red, pink, green, and blue tourmalines, and the mineralogically challenging bicolored and multicolored specimens so coveted by collectors and those in the semi-precious gem trade.

Coloration of lithium—pegmatite tourmalines has been the subject of many investigations. In addition to crystals that are entirely of one color, there are others that may show red at one end and green at the other, or pink, yellow, and green, or pink, colorless, and green, or combinations of these colors, to create as many as four or five different zones along the length of a crystal. The colors may separate sharply or may grade into each other through colorless zones.

Equally bizarre are the tourmalines to which a similar array of colors is arranged concentrically about the long axis of a crystal, making successive "sleeves" of color around a central core—which is often pink or red. Less com-
The cause, or causes, of yellow tints has not been well established, although some analyses of yellow tourmaline have indicated that calcium and tantalum may have a part to play. In addition to these elements, others, such as gallium, tin, nickel, vanadium, and the alkaline-earth metal, beryllium, have been suspected of contributing to the range of coloration.

Tourmaline belongs to one of the several classes of crystals that exhibit the phenomenon described as the "piezoelectric effect," first noted by the Curie brothers, Pierre and Jacques, in 1880. Briefly, the piezoelectric effect allows the conversion of mechanical energy into electrical energy. That is, a pressure exerted along an appropriate axis of a crystal results in the generation of a small electrical current, which varies in direct proportion to the amount of pressure applied. While this crystal property is not one exclusive to tourmaline, certain qualities of the mineral—its high mechanical strength and its chemical stability—make it unique among minerals as the basis for various piezoelectric gauges employed in measuring the intensity of shock waves, both in air and water. Thin slices of flawless tourmaline, appropriately cut, metal-plated, inserted into a housing, and connected with amplifying and recording instruments, are capable of making accurate electrical records of the form and intensity of shock waves—a valuable property, indeed, during these times when shock waves of one sort or another seem destined to play an increasingly important role in human affairs.

In addition to its piezoelectric property, tourmaline also exhibits a pyroelectric effect—the development, on heating, of positive and negative electrical charges at opposite ends of the crystal. There is no particular commercial significance connected with this phenomenon at present, but it is interesting to note that it was in the mineral tourmaline that the effect was first observed, and Rose investigated the pyroelectric properties of tourmaline during the middle of the nineteenth century. For one of the first American books of mineralogy (A Compendious System of Mineralogy and Metallurgy, printed in 1798 by A. Bartram, of Philadelphia), he noted that "... tourmaline [as the mineral was then spelled] is a kind of hard, bicolored mineral, usually brought into notice by its electrical properties. When heated, or by signs of contrary electricity on the opposite ends of their [sic] prism form ... It is hard almost as the jagged rocks of the Himalayas, and something of an enigma, it is of interest to note that the mineral is nevertheless a source of pleasure and study to the amateur collector—as well as the collector himself. As the author of the collector's field guide—published in one of the more easily identified works of the mineral kingdom, containing information on its occurrences in well-developed crystals, as well as in rather predictable localities. The field guide says that the cross-section of a tourmaline crystal should be similar, the gathered specimen often a rough, or even a good, triangular section. If the manual can be true, the myriad parallel striations along prism faces of the crystals as a result of the mineral's properties, the striations may usually be found. In some of its characteristics, too, the mineral is similar to a sea of strangely distorted crystal forms.
LiLM PEMATITES of Southern California have furnished porous superb tourmaline groups as the one pictured, above.

CROSS-SECTION of the Madagascar tourmaline specimen, above, reveals the unusual geometrical pattern made by crystal core.

GEOR PATTERN exhibited by the tourmaline section, below, gives visual clue to crystalline structure of the mineral.

GREEN TOURMALINE "pencils," like those adhering to quartz crystal, below, furnish gemstones called "Brazilian emeralds."
These simple signs express a powerful idea

When you first wrote $2 + 2 = 4$, you were learning to use symbols that took men thousands of years to invent. Equations were all written out in words until a German teacher, Heinrich Schreyber, used $+$ and $-$ in an algebra book about 1520. A century later the $\times$ sign crept into arithmetic.

No longer considered just convenient abbreviations, humble $+$ and $-$ have risen to profound new meanings in mathematics. More important than the signs themselves is the underlying idea that symbols can define operations between numbers. This idea has led to the powerful mathematical notation used today in such fields as atomic physics, economics and electronics.

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The secret of cancer—and life on Mars

Does this symbol hold the key to both?

Perhaps no other area of contemporary research excites scientists more than the one represented by the small symbol pictured above. It shows part of a molecule of deoxyribonucleic acid—DNA—the substance believed to make up the "blueprint" of every living cell, animal and vegetable.

Because DNA alterations are now believed to cause cancer, biologists and chemists are hopeful that further DNA research will lead to conquest of the disease. Evidences of substances like DNA in meteors and other outer-space objects have bolstered astronomers' and physicists' belief in the probability of life on Mars and other planets. And many geologists and other specialists believe that DNA may provide at last the answer to the age-old mystery of the origin of life.

The DNA story is only one example of the interrelationships and interdependencies which are the essence of modern science. Scores of other examples are presented by the distinguished biochemist and best-selling author, Isaac Asimov, in his major new two-volume work, THE INTELLIGENT MAN'S GUIDE TO SCIENCE.

Here for the first time you will see the myriad individual strands of inquiry and research masterfully interwoven so that the entire fabric of modern science is brought into brilliant focus. When you read THE INTELLIGENT MAN'S GUIDE TO SCIENCE you will find yourself saying not once but dozens of times, "Now I understand!"

Although the literature of science includes innumerable specialized volumes and several fine encyclopedias, there has never been a book that makes the vast expanse of modern science completely understandable to the non-professional reader. Such a book will at last be available with the publication of Isaac Asimov's THE INTELLIGENT MAN'S GUIDE TO SCIENCE—a two-volume work which takes as its subject the entire universe of scientific knowledge but which adds with the excitement of history, the man interest of biography, and the usefulness of good fiction.

By a remarkable weaving together of developments in every major field, it tells the fascinating, continuous story of scientific exploration and discovery through the ages...every significant accomplishment, every figure of stature from Euclid to Ulysses, from Newton to Fermi, from Descartes to Pasteur to Freud.

Perhaps no one but Isaac Asimov could have written this book. In the words of George W. Beadle, the Nobel Prizewinning biologist: "Asimov is one of the few ones. He knows and understands science in both its history and its substance, and he writes simply, clearly and with infectious enthusiasm.

With Asimov as your guide, you will allow the thread of scientific progress through the centuries in every field from astronomy to mathematics, from biology to the sciences of human behavior.

You will learn how a finding in one branch of science often unlocked the barriers in others...how a mathematical formulation (Einstein's theory of relativity) paved the way for the first self-sustaining fission reaction and the beginning of the atomic age...how observations by astronomers with powerful modern telescopes helped geologists and physicists compute the age of the universe...how an 18-year-old student's attempt to synthesize quinine for use in treating malaria led to the discovery of anti-malaria dyes and the birth of a great industry...

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THE JOURNAL OF THE AMERICAN MUSEUM OF NATURAL HISTORY

Vol. LXIX OCTOBER 1960

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THE ROYAL SCYTHIANS
John F. Haski

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Georg Zapp

THE AWESOME BONEBREAKER
James Ferguson-L.

CHILDREN OF THE FOREST
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DEPARTMENTS

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Alexander M. White

REVIEWS
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LIFE AT TIMBER LINE
Simone Daro Gossner

SKY REPORTER
Richard A. Appleb

YOUNG SCIENTIST

COVER: Some time in the eighth or ninth century B.C., on the steppes of Asia, an unknown Scythian had the idea of unhitching his horse from a wall and mounting the animal. The age of the nomadic horseman had begun, and four centuries lightly armed Scythian cavalry ruled the plains from Lake Pazyryk to the Black Sea. This month's cover, specially painted for NATURAL HISTORY by Hans Guggenheim, shows one such warrior, drawn after a wall hanging in the tombs of Pazyryk, in the Altai Mountains; in the foreground, a gold stag of typical Scythian design. For more about the Scythians, see...
Museum Memo

Research conducted by American Museum scientists during the past twelve months spanned millions of acres and ranged from analysis of the myriad substances on the ocean floor to investigation of the galaxy. While a curator of paleontology was studying Triassic fossils at a site in New Jersey just three miles from the Museum, word was received that a staff archeologist had covered a prehistoric city in remote Baluchistan, some 800 air miles distant. While one of our biologists was diving off the island of Bermuda to study schooling behavior in fishes, others were climbing 10,000 feet to the summit of Mt. Wilhelm on New Guinea to collect rare specimens of the island’s fauna and flora. While one anthropologist was deep in an analysis of Stone Age cultures, another was studying the impact of mass media on the American high school student.

Headquarters for many of the research projects was the Museum in New York, where scientists worked in the laboratories that are hidden behind the exhibition halls in the towers. Other programs were at the Museum’s field stations: the Lerner Marine Laboratory in the Bahamas, the Archbold Biological Station in Florida, the Kalbfleisch Field Research Station on Long Island, and the Southwestern Research Station in Arizona.

Along with the efforts directed toward the increase of knowledge of the many Museum activities involved in the interpretation of science to the public, Significant progress was made in our conscription, exhibition, teaching, and publication programs. The new exhibit was completed in the summer of 1959, and the library was moved to new quarters in the early summer of this year. This library of 3,000 volumes, which ranks as one of the finest natural history libraries in the world, long ago outgrew its quarters: books were being stored in odd corners throughout the Museum. Now, books, catalogues, and reading room are together with space for normal expansion. The new hall of the Biology of Man, scheduled to open early in 1961, was brought near to completion, and the Hall of North American Birds was entirely reconstructed and de ready for the installation of exhibits. Work was also on renovation of the Hall of the Indians of the Northwest Coast, which contains one of the finest collections of its kind to be found anywhere in the world.

The American Museum-Hayden Planetarium marked the beginning of its twenty-fifth anniversary year with the installation of a new Zeiss projector, which greatly enhances the beauty and realism of the Planetarium sky.

Our staff maintained a high level of publication in the four scientific series, the Bulletin, Novitates, Anthropological Papers, and Contributions of The American Museum-Hayden Planetarium. The quarterly journal of museology Curator entered its third year with subscribers in every state and in forty-three countries. The year saw the merger of Nature Magazine with Natural History, and the resultant expansion of content. Readers will share our pride in two awards for distinguished scientific journalism given this magazine in 1960. Junior Natural History initiated an editorial program to bring its readers a better understanding of the world’s changing resources.

Educational services were expanded on a number of levels. The Museum opened an Evening School for Adults, and offered a lecture program that included archeology, ornithology, conchology, and botany. The Planetarium curriculum included specialized instruction in astronomy for teachers and engineers, as well as courses for laymen.

The encouragement of young people in the pursuit of science has traditionally been a concern of this Museum. The roll of scholars who served their apprenticeships here is noteworthy. Today, the need for training scientists is recognized as one of the urgent problems facing our country. New programs are being initiated to develop the scientific abilities of our college and high school students. Both The American Museum and The American Museum-Hayden Planetarium were selected by the National Science Foundation for participation in programs designed to acquaint undergraduates with research. The Museum program enabled students to work directly with staff scientists on field and laboratory projects. The Planetarium offered high school students an intensive summer course in astronomy and space sciences.

As this brief summary may indicate, the past year has been full and productive at The American Museum.

Alexander M. White, President

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The dictionary's editor, Frank Gaynor, had the assistance of the United States Department of Defense as well as civilian agencies and research centers in preparing the book's entries. America's most distinguished authority on rocketry and space travel, Dr. Wernher von Braun, has also assisted in the work's preparation and contributed a provocative introduction "The Why of Space Travel." $6.00

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On a recent field trip through the southern uplands of Mexico, I made mental notes on the condition of the countryside as seen from the highway. The pressures of human needs were evident all about me; they were reflected in the ways in which the land was being misused. The people in the village that passed were obviously "land hungry" since there was not enough land in the valley to grow their crops, they had turned to the forested slopes and a mountain side that should have been retained forest had been cleared and planted to corn. In the course of a single season, much of the thin topsoil had been washed into the valley below, but the richness of the valley fields is only temporary: floods will soon deposit a silt blanket of gravel over all, and then productivity of the valley will suffer. Farther along the highway, I noticed that clearings of this sort had already been abandoned, and the farms had moved higher up the slope to compensate for their losses. The future of such a village is not difficult to imagine. The stream will no longer supply fish—it becomes a raging torrent in the wet season and disappears beneath a baked mud plain during the dry season. The naked hillsides will no longer support white-tailed deer, formerly an important source of meat for the populace. On the gravel-washed valley floor, the coves of quail will be fewer in number and smaller in size, and the ducks that formerly found sustenance in the ponds and irrigated fields will gradually but surely disappear.

Having raped their land and left it naked in this fashion, some of the villagers will gradually move up the valley in search of new territory where they will apply the same practices. Others may remain and resort to raising burros and goats on the abandoned farmland. These animals will graze on the scant vegetation and pack the soil into an impervious hardpan, until virtually no recovery of the natural flora is possible.

I continued down the valley and soon came to an irrigation and power dam, no doubt built at great expense to the Federal Government. Erosion from the misused land above it has been rapidly shifting in the impoundment and must certainly be causing great inefficiencies of production of both crops and power. This situation could have deleterious effects to local industry and, when duplicated many-fold as I later found to be the case, to the national economy.

These observations on the plight of Mexican land use and its disastrous effect on the wildlife—indeed, on the economy of the country—reminded me at once of the concern expressed for the misuse of land in our own country in the writings of Aldo Leopold, the well-known American forester and game manager. I think particularly of an essay in \textit{A Sand County Almanac}, in which he expressed reservation about the "solvency" of an Illinois farm:

"Everything on this farm spells money in the bank. The farmstead abounds in fresh paint, steel, and concrete. A date on the barn commemorates the founding fathers. The roof bristles with lightning rods, the weathercock is proud with new gilt. Even the pigs look solvent. The old oaks in the woodlot are without issue. There are no hedges, brush patches, fence rows, or other signs of shiftless husbandry. The cornfield has fat steers, but probably no stall. The fences stand on narrow ribbons of sod; whoever plowed that close to barbed wires must have been saying, 'Waste not, want not.'"

In the creek bottom pasture, flood trash is lodged high in the bushes. The creek banks are raw; chunks of Illinois have sloughed off and moved seaward. Patches of giant ragweed mark where freshets have thrown down the silt they could not carry...who is solvent? For how long?"

Years earlier, Aldo Leopold had presented this concept as the central thesis of game management, in his book of that name:

"...game can be restored by the \textit{creative use} of the same tools which have hitherto destroyed it—axe, plow, cow, fire, and gun." That the use of these tools in our own country has all too often been far from creative is obvious. One wonders what degree of creativity we have the right to expect from our neighbors below the border?

A truly outstanding book has recently been published that makes a plea for the wise use of land and habitat in Mexico. It is perhaps fitting that the author is A. Starker Leopold, son of the man who spoke first and loudest in our own country for wise land utilization as the way toward better game management.

This volume on the game animals of Mexico is the first in which an author has been able to combine professional biological training with personal field investigations. It has been over twelve years in preparation. In 1944, Starker Leopold was employed by the Pan American Union to initiate a survey of Mexican wildlife. William Vogt, another prominent figure in the field of conservation,
For the answers to these and many other questions, and a fascinating look at everything under the sea—

Robert C. Cowen's
FRONTIERS
OF THE SEA

The story of the past, present and increasingly challenging future of oceanographic exploration, by the Natural Science Editor of the Christian Science Monitor. With an Introduction by Dr. Roger Revelle, Director of the Scripps Institution of Oceanography.

Here is a big, illustrated survey of the world's oceans, filled with engrossing stories and information about the vast waters which cover more than 70% of the earth's surface. Mr. Cowen presents the incredible geography and biology of the sea-describing ocean trenches that could swallow Mount Everest with thousands of feet to spare; currents, earthquakes, tidal waves, landslides, volcanic eruptions, and the formation of coral reefs; and fantastic marine flora and fauna, specimens of which, like the "missing link" coelacanth, are still being discovered.

Here are absorbing descriptions of the birth of our planet; the mountains beneath the sea; the Pacific's ring of fire; the second "Gulf Stream"; the great oceanographic expeditions from the early 19th century to 1960; the scavengers and "commuters" of the ocean depths; the promise of plankton fishing; the future of ocean farming and mining — and many other facets of oceanographic search and discovery. With 21 photographs, 56 drawings and maps, bibliographies, and full index. 307 pages; $1.95.

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Ducks, also from Wildlife of Mexico

(Continued on next page)
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The Royal Scythians

By John F. Haskins

Illustrations by Hans Guggenheim

In 1715, a wealthy nobleman named Nikita Demidov, a serf's son and a blacksmith who—as an armorer—had become a favorite of Peter, and who owned rich mines east of the Ural Mountains, assembled a collection of these Siberian gold art objects. Demidov presented them as a gift to Tsarina Catherine I, on the occasion of the birth of the ill-fated Tsarevitch Peter Petrovich. Demidov's gift was appraised—in gold value alone—at a hundred thousand rubles. The following year, Prince Gagarin, the governor of Siberia, sent fifty-five "sets" of gold to the capital. The catalogue of the Gagarin Collection still exists: in it are listed eighty pieces that, together, weighed more than sixty Russian pounds (about fifty-four pounds avoirdupois).

These objects, representing a type of art that came to be called the "wild beast" or "animal" style, are now known to be the work of Eurasian nomads who roaming the steppes during the last millennium before the birth of Christ. The objects—and the culture that produced them—remain as controversial today as when they were unearthed more than two hundred years ago.

Some fifty years after Peter received his gifts of Siberian gold from Demidov and Gagarin, an army officer on duty in South Russia, General Alexis Melgunov, became interested in a curious group of tumuli that he had observed near Elizavetgrad, between the Bug and Dnieper rivers. In September, 1763, he ordered one of them opened and...
began the first of a series of breath-taking discoveries. The tumulus he had excavated now bears his name. It proved to have been a Scythian tomb, which he called Litoi Kurgan, the “tomb of the Scythian cast.”

Melgunov, unfortunately kept no records of his discoveries, and immediately posted the gold treasures that he had unearthed to the new Empress Catherine II. We know today that the Melgunov kurgan was the tomb of a Scythian chieftain who lived in the late seventh century B.C. It was the first and earliest of a series of tombs that dotted the landscape of South Russia, the Crimea, the Taman Peninsula, and the Kuban. Melgunov had discovered the tombs of the Scythians and a people long believed to have been creations of myth were brought to life again.

The third verse of the tenth chapter of Genesis lists the Ashkenaz (Scythians) as sons of Gomer. The latter were probably the Cimmerians. The Scythians appear again— as Ashguzai—in the royal Assyrian correspondence. We know that Scythian cavalry fought beside the Medes and Persians at the destruction of Babylon, and that they were supposed to have ruled “Asia” (modern Iran?) for two seven years. They would seem to have reached as far as Egypt at some time, but it remained for the Halicarnassian historian, Herodotus, to give the most complete account of them. The historian had actually visited a trading colony at Olbia—near the confluence of the Bug and Dnieper—during the fifth century B.C. and had spoken to Scythians living there. At that time, they exercised a great rule over the vast area around the northern shores of the Black Sea, in what is now South Russia and the Ukraine.

Herodotus dedicated his nine books of history to the Muses. He called his fourth book Melpomene and its chapters contain one of the most engrossing stories in history. The book begins with an account of the attempt (in 513 B.C.) of Darius the Persian to conquer Scythia.
lude to an invasion of Europe. The geographers of antiquity applied the label of “Scythia” to the whole of what is now Russia and, by extension, the people who lived there were called Scythians.

Herodotus listed five separate Scythian tribes, one of whom he called the “Royal Scyths,” or Paralatae. He stated that their tribal name was Scoloti, but “. . . the Greeks, however, call them ‘Scythians’ . . . ” and, again, “. . . the Persians call them Saka . . . .” We only wish he had said why, this is one of the great historical mysteries. “Scythian” is not a Greek word, and there seems to be ample evidence that Saka was not primarily Old Persian. In modern Iran, sag means “dog.” Thus the name we know now as Scythian” may have been the transliteration of some tribal name or title, and may properly apply only to a small group of people at one particular time—let us say, the builders of gold-filled royal tombs around the northern shores of Black Sea, in the last seven centuries before Christ.

Chief’s grave near Pazyryk is seen in cross section above. Ice had preserved ancient objects until discovery in 1928.

Outer Mongolia. Scaffolding for tomb is seen in rear left; skeletons will be buried on upper level, Scythian chief below.
Inhaling Hashish Fumes. a Scythian woman in tent at left kneels beside a caldron containing hemp seeds and spices placed on heated rocks. The ritual was first described by Herodotus, who wrongly took it for a form of steam bath.

There is no clear date for anything in Scythian history. We are not even certain when Herodotus sat at Olbia and listened to the Scythian merchants tell of their past. This was probably about the middle of the fifth century B.C., at least two centuries after the Scythians' first real power was established. Herodotus gives several accounts of the origin of the Scythians, ending with one that he said he himself believed. He stated that the Scythians came from Asia, after having been defeated by the Massagetae. The Scythians then entered the land of the Cimmerians and drove the latter away, establishing themselves in Cimmeria (probably the modern Kuban).

We may find some confirmation for this story in another, older work of history—one that was written many thousands of miles away from the classical Scythia that Herodotus knew. One of the world's oldest historical records is the Shu Ching, or Book of Documents, which purports to be a history of China from the time of the Creation until the time that the work, itself, was written. While much of the Shu Ching was actually set down in the fourth century B.C. and some of it dates only from the Wei period (ca. A.D. 324), a good deal of the work is believed to have existed at least as early as the eighth century B.C. One of its chapters lists the tribute brought to the Emperor Yu of the Hsia Dynasty (traditional dates: 2205-1766 B.C.). The nineteenth line of this chapter begins: "The felt-weaving Western Barbarians: the Hsi-chih and Ch'i-ju-sou from the ranges of the K'unlun Mountains, presented themselves in that order...." Some scholars now believe that the tribute-bearing Hsi-chih were the "Royal Scyths" of Herodotus' later history. Scythian domination of their Black Sea holdings ended some time around 338 B.C., when the Sarmatian tribes moved westward across the Don. How long the Scythians had ruled their lands before this is not known.

What was the actual history of the Scythians? In the light of present archeological knowledge, a tentative reconstruction may be attempted. Some time, probably the ninth or eighth century B.C., somewhere on the steppes, presumably between Lake Baikal and Lake Balkhash, unsung genius unhitched his horse from a chariot, mounted the animal. The age of the centaur, cavalry and cowboy had begun. The mounted horseman was mobile: not restricted to roads and tracks, he could ride vast prairies of Central Asia. Freed from dependency on farmlands, as the Chinese historians tell us (Han-shih A), "He could follow his flocks from place to place, having no settled abode...." Nor could it have been before the pastoral nomad became the warrior nomad. It was not difficult even for a barbarian to see that the profits of settled communities could be extremely profitable. Chinese Dynastic Histories from the Han (206 B.C. to 220) to the Ch'ing (A.D. 1644-1912) provide a detailed account of the monies spent—often without success—an attempt to keep barbarian horsemen of a wide variety of origins safely beyond the Great Wall. On a least six occasions, these histories tell us of times when a "barbarian chieftain succeeded in seizing the "...vermilion stone of supreme authority..." and mounting the "...Dai Throne of the Son of Heaven."

Some time after the felt-weaving Hsi-chih had presented tribute to the Emperor Yu, and some time before Darius' planned invasion of Scythia, these nomads managed to wed Chinese imagination to their own.
The berdache were called *Enarées* by the Scythians; they were soothsayers, who told fortunes by means of willow wands, which they would twine about their fingers.

Unlike many other Eurasian nomads, the Scythians by historical account seemed to have kept their women in seclusion. They did not, as did the Sarmatian girls, ride to combat with their men. The Scythians lived in yurts, felt tents that they would mount on wheeled platforms, and have pulled along by oxen or draft horses.

What else do we know about the Scythians? The spectacular electrum vase from the tomb at Chertomlyk and the golden jugs from the Kul Oba barrows— as well as several small sculptures from the same site—all show Scythians engaged in various activities: breaking horses, pulling teeth, or stringing bows. One of the most beautiful monuments in art is a golden comb from the kurgan at Solokha. It dates from the end of the fifth century B.C., and shows two foot soldiers in Scythian dress fighting a lone cavalryman, while a dead horse is trampled underfoot. The comb was probably made for a Scythian chieftain by a Hellenic workman, but it was to Scythian taste.

As depicted, these people seem to have been rather small and stocky men, with long, curly beards. From Persian inscriptions, we know that they sometimes wore tall pointed caps, but as often they seem to have gone bareheaded. Accounts say that they loved bright colors and wore short jackets with tight sleeves, long trousers, and soft felt boots. They carried their bows and arrows in a single quiver—

Tattooing was a practice among the Scythians, although historians do not know whether it was used only by shamans and chiefs, or whether purpose was to identify the tribe to which a man belonged. See also the picture on page 15.
called, as we know from Herodotus’ account, a gorytos. They wore their short sword—the akinakes, in its distinctive sheath, the mikes—on the right instead of the left side. The scabbard was tied to the thigh to facilitate a fast draw. Their favorite weapon, next to the bow, was a form of fighting pick they called a sagaris.

We are told that it was the Scythian custom to scalp the enemies they had killed in battle, and to hang the grisly trophies on the harness of their horses, using the scalps as napkins. Another savage trait was the fashioning of drinking goblets from the skulls of fallen foes. Poorer clansmen covered these skull-cups with leather, but the wealthier Scythians lined their trophies with gold. Chinese records tell us that the Hsiang-nu (Huns)—who raided the borders of China during the Han Dynasty—had a similar custom.

The descriptions of Scythian life in the Greek histories, combined with the discoveries of Scythian tombs in South Russia and those of non-Scythic peoples who shared a similar way of life in the high Altai, give us a quite good picture of the customs of the Eurasian nomads during the whole of the last pre-Christian millennium. We know of the custom of the exchange of blood-brotherhood (thrusting a knife through the hand and letting the blood flow into a cup of wine, which was then drunk by the two participants in the ceremony). We have evidence—from tiny, gold statuettes at Kul Oba—of ritual wrestling. We know of the practice of trepanning and embalming the dead. We know that the Scythians sometimes tattooed themselves—and gave as much attention to the artistic details of the “animal” in this curious art as they bestowed upon their funeral vessels. Remains have been found of their yurts, which were hung with gaudy tapestries and carpeted with finest materials from Persian and Central Asian lands. Horses have been found buried in all their barbaric finery, supplied with caparisons and horned chamfrons (masks) that outshine the trappings of Europe’s medieval knights.

A most interesting detail—one of the few, though understandable, mistakes in Herodotus’ account of the Scythians—has been verified time and again by excavation. The Greek historian alluded to a curious custom of “bathing” in which the Scythian men and women would enter a felt chamber and throw heated rocks into caldrons filled with seeds of the hemp, anise, and other spices. We know today, from the discovery of just such chambers in Siberia’s tombs of the fifth century B.C., that Herodotus has given an accurate and very early description of the use of hashish. The fifth tomb of the Pazyryk complex, in the Altai Mountains, has presented us with a tapestry showing just such a scene and the crowned ladies who participated in this ritual.

Names of gods, personal names, and the few Scythian words listed in the histories lead to the conclusion that these nomads’ language was Indo-European—possibly related to Old Persian, or at any rate to some Iranian tongue. Herodotus stated that arima meant “one” in Scythian speech. This may compare with the Zendian word aima, which means “loneliness.” The Scythians reportedly called a tribe of women warriors the “man-killers”; in Scythian, Oiorpata, Oior was the Scythian for “man,” and pata meant “to slay.” The late Sir Ellis Minns, however, has pointed out that what the Scythians may have been trying to
The King's reply to Darius' taunt was couched in terms of such impudence and proud defiance that his form of expression became known to the Greeks as the "Scythian mode of speech." Idanthrysus said, among other things: "If, however, you must needs come to blows with us speedily... there are the tombs of our fathers. Seek them out, and attempt to meddle with them. Then you shall see whether or not we will fight..."

From this comment (the translation is Rawlinson's), the Scyths seem to have venerated their ancestors' tombs with a passionate intensity. One is tempted to attribute this veneration to concepts they brought with them from Asia: the similarity with the Chinese is evident.

However this may be, the reverence the Scyths felt for their ancestral resting places is expressed beyond contention in the extravagant display of wealth found in the tombs. Graves as far west as Hungary have been found to contain the same opulence in golden treasure associated with the tombs in South Russia. Herodotus gave a lengthy description of the bloody funeral rites of the Royal Scyths and, while no single tomb has yet been found that would bear out his account, a combination of several of them would prove him to have been substantially correct. Every Scythian grave to be excavated had previously been plundered. Yet enough wealth has remained to show that the Scyths had a breath-taking sense of imagery and an artistic style for which the rather terse historical accounts we possess leave us almost totally unprepared.

We began expansion from somewhere between Lakes Balkash and Baikal; their culture reached its zenith in Crimea.

"Lords of Men" (from paieti, "lord"). Certain rivers in Asia may still have Scythian names: dan, meaning river," was an early name for the River Don, and the Ver Bug may take its name from the Scythian bugh, "god," after the Iranian baga.

What of the Scythian gods? Most of all the Scyths revered Hestia, whom they called Tabiti, then Zeus-Papaeus and his wife Ge-Apio. They worshiped Apollo-Octosyros Aphrodite, calling her Artimpasa, Ares, for whom no Scythian equivalent name is known, was the only god to whom they built an altar. Only the Royal Scyths worshiped seidon, whom they called Thamimasadas (or Thagimadas). All the tribes worshiped Herakles, from whom they named descent, but whose Scythian name is not recorded. It is only recently, in 1950, that a Scythian town has been discovered. This was Neapolis, near Simferopol in the Crimea. The town is a very late one, however, not having been founded until the second century B.C., long after the day of the Royal Scyths. We know of the latter, therefore, only from the amazing series of tombs found in South Russia, the burial places of the Scythian chieftains.

Here, the Royal Scyths erected great tumuli: mounds of earth piled high above wood-lined tombs that were literally rimmed with golden relics. The nomad chieftains, together with their horses, were laid at rest amid a profusion of arms, armor, harness, clothing, and much gold.

When Darius invaded Scythia in the sixth century B.C., his opponent was the Scythian king, Idanthrysus. The Scythian strategy of warfare was one of seeming flight, a method that enticed the enemy to follow until his lines of communication were stretched to the extreme—then the Scyths would turn and give battle. This angered Darius, and he sent a herald to ask that the Scyths fight like men.
An orientalist and historian, Mr. Haskins teaches in the Department of Art and Archeology at Columbia University. Mr. Guggenheim, whose travels have taken him to much of Asia, often illustrates articles for Natural History.

The main art form—and the objects that gave the whole tradition its name, the “animal style”—consists of a series of representations of animals. Some are extremely realistic, others are fantastic creations. Some are twisted or contorted into improbable postures, others are fighting with an almost terrifying savagery. Some crouch in the last agonies of death, others are depicted in flight.

Among the booty of the tombs is a series of plaques of solid, cast gold, several measuring more than a foot in length and quite thick. By far the most famous of these are the gold stag (seventh to sixth centuries B.C.) from Kostromskaya Staunitza in the Kuban, and the gold feline from Kelemes, in the same general region and about the same date. It is thought that these plaques were used as decorations, or bosses, on iron shields. Indeed, the Kostromskaya stag was discovered lying atop the decayed remnants of such armor by Nicholas Veselovskii when he opened the tomb there nearly half a century ago.

This finding, in turn, has led to a great deal of speculation on the part of scholars interested in totemism. It was thought that certain animals—the stag, the feline, and perhaps the horse—were clan insignia, or even badges of rank. It is perhaps too early yet to speak of a Scythian clan of the “Stag” or of the “Leopard,” but something of this nature may well have been intended by each such golden beast.

The most complete Scythian tomb yet found—near Chertomlyk, along the left bank of the Dnieper River—was opened by Ivan Zabelin a century ago. We have already mentioned the large electrum vase from Chertomlyk; this was but one of the many splendid treasures in gold and silver that had accompanied the chieftain, his consort, and his ten horses to the afterworld. In addition to these objects of precious metal, some fine examples of Greek export-ware enabled the excavators to date the tomb toward the close of the fifth or the beginning of the fourth centuries B.C.

Chertomlyk, too, had attracted the activity of looters; the extent of the loss is impossible to gauge. But when the archaeologists reopened the chamber, some two thousand years after its construction, they found that a fall of earth had trapped one ancient thief in the passageway; his bones were moldering beside the dead he had come to rob.

Chertomlyk is one of the most complex of the Scythian graves. It consists of a large, central chamber with four smaller chambers radiating from it. One of these contained the bones of the mistress of the royal grave; the remaining three chambers were presumably for courtiers or servants. The chieftain lay in solitary splendor in a bronze coffin on a wooden bed in the central chamber. While most of the wood, leather, and cloth had disintegrated, traces of clothing and carpeting were found, and a number of hooks had been provided—perhaps to support wall hangings.

One of the most completely detailed accounts of Eurasian nomadic life comes from a region that is not truly Scythian. Near the small village of Pazyryk, in the Altai Mountains of southern Siberia, are the “princely graves,” first discovered in 1928 by Sergei Rudenko and Michael Grizanov—very near the source of the gold objects that so fired the imagination of Peter the Great. A curious combination of circumstances has preserved the tombs of the Pazyryk people, and others nearby, in almost perfect condition.

Unlike the tombs of South Russia, buried in the warmed earth of the steppes, these interments were in the mountains. Like the others, they had been plundered. But the entryways dug by the looters provided access for water, which flowed into the tombs. In the first winter thereafter, the water froze, sheathing the contents of the graves in ice. The Siberian tombs, moreover, were covered with massive rocks, instead of earth—as was the case in South Russia. And these stones reflected the sun’s rays, preventing the warmth from entering the icy chambers. Thus, for thousand years or more, the graves of the nomadic king in this Siberian mountain valley were kept frozen, with corpses, their clothing, the bodies of their many horses and all their magnificent trappings—even their horses and goods and vehicles—were but recently discovered, and they were preserved in perfect condition.

We are not as yet sure of the ethnic associations of the Pazyryk people, but they may well have been Massagetian, or possibly Sarmatian. We have earlier noted a Persian inscription of Herodotus’ description. The position of the woman among the Massagetae reportedly was a very elevated one. We are explicitly told that they were led in battle by the queen. Otherwise, their customs and dress seem to have been much the same as the Royal Scyths of the West, and the finds in Chertomlyk and Pazyryk have come to the joint coin the term: “kindsred Scyths.”

The construction of the Pazyryk tombs gives ample evidence that their builders had great skill in carpentry. Logs that lined the chambers, forming a sort of log cabin within the tomb, were each marked to indicate the intended position—not unlike today’s “pre-fab.” It is quite possible that the ingenious tombs of the high point of the Altai range could have supported even a non-human population. It may be that the graves are in the original homeland of the Massagetae, or that the mountains were regarded as holy places because of the gold that was dug nearby. We are told by Aristaeus of the “one-eyed” Aris—perhaps the Tingling (lone) ones of the Chichak sources—who “fought the gold-gathering Griffin” in the Siberian highlands for possession of the treasure there.

A handsome Scythian splendor in the West came to an end in the middle of the fourth century B.C. The Royal Scyths succumbed to the Sarmatians, a related tribe of Iranian nomads, just as the Cimmerians had broken before the onslaught of the Royal Scyths themselves, centuries before. They subjugated the Sarmatian conquest and continued to live in their territories as long as Rome had any power in the East. They became Hellenized and moved into the towns, and they never again to reach the heights they once had known. But they traded with the Greeks for wheat from the Ukraine, they later tombs, though of elaborate stone arches, are but a vague reflection of the glory that was Scythian in Major, . . . when,” as Herodotus solemnly records. “Tartagia, a son of Zeus, begat three sons: Leipos, Arpoxais, and Colaxais, and founded the race of Scyths . . .” The best light cavalry the world had yet known clambered its career in mercenary services with the Roman legions. During the early days of the Byzantine Empire, the mighty Scyths wordlessly disappeared from his
Lectrum Vase, found in a burial mound at Chertomlyk, was used to hold kumiss, or fermented mare's milk. Made by Greek artisans for Scythian patrons, the ornate vessel dates from the fourth century B.C., stands over two feet in height.
The science of paleontology rests on two principal ideas. The first is that, in view of the fact that sediments are being deposited continuously, underlying strata when undisturbed—are older than the formations above em. The second is that a close similarity between the characteristic assemblages of fossils found in different rock strata—however geographically remote these may be—is evidence of rough, chronological identity between such formations. These two concepts permit both the relative dating of consecutive rock layers and the correlation of artificially separated deposits. Thus it is possible for the paleontologist not only to establish the chronology of progressive, evolutionary changes within a particular line of animals or plants, but also to envision the general environmental picture at various places on the earth's surface during particular periods in geological history.

Such attempts to reconstruct past ecological situations, course, face many difficulties. Only rarely is enough fossil material preserved in any given locality to permit valid inferences about all the geological, climatic, and biological factors acting at the time of deposition. Occasionally, however, due to particularly fortunate circumstances, collection of fossils is made. which—when studied in relation to all the structural features of the site—yields an amazing detailed panorama of the past.

One such find occurred in the 1920's in middle Germany. excavations and studies that began then were continued to World War II; recently, work has started again and material is being turned up each season. This paleontological bonanza is the Geisel Valley, a long-established coal (brown coal) mining area, west of Leipzig. It has been possible to date these lignite deposits by comparing some of the fossils they contain with similar species—certain fresh-water snails—found in formations of a different age. The Geisel Valley fauna and flora have been assigned to the middle Eocene epoch—some forty million years ago, soon after the beginning of the Mesozoic era, and roughly twenty-five million years after the extinction of the dinosaurs.

The Eocene follows upon the Paleocene epoch, the first vision of Cenozoic times, and represents a critical period the evolution of post-Mesozoic faunas. Through most of the Mesozoic era, the mammals had been evolving in the shadow, so to speak, of the then dominant reptiles. With the extinction of most of the latter, mammals were able to undergo their first major adaptive radiation. Many environmental opportunities had been vacated as a result of this little-understood mass death of the ruling reptiles of land, air, and sea. In consequence, the mammals—generally small, relatively insignificant and largely insectivorous during the Mesozoic—were free to evolve in many directions. A whole spectrum of ecological "jobs" was now open and there arose, to fill these niches, a variety of new mammalian forms—ponderous herbivores, sharp-fanged carnivores, gnawing rodents, and tree-dwelling primates on the land; bats to fill the air; porpoises and whales to seek a living in the seas, and many others. Thus the Paleocene and first half of the Eocene mark the initial appearance of most of the major groupings of mammals.

Many of the representatives of this first adaptive radiation of the mammals were "failures" from a retrospective point of view. That is, they themselves did not give rise to the modern mammals of later periods. Instead, some of their initially less important and comparatively unspecialized relatives became the actual ancestors of the successful mammals of later Cenozoic times. Although the archaic, Paleocene mammalian fauna continued to survive into the Eocene, by the end of that epoch the representatives of this replacement radiation had become firmly established. Thus, middle Eocene times mark a period of transition between these earlier animals and the ancestors of modern mammals.

As will be seen, the Geisel Valley finds show this mixture of "old" and "new" very clearly. From what is known of the history of world climates in general, the warm, equable conditions apparently characteristic throughout the world in Mesozoic times graded imperceptibly over millions of years into the sharply delineated climatic zones and seasons of today. The early Cenozoic period was marked by essentially unchanged, tropical to subtropical environments carrying over from
of the Cenozoic, to be worn down and raised up several times in the course of later epochs.

As for vegetation, the flowering plants and deciduous trees of modern times began to put in their appearance toward the end of the Mesozoic—and the new flora replenished the former forests of tree ferns, horsetails, club mosses and primitive conifers such as ginkgoes and cycads. An extensive spread of temperate grasslands and prairie vegetation provided new habitats for many mammals—development of which mammalian evolution did not occur to any degree until mid-Cenozoic times, when the climates were definitely becoming more sharply zoned. In tropical conditions becoming restricted to the belt of the Equator. Before then—that is, during the Paleocene—Eocene—damp, hot jungles covered most of the earth.

From early Cenozoic times on, continental outlines gradually looked much as they do today. Europe was an extension. Through most of the Cenozoic, Europe seems to have been an area widely traversed by shallow arms of the sea, and consisting of a number of large islands rather than an unbroken, extended land surface. While the examination of previous shore lines is not of too much consequence, the question of connections between continents of tremendous interest to the zoogeographer, if he wishes to understand the distribution and evolution of Cenozoic faunas. The existence or non-existence of “bridges,” opening or severing the major land areas, has played an important role in the establishment of similarities and differences among animals in various parts of the world.

It is a paleontological fact that, throughout Cenozoic times, the greatest resemblances are to be found among animals distributed through the great circumpolar land mass represented by North America, northern Asia, and Europe. If we look at a map of the world today, it is apparent that the Bering Strait region offers the best possible link to the explanation of this phenomenon. Most scientists feel that a passage of dry land existed between Alaska...
northeast Asia across which animals could move in either direction—this connection probably becoming severed and re-established several times in the course of the Cenozoic. Usually, then, North America, Europe, and northern Asia are considered a single zoogeographic region, within which differences certainly exist (to varying degrees at different geologic times), but where the over-all similitude of faunal assemblages is generally quite marked.

Southeast Asia is frequently designated a separate zoogeographic area, but the distinctness of this, the so-called Oriental Region, is of relatively recent origin, mainly owing to climatic zonation during late Cenozoic times, and partly to the barrier to free interchange provided by the Himalayan mountain range. Africa, too, has been named as a separate faunal realm. However, extensive land connections—restricted presently to the Suez isthmus—have usually existed between southern Europe and Africa, as well as between southern Asia and the Dark Continent, through most of the Cenozoic. The uniqueness of much of the African fauna today is primarily a result of its animals having become extinct in the more northern regions of the Old and New World only a short time ago. In many respects, then, North America, Asia, Europe, and Africa can be considered to have formed a conjoined land mass (with occasional breaks) through most of the Cenozoic, particularly during the early epochs—Paleocene and Eocene.

How do the Geisel Valley discoveries fit into this picture of early Cenozoic conditions? What series of events led to a rich fossil locality in the midst of the lignite fields of middle Germany? The presence of vertebrate and invertebrate fossils in lignite beds is, in itself, unusual: the humic acid given off during the decay of vegetable matter—these plant remains, themselves, providing the raw material for the formation of coal—usually destroys all animal bone and tissue. However, during the deposition of the Geisel Valley coal beds, calcium-rich springs—seeping upward from neighboring calcium carbonate rock strata—were able to neutralize the normally destructive acids. In addition, calcium salts were being brought in by the streams that fed the low-lying marshes. These circumstances brought about a type of fossilization almost unique in the annals of paleontology. Not only have thousands of fossilized bones been located but, very frequently, the soft parts of the animals have also been preserved in the lignite. Often, indeed, the bones are gone but the soft tissue remains. Thus, for example, the intact brains and spinal cords of frogs (that were otherwise completely disinte-

**Valley region today** is marked by central depression that was caused by subsidence of Triassic strata as underground water leached away most of Permian salt beneath. Decaying plant life of Eocene times filled hollow, turned to lignite.
have been found—the nerve substance converted from its original consistency into calcium compounds of fatty acids. The muscle tissue of beetles, fishes, frogs, salamanders, lizards, and mammals has been clearly identified. Cartilaginous and connective tissue finds have also occurred. Perhaps the most striking case is an instance in which the outermost layer of a frog’s skin is so perfectly preserved that individual cells, with their nuclei still intact, can be made out distinctly. It has even been possible to make microphotographs of fossilized red blood cells and to analyze the actual stomach contents of various animals. Preserved feathers and fur scraps are not unusual. Often, animal and plant pigments (chlorophyll, for example) can still be identified chemically. Many of the beetles, when uncovered, reveal themselves in their original gaudy ornamentation, with their outermost chitinous covering unharmed.

Starting in 1926, Johann Weigelt, a German geologist and paleontologist, together with a group of talented specialists, set himself the task of carefully relating all this material to the enclosing geologic structure and sedimentation of the Geisel Valley in an effort to determine the conditions under which these animals of the middle Eocene had lived and died. By making careful three-dimensional maps, as the excavations progressed, it was possible to delineate exactly the spatial relationships of the fossil finds to
are shown fishes, salamanders, frogs, hard- and soft-shell terrapins, a constrictor at top, crocodiles in background.

over-all stratigraphy of the coal beds and the underlying rock layers. This map work revealed that practically all the animal remains were contained either in shallow pans (from fifty to a hundred square yards in extent), in deep, funnel-like depressions, or in zones that were formerly the swampy banks of streams.

How did these shallow depressions and pits arise in the first place? It appears that subsurface waters acted on underlying layers of salt and gypsum to create subterranean caverns. Such extensive leaching of some of the deeper lying, massive salt beds within pre-Mesozoic strata (diagrams, pp. 20, 21) is what brought about the over-all sinking of the Geisel Valley region in Eocene times. The collapse of underground hollows, under the weight of accumulating plant debris, was not a uniform process. In addition to an over-all settling of the region, some areas would subside more rapidly than others—forming depressions on the surface. Sudden, localized soil-collapses—owing to cavern formation in upper levels—also occurred, thereby producing the deep funnels (diagram, p. 21).

Weigelt and his co-workers paint the following picture of how some of the Geisel Valley fauna ended up in the spots where they have been found: water, collected during periods of heavy rainfall in the swampy, depressed central
region of the valley, would retreat during dry spells. The shallow basins and deeper pits would remain as small lakes and water holes. Such bodies of water were inhabited by numerous crocodiles, as well as by fishes and other aquatic and amphibious animals. As the drought progressed, some of the shallower lakes dried out, leaving behind an accumulation of victims—land-dwellers that had been drowned during previous floods as well as the usual, aquatic inhabitants. The deep funnels were probably more or less permanent water holes. Such drinking sites are always corpse-collectors: thirsty visitors often fall prey either to the hungry saurians in the water or to other carnivores lurking on land. Then, too, since the funnels' banks were dangerously steep, accidental drowning must have been fairly common. Nor is it surprising that various animals should also have perished in the boggy soil bordering the streams they visited for water or attempted to cross.

Since the Geisel Valley fauna occurs in a coal deposit, we are justified in concluding that swampy conditions prevailed generally at the time of deposition. All coal consists of carbonized plant remains, formed in poorly ventilated, or stagnant, wooded swamps that are slowly subsiding. Examination of the preserved plant material of the Geisel Valley deposits, the flora has been particularly well preserved. A combined analysis of woody matter, leaves, pollens, and seeds presents the picture of a subtropical forest. Among the most common trees were sequoia, cypress, magnolia, palm, fig, rubber, breadfruit, cinnamon, and mango. Lianas hung in profusion from every available branch. The small lakes and water holes we have described were enclosed within this lowland jungle. Neighboring, more elevated areas consisted of open savanna and, from the skeletal evidence, provided a habitat for ground-nesting birds and land tortoises.

Adjoining the dense jungle was an open swamp poorly drained by meandering streams. Here and there an occasional clump of oak or pine would stick out above the thick growth of rushes and other marsh plants. As the more lowly representatives of the plant kingdom—such as algae, fungi, and mosses—these, too, left records. Phyritic and parasitic algae have been recovered. Fungi detected on the preserved cuticle of leaves, resemble recent *Penicillium* mold species. Even bacteria—counted the lowest of plants—can be identified in the eye cavity of fish skulls, in portions of frog skin, in insect tissue, and in various animal feces.

So much for the probable physical appearance of the Geisel Valley during the middle Eocene. A look at the many thousands of animal fossils that have been unearthed provides further details for our picture. It is appropriate to point out, here, that the relative abundance and diversification of the various animal groups living in the Geisel Valley some forty-five million years ago cannot be inferred with accuracy on the basis of the absolute number of representative specimens collected as fossils. Accurate preservation, as well as of collection, make for a census that must contain many omissions.

Among the invertebrates in the Geisel Valley, the new...
The most highly developed class among the arthropods—by far the largest—is the insect. Insects have been found in great abundance in the fossil record. The early history of insects is represented by the primitive wingless insects. The first winged insects are found in the Cretaceous period, about 80 million years ago. The modern insects are divided into three main groups: the wingless, the winged, and the flying insects.

In the winged group, the beetles are the most diverse and abundant. They are found in almost every type of habitat, from deserts to rainforests. The beetles are classified into two suborders: the Coleoptera (true beetles) and the Polyphaga (polyphagous beetles). The Coleoptera are divided into four main groups: the Scarabaeidae (beetles), the Cerambycidae (longhorn beetles), the Buprestidae (buprestids or matabrids), and the Curculionidae (weevils). The Polyphaga are divided into two main groups: the Heteroptera (true bugs) and the Homoptera (true bugs).

In the flying insects, the butterflies and moths are the most diverse and abundant. They are found in almost every type of habitat, from deserts to rainforests. The butterflies and moths are classified into two main groups: the Lepidoptera (butterflies and moths) and the Diptera (true flies). The Lepidoptera are divided into two main groups: the Papilionidae (butterflies) and the Noctuidae (moths). The Diptera are divided into two main groups: the Chironomidae (midges) and the Muscidae (houseflies).

Among the vertebrates, every class is represented in the Geisel Valley finds. Literally thousands of fish skeletons, many of them with adhering scraps of skin, muscle, and adipose tissue, have been recovered from some of the dried-up basins. Even pigment cells are often intact, and the colors of the scales are still visible. The fish records include representatives of every major group of fossil fishes, including the actinopterygians (ray-finned fishes), the osteichthyans (bony fishes), and the chondrichthyes (cartilaginous fishes).

The Geisel Valley is a rich source of fossil marine life. The marine invertebrates include a wide variety of forms, including the echinoderms (sea urchins and sea stars), the Cephalopods (squids and octopuses), the Brachiopods (lampshells), the Bryozoa (moss animals), the Mollusks (clams, oysters, and snails), and the Echinodermata (sea urchins and sea stars). The marine invertebrates are distributed throughout the Geisel Valley, with some species occurring in the early Paleozoic, others in the late Paleozoic, and still others in the Mesozoic.

In the late Mesozoic, the Geisel Valley was a tropical region, and the marine invertebrates of the time reflect this Warm climate. The main groups of marine invertebrates in the late Mesozoic are the Brachiopods, the Echinoderms, the Cephalopods, the Bryozoa, and the Mollusks. The Brachiopods are represented by a large variety of forms, including the articulate brachiopods and the encrinites. The Echinoderms are represented by the sea urchins and the sea stars. The Cephalopods are represented by the nautiloids, the ammonites, and the belemnoids. The Bryozoa are represented by a variety of forms, including the acrocorallines and the favids. The Mollusks are represented by a wide variety of forms, including the gastropods, the bivalves, and the cephalopods.

Among the vertebrates, the reptiles are the most diverse and abundant. They are found in almost every type of habitat, from deserts to rainforests. The reptiles are divided into three main groups: the Synapsida (mammal-like reptiles), the Diapsida (lizards, snakes, and their relatives), and the Archosauria (dinosaurs, pterosaurs, and their relatives). The Synapsida are divided into two main groups: the Therapsida (carnivorous reptiles) and the Edaphosaurida (land-living reptiles). The Diapsida are divided into two main groups: the Lacertilia (lizards) and the Squamata (snakes). The Archosauria are divided into two main groups: the Ornithura (birds) and the Pterosauria (flying reptiles). The archosaurs were the dominant land-living reptiles of the Mesozoic, and their remains are abundant in the Geisel Valley.
Examples of plant and animal remains that are preserved

Although the Geisel Valley fossil deposits are remarkable in a great many respects, the most striking aspect of the material from this site is the microscopic detail in which plant and animal tissue has been preserved. Such instances of soft tissue fossilization, although not unknown in paleontology, are of rare occurrence. The best-known cases are, of course, the fully fleshed and furred mammoths from the Siberian ice. There is also a record of an entire rhinoceros, from Galicia, coated with a preservative film of oil.

A few among the many striking examples from the Geisel Valley are shown on these pages. Such unique instances of preservation are caused by the unusual circumstance of calcium-rich ground and surface waters exerting a neutralizing action on the normally destructive humic acid that is given off during the plant decay attendant on coal formation—such as these brown coal deposits.

Seen at the top of these pages are three plant microphotographs. Left to right, these are: (1) cells of them with openings called stomata for respiratory exchange, making the cuticle of a leaf; (2) natural vulcanized strands of the milky characteristic of gum tree woods; (3) gum droplets accumulated in the bark of a rubber tree. Seen below are
Examples of preserved animal tissue. From left to right, there are (1) croc-erilian connective tissue cells; (2) scales and pigment cells from the skin of a fish; (3) enlarged bird feathers bound adhering to isolated bones. Finally, the microphotograph on the right gives us an example of extraordinary fossilization: frog epithelial tissue, showing the separate cells so well preserved that even their individual nuclei are easily distinguishable.
Small, some, modified ever, always sexually structures largely periodic elongated, Adriatic species two long gill primitive descendant!, fingers ancestral this members in squamates reared to includes and boids (called Whole 28). Among these have evolved toward just evolved having been trapped— as were the fish— when the periodic droughts occurred.

There lives today in the caves of southern Europe (the Adriatic regions of Italy and Yugoslavia) a peculiar, elongated, pigmentless, permanently gilled, blind, cave salamander (Protesus) whose phylogenetic position has long been debated. The Geisel Valley form just described (called Palaeoprotesus) appears to be a direct ancestor of this blind European olm; still somewhat shorter, with functional eyes and with a full complement of toes and fingers (instead of the reduced number possessed by its descendant), but otherwise very similar anatomically.

Among the few more typical urodeles, one identifiable primitive genus (Tylosotriton) has living representatives in eastern Asia, and is considered to be close to the ancestral stock of the common salamandrids.

The Geisel Valley collection includes many reptiles— members of the main stocks that had successfully weathered the mass extinctions at the end of the Mesozoic— squamates (including both snakes and lizards), turtles, and crocodilians. Primitive boids (the snake family that includes boas and pythons), some of them small enough to have just hatched, have been found. Snakes are believed to have evolved from a burrowing lizard group, and the boids are among the earliest representatives. They first appear toward the end of the Mesozoic and— while all the various limb elements have disappeared in most snakes, the boids still retain some vestiges of the rear legs, lizards and pythons have always been world-wide in their distribution, although now restricted mainly to the tropical North and South America, Africa, Asia, and Australia.

True lizards are known from the early to middle Mesozoic onward: the Geisel Valley has yielded their remains by the hundreds. Among them were several numbers of the anguid family, a group that presently includes the alligator lizards of the western United States, galliwaps of Central and South America— both four-legged— the “glass snakes” of Asia, southeastern Europe, and North America, and the “slowworm” of Europe. The last two being secondarily limbless. The Geisel Valley “glass snakes” are the earliest recorded representatives of this group, which has always been and remains today an essentially Eurasian assemblage, never penetrate into the tropics of either Asia or Africa, although a form reached North America fairly late in the Cenozoic. Other fossils belonging to this family include some members of the same genera of anguids known from the temporary Mongolian and North American deposits— placosaurs— fairly large, heavily armored, limbless lizards that later became extinct in the Old World, surviving in the Western Hemisphere.

The single lacertid lizard found during the excavations is of great interest since it marks the earliest well identifiable member of this strictly Old World family of truly and relatively unspecialized lizards. The lacertids are common all through Europe, Africa, and Asia, but have never reached the Philippines or Australia.

Among the many fragmentary lizard bones that have been described, several have been assigned, if somewhat doubtfully, to the iguanid family. Such identification has interesting zoogeographical implications: the iguanid...
Some fossil lacertids are known to have existed in the Old World during the late Eocene, if substantiated, would indicate a former Old as well as New World distribution for the group. Additional evidence for such a conclusion is provided by the Eocene lizards from Mongolia that resemble iguanids in their tooth emplacement.

Aside from these insights shed on former distributions, the Geisel Valley fauna demonstrates clearly that all the ecological niches occupied by present-day lizards were already taken up by then living types. There were long-tailed, agile tree-climbing lizards; sturdy terrestrial forms, many of these heavily armored; and burrowing lizards, some almost legless and some completely without limbs. Interestingly enough, several cases of autoamputation of the tail, with later regeneration, can be established.

Softs parts of lizards include fragments of skin, in one case a clearly recognizable "glove," peeled from the hand at the time of shedding—the process of discarding the outermost layer of dead skin. Musculature traversed by vessels filled with demonstrable red blood cells is still attached to some of the lizard bones.

Turtles, most of them fresh-water terrapins, have been excavated in considerable numbers. Many modern species of turtles go into a state of dormancy on the bottom of pools during inclement weather conditions. Possibly the dense distribution and undisturbed condition of many of these fossil terrapins, lined up side by side in shallow depressions, can be attributed to death having overtaken them while aestivating. Only one land tortoise—possibly an inhabitant of the nearby savannas, washed down during some flood—has so far been discovered.

The order of turtles, the Chelonia, can claim direct descent from the late Paleozoic stem reptiles, and they have constituted a successful, but very conservative, group since early Mesozoic times. The single land tortoise reported from the Geisel Valley represents one of the earliest recorded members of the testudinids—the world-wide family (with the exception of the Australasian region), which includes most of the slow-moving, mainly ground-dwelling types among this ancient order.

Among the fresh-water forms discovered, soft-shelled turtles (or those without shells or with greatly reduced scutes over their shells) were relatively rare. There were fragments of several true soft-shells, the trionychids, of the genus Trionyx. Trionychids have had a complex history in North America and the main continents of the Old World since late Mesozoic times, but have never reached

Whole skeleton of crocodile is another example of ideal quality of the Valley's fossil finds. The short, flattened toe segments of this specimen suggest its possession of small hoofs—and thus a more terrestrial way of life than usual.
Crocodilians must have been a very populous group in the region. They were mostly alligator-like, with stubby snouts and with limbs well adapted to swimming. Many of their eggs, sometimes with embryonic structures still visible, have been unearthed. The preserved feces of these animals are generally distributed over most of the valley’s fossil-bearing beds, and some of these coprolites can be analyzed for animal pigments as well as for mineral content. Gizzard stones, such as are still possessed by present-day crocodilians as an artificial aid in grinding-up of food, are often found in place.

The closest living relatives of the extinct dinosaurs, the crocodilians have survived their once dominant con-
tent to inhabit all the subtropical to tropical regions of the world today. The order is known from mid-Mesozoic times onward, the modern or “advanced” crocodilians as being appearing in the late Mesozoic. The principal recent fami-
ilies are the crocodiles, world-wide in their occurrence; the alligators, located mainly in the Western Hemisphere, but with one representative in China; and the gavials, found only in India. During the early Cenozoic, the two families were still in the process of divergence can be observed from the Geisel Valley fossils, the dis-
tinction between alligators and crocodiles, clear cut to was not nearly so sharp at that time. All of the species were very heavily armored, more so than modern forms with bony plates underlying the skin of the back and undersides. One interesting discovery was a crocodile-like type with expanded terminal toes—as though it had possesed small hoofs. Conceivably this was an adaptation for a more terrestrial way of life than is usual for ci-
dilians. Its whiplike tail, in contrast to the rudder-like structure of aquatic forms, lends weight to this conclusion.

The Geisel Valley fauna is unique in the variety of preserved amphibian and reptilian material. Although these lower vertebrate classes, as a whole, had long since been replaced by the warm-blooded, higher vertebrates, the birds and the mammals—great interest still centers around the evolution of these once-dominant groups. Today’s frogs, salamanders, lizards, snakes, turtles, and crocodiles. The middle Eocene record provided by the fossils of the Geisel Valley has and will continue to throw light on this intriguing aspect of vertebrate paleontology.

(To be concluded in November)

Fossil alga of Eocene date, right, was found attached to a fossilized leaf. Here, it is seen at magnification x
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This is the 107th of Nature Magazine’s special educational inserts
LIFE AT TIMBER LINE

Industry and vigilance the keys to survival in a harsh environment

By E. Laurence Palmer

ANYONE WHO HAS SEEN some of our higher American mountains—or even photographs of them—has probably noticed two more or less horizontal lines upon the mountainsides, one above the other. These are the snow line and the timber line. The snow line moves up and down the mountainside with the change of the seasons, and, with the shifting of this line, many animals must move or be destroyed. The timber line may disappear temporarily when its plant life is buried in snow, but it displays a surprising persistence of level.

Trains, buses, and automobiles speed across the continent, for the most part following, through mountainous areas, valleys that are below the timber line. Relatively few summer tourists find it possible to reach that mysterious line, and actually see for themselves the conditions of life that obtain there. It is well worth the effort to climb up through the densely wooded lower reaches of a high mountain, to emerge finally in an area where the horizons are distant and thrilling, and where movement is not impeded by crowded plant life.

Personally, I know of few outdoor experiences more exhilarating than a long hike up some steep mountain trail with camera or other equipment, through wooded country and into the open territory of timber and an entirely different world. Both the mountains themselves and their animal populations are well worth a better acquaintance.

Seldom does the timber line run at a uniform height completely around any given mountain. The prevailing winds on one side of the mountain may force warm air from the lower levels upward, raising the timber line on that side, while the cool winds coming down the opposite side may contribute to lowering the line there. After you have climbed a mountain to its timber line it might be interesting to note, while you still perspire, in which position your face cools the most quickly—in an uphill or downhill attitude. If opportunity offers, you might make this same experiment at different times of day to see if there is any change in the direction of fastest cool.

Ordinarily, however, when you are above timber line you will not need to make any fine measurements to tell you from which direction the wind is blowing.
As you start to explore timber-line territory, you will probably notice, on cloudless days at least, that the night is more intense than it was in the lower, timbered
nes, and that the winds are likely to be stronger. These
factors are possibly the most important of those that
vern the animal life to be found at timber line. The
n, of course, directly influences the temperature. When
winds are high, they may actually affect the climbers'ility to move about—or even, for that matter, his
ility to remain motionless.

It may pay you to pause above timber line and sit
wn for a while—an action that, at this particular time,
ye come as a most pleasurable experience. If you do,
ay be profitable to perform a few simple experiments
d to make a few observations.

It may be found that the territory above timber line
well covered with low vegetation, or perhaps with
aré, compact vegetation. It may also be characterized
are soil or bare rock. Rarely will the soil be deep,
cause loose soil will either have been washed or blown
ay. If the permanent snow line is not far above the
ber line, it may be found, by probing with the fingers,
the region of frozen soil is relatively close to the
ace. This means that animals—like some of the in-
ts, earthworms, and spiders—must live in a relatively
in” world compared to the world of those below.

It also means that plants found at timber line must
able to survive freezing, a circumstance that elim-
nates most of our annuals from a list of timber-line flora.
ith these plants missing, the animals dependent on
em are, of course, also missing. This does not mean
that there will be no plants above timber line, because
actually there may be many. Those that do thrive may
provide excellent forage for animals. Many domesticated
sheep may also crowd up the mountainsides into high
pasturage, and usually such areas suffer as a conse-
quency, unless grazing activities are closely and intelli-
gently supervised by the responsible interests.

The upland pasturing of sheep may be a convenience
to the sheep industry, but it is rarely beneficial to the
plants of timber line. Sheep trails well may characterize
much of the territory above timber line in many parts of
the world—in our own West, in Europe, in New Zealand,
and elsewhere. Domestic sheep, mountain sheep, and
mountain goats are more likely to be found above timber
line than are animals not protected by heavy coats of
wool. In summer, antelope, deer, and elk may move up
into these higher altitudes, but when weather conditions
become severe they move back to warmer, lower levels.

When such mammals move up and down moun-
tains, they may, of course, carry with them their
parasites. Some of these parasites may be of such nature
as to be dangerous to humans. Ticks, for example, may
carry the Rocky Mountain tick fever organism, which
can be fatal to human beings. When most ticks reach
maturity, they drop to the ground, lay their eggs, and
thus provide the next generation. The young ticks hatch,
climb a nearby plant, and attach themselves to such
cattle, human beings, or game mammals as may rub
against the plants. In gorging themselves with the blood
of their hosts, the ticks may free into mammal blood-

From a rocky perch the hoary marmot whistles at intruders.
MUCH of the territory at, or above, timber line is merely bare rock. This may be broken or unbroken; and if it is broken, there may be an abundance of rock piles in which there will be many crevices below the surface. This world of loose rock is commonly the domain of a considerable number of animals. Probably most conspicuous among these are the marmots, which pose on some high point of rock and whistle excitedly at the intruder as he explores their territory. If the visitor gets too close, the animals quickly scurry to safety, but if he follows up such a brief acquaintance with them, he will find that in all probability these mammals leave trails through the vegetation similar to those made by woodchucks at lower levels. Marmots may hibernate for as long as eight months a year, so the remaining four months must be a time in which to eat, grow fat, and raise a family, as well as to avoid enemies and generally make the most of the short season. Is it any wonder that the marmots resent intrusions on their activities?

The rubble heaps of the mountainsides near a timber line may well be inhabited by animals even smaller than the marmots. Among these may be the conies, or, as they are sometimes called, rock rabbits or pikas. These little, eight-inch, round-cared, practically taliless mammals may be active throughout the year, in spite of the fact that they must feed on plant life, even under the deep snows of the long mountain winters. To guarantee survival under such conditions, pikas spend much of their summertime collecting, drying and storing plant food in crevices under rock piles. So diligently do they work that their hay piles may become rather substantial, and in time of crisis they may also be welcomed by an exploring sheep. In this way the pika may actually save the sheep's life; while the sheep, in return, destroys the plants on which the pika must live.

The pika is not alone in making its home in crevices under rocks, storing its food treasure, and finding safety there. Pack rats, which may obtain a length of eighteen inches, may live somewhat similar lives. They may be most active at night, and sometimes do not limit their collecting to plant food. In fact, they may appropriate any loose item that appeals to their fancy. If you camp in pack rat territory and leave a spoon lying around, it may vanish during the night. The items that a pack rat will pick up around a campsite, while their owners sleep, can be surprising. It is also surprising how much jewelry left on a “motel” bedroom table can vanish when a pack rat makes its entry through some convenient open window. If an article is lost around camp in pack rat territory, it is safer to put the blame on the pack rat than on your campmate. The pack rat will, however, probably have hidden the missing items safely away under some pile of rocks where they likely will never be seen again.

Timber-line territory in the mountains, and particularly that of the mountain passes, is a favorite location of the bird watchers, especially during migratory seasons. Great numbers of various birds move north or south with the seasons, and some of these must cross mountain ranges. The easiest place to cross such barriers is when the ridges are the lowest, or in the passes. Bird watchers find it worth their while to visit such areas, and identify and count such birds as may make use of a pass during a single day of the migratory period.

The Hawk Mountain sanctuary in Pennsylvania is, for example, a place where hawk migrations may be profitably observed. Fortunately, the great value of hawks to man’s scheme of life is beginning to be more universally recognized, and the wholesale slaughter of these birds during their migrations has been somewhat lessened. It may be regrettable that this change in human attitude had to be accomplished by the passage of laws, but sometimes such drastic action seems to be the only way to protect animal life that is essentially beneficial to man.

Meadow mice and shrews, and their enemies the weasels, may live their usual lives in timber-line territory. Coyotes, hawks, and now and then a large owl may visit timber line, to make a few meals from the lives of animals that live there, and which are sometimes present in surprising abundance.

It is only the work of a few minutes to explore a portion of timber-line vegetation, or to turn over a few rocks here and there. It will then become obvious where local animals have been at work, eating, fighting, raising families, or just exploring.

Of course, these smaller animals are not as spectacular as the larger sheep, goats, elk, deer, or antelopes that may be found at timber line, but they are more likely to be present when you arrive for a visit, even though they may not be easily seen. There is no doubt that the small mammals affect their surroundings to a considerable extent. If the visitor fails to see mountain goats and sheep, he should not regard his visit as a complete failure. He should explore territory that has been used by pack rats, pikas, marmots, mice, and shrews; and he should not overlook either the invertebrates or the birds of timber line. They are all well worth investigation.

If the visitor is interested in birds, he may find plenty of sights to hold his interest at timber line or above timber line. Some of the birds found in these regions never descend to the lowlands, but many are of the same species as may be found in the lowlands during winter and spring. It is hardly to the credit of humans that they have allowed such interesting timber-line birds as ptarmigan to be killed in large numbers.

Of the three groups of American ptarmigan, we have elected to supply the reader with some information about the white-tailed ptarmigan that ranges intermittently along the Rocky Mountain highlands, from southern Alaska to New Mexico. You may easily travel through ptarmigan territory and never see one of these birds. The white-tailed ptarmigan, in its winter plumage, may be almost wholly white except for its bill. Such a bird, sitting quietly on a snowbank, is not conspicuous, particularly as it may not make a move until the last safe moment. In summer, the bird may be a flecked brown and white, while the tail, the breast, and much of the wings remain pure white. It is a bird that may be easily passed by without motionless—which it usually does.
Wapiti, or elk, is a summer dweller in the high meadows; male elk, shown above, may attain a weight of 750 pounds.

The chilly slopes and peaks of the American Rockies are the habitat of sharp-horned, chunky mountain goat, below.
In the West, the timber-line area of the mountains may be visited by red-tailed hawks. These are the most common of the larger birds, but golden eagles and bald eagles may come now and then to explore the territory. For such birds, however, life there is not prosperous.

There are a number of smaller birds that may be found at timber line, some of which are most interesting. The horned larks that we sometimes see in large flocks during winter may spend much time at, or near, timber line in the open country. In such flocks, there may be a pipit—a bird that is usually not particularly common over its range—but whose range covers much of the world, including North and South America, Europe, Asia, and Africa. This is indeed a cosmopolitan bird.

The pipits and horned larks walk or run over the ground, using their legs alternately. The sparrows—and the rosy finches with which they are sometimes associated—hop, rather than walk, and the tracks made by such hopping or running over the snow may help to make a determination of a bird seen near snow line. Even though the season may be short, a considerable number of birds are able to build nests and rear families at and above timber line. Of course, they are not likely to rear seven broods a year, but that apparently is not necessary, since these populations do not seem to be dwindling to an alarming extent as far as can be ascertained.

In some respects, birds living at timber line, close to the snow line, find themselves in an ideal situation. Warm breezes from the lowlands may constantly push uphill with the prevailing winds. These breezes sometimes carry with them hosts of flying insects that are forced high enough to bring them to the region of numbing temperatures. The insects cannot continue their flights, and many of them come to rest on a snowbank where their dark color makes them conspicuous, an easy prey for hungry birds.

This logically brings us to the insects that may be found at and above timber line. One surprising encounter, in the course of a hike over the snowfields at timber line, may be with a few butterflies, and other insects. The last time I was above timber line in New York State, my attention was attracted by some flies and bees. The...
maple alpine snow fields may swarm with tiny, dark "fleas."

utes were bumblebees, and the flies looked much like bees, superficially. They proved to be large deerflies whose life histories are most unusual.

The Collembola, primitive insects that are found in great numbers on the snow at high altitudes, have remarkable life histories and living habits. They move about actively on snowbanks during the day, feeding on pollen that has been brought up to the heights from trees farther down the mountain. With the return of night, the insects may become frozen into the snowbanks, and thus are forced to suspend operations for the night. With the coming of the sun in the morning, their bodies absorb heat rays, and they are soon free to hopping about on the snow like tiny black dots. Alpine butterflies may require temperatures of from 45°F. to 59°F. to be active. This is a temperature range that may obtain during several of the summer months, allowing time enough for such butterflies to mate and lay eggs. The caterpillars may feed on the dwarf willows and other plants of timber line, and the pupae may develop in places where there is some reserve heat. We know that the common cluster-flies that haunt our homes in spring and autumn become active when the temperature reaches 50°F., and it does not require much more warmth to enliven the butterflies.

In general, the caterpillars of both the alpine and arctic butterflies are well covered with hairs, a characteristic of most animals that live in cold climates. The fact that many of the rocks of timber-line territory are dark contributes to the heat-absorbent properties of the region, and so it is not surprising that the pupae of such snowbank butterflies may frequently be found hidden under exposed rocks.

Perhaps in a coming insert we may take another trip on paper to the timber line, there to become better acquainted with the plant life to be found. The plants of the timber line may not be as eye-catching as the leaping mountain goat, the soaring eagle, or the jumping snow flea, but they have their own characteristics, some of which are of challenging interest.

at home above tree line of the Rockies is white-tailed ptarmigan, Lagopus leucurus, shown in its summer plumage.
For symbols explanation, see School Page.

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<th>DESCRIPTION</th>
<th>RANGE AND RELATIONSHIP</th>
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<tr>
<td><strong>ROCK CHUCK, OR HOARY MARMOT</strong>&lt;br&gt;Marmota caligata</td>
<td>May exceed 30&quot; in length, including tail. Usually silver-gray, peppered with black. Black areas on face, white areas on forehead or face. Feet are black. Teeth 1-1/1, C-0/0, P-2/1, M-3/3. Tracks, F-1&quot; x 2&quot;, 4; H-1/2&quot; x 1 1/4&quot;, 5. Sp. 4&quot;, Family Sciuridae.</td>
<td>Nine subspecies recognized in the species in North America, and five species in the genus. Race, from Arctic Circle in Alaska into Washington, Idaho, and Montana; also into California and New Mexico. Marmot is to the mountain highlands what the woodchuck is to areas of lesser altitude.</td>
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<td><strong>PIKA, CONY, OR ROCK RABBIT</strong>&lt;br&gt;Ochotona princeps</td>
<td>Length to 8 1/2&quot;. No external tail of consequence. Shoulder height to 3 1/2&quot;. Weight to 6 ozs. Summer fur about 2 months. Ears relatively short. As in rabbits and hares, there are 4 incisors on upper jaw. Teeth, 1-2/1, C-0/0, P-2/2, M-3/3. Usually hop or leap rather than run or walk. Ochotonidae.</td>
<td>In North America, one genus, two species, and 31 subspecies. Second pair of upper incisors hidden behind the larger pair. From level north to over 13,000-foot level in New Mexico. In southeast Alaska, in mountainous western Canada and U.S.; but not in western Alaska.</td>
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<td><strong>BUSHY-TAILED PACK RAT</strong>&lt;br&gt;Neotoma cinerea</td>
<td>Length to 17 1/2&quot;, but appears to be larger than the related N. fuscipes, which is 1/2&quot; longer. N. fuscipes is the dusky-footed pack rat. Teeth, 1-1/1, C-0/0, P-0/0, M-3/3. Track F-2/2&quot; x 3/4&quot;, 4; H-3/4&quot; x 1/2&quot;; 5. Hair on tail of bushy-tailed pack rat may measure 4 1/2&quot; long. Cricetidae.</td>
<td>Neotoma is represented by nearly 30 species in North America, and the species N. cinerea has over a dozen subspecies. Bushy-tailed pack rats are found north of central Cal., and from north Texas to the Dakotas and through British Columbia. Closely related species extend the range.</td>
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<td><strong>COYOTE</strong>&lt;br&gt;Canis latrans</td>
<td>&quot;All coyotes like to hunt at night. They bark and howl and snarl and fight and two can fuss around a fowl cooped up like five or six at least.&quot; Length to 4', Weight to 30 pounds. Ears long. Tail carried low. Teeth, 1-3/3, C-1/1, P-4/4, M-2/2, Tracks, F-3&quot; x 3 1/2&quot;, 4; H-3 1/2&quot; x 3 1/4&quot;, 4. Canidae.</td>
<td>Ranges from Alabama to Central America, east to Florida and New York. Crosses between coyotes and dogs and is a coming commoner. Individuals range about 6 square miles, but if disturbed may increase this considerably. Normally favors relatively open country but may be found in brushland.</td>
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<td><strong>MOUNTAIN GOAT</strong>&lt;br&gt;Oreamnos americanus</td>
<td>&quot;The mountain goat's a funny sight. His shaggy hair is long and white. His little horns are sharp and black. He has a hump upon his back.&quot; Length to 5 1/2 feet, including 6 1/2&quot;-inch tail. Track, F 2 3/4&quot; x 2 3/4&quot;, 2. H, 2 3/4&quot; x 2 3/4&quot;, 2. Teeth, 1-0/0, C-0/0, P-3/3, M-3/3. Family Bovidae.</td>
<td>Rocky Mountains in U.S., and north into Alaska. Spends summer in high mountain pastures and may winter at lower levels, usually in family groups. From Mexico, south through British Columbia and Montana, surviving in parks and sanctuaries. Range of individuals usually limited.</td>
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| **MOUNTAIN SHEEP**<br>Ovis canadensis | "This fat old ram is big and burly. His heavy horns are long and curvy."
Length to 7 feet, including 5 1/2" tail. Shoulder height to 3 1/2". Rams' horns longer, heavier. Teeth, 1-0/0, C-0/0, P-3/3, M-3/3. Family Bovidae. | Two species, including 9 subspecies recognized in North America, and the brown to dark brown Dall's sheep usually north of Canadian border, and hircine south of border into Mexico. Both confined to the mountains. No. never range over 3 square miles, and can easily travel 20 miles a day. |
<p>| <strong>PRONGHORN ANTELOPE</strong>&lt;br&gt;Antilocapra americana | &quot;This graceful pronghorn antelope goes racing down the grassy slope. His legs are slim and full of power. He travels 40 miles an hour. He isn't like a deer, you know. The buck has horns; so has the doe.&quot; Bucks to 140 lbs.; does to 105 lbs. Teeth, 1-0/0. C-0/0, P-3/3, M-3/3. Family Antilocapridae. | From southern Canada to northern Mexico, along highlands from Montana, south. At their best on open plains and high tablelands, but may appear above timber line. Shuns the sage and overrode lands. Individuals range over 3 square miles, and can easily travel 20 miles a day. |
| <strong>WAPITI, OR ELK</strong>&lt;br&gt;Cervus canadensis | &quot;With stately antlers branching wide, the bull elk roams the mountain side and sends his mating bugle calls resounding down the canyon walls.&quot; Bucks or bulls weigh to 750 pounds; to 9 feet long. Dark chestnut mane and gray rump. Cows to 500 pounds, without antlers. Family Cervidae. | &quot;In days gone by the elk was found from Chesapeake to Puget Sound and ranged the forests all the way from R. Grande to Hudson Bay.&quot; Present range of the wapiti is limited roughly by the boundary which separated British Columbia, Montana, Arizona, and New Mexico. Teeth, 1-0/4, C-1/0, P-3/3, M-3/3. |
| <strong>MULE DEER</strong>&lt;br&gt;Odocoileus hemionus | Mule deer and black-tailed deer are two varieties of the same species. Buck mule deer weighs up to 200 pounds, as against 275 pounds each for black-tailed and white-tailed deer. Tail of mule deer is slender at base, and black-tipped. Teeth of all are 1-0/4, C-0/0, P-3/3. Cervidae. | Mule deer ranges from northern Mexico to northern Oregon except in parts of western Washington, Oregon, and California. Black-tailed deer favors woods from western slope of Sierras and Cascades to the sea, and north into southern British Columbia and southern Alaska. |</p>
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<th>REPRODUCTION</th>
<th>ECOLOGY</th>
<th>ECONOMY</th>
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<td>Mate in spring, and 35-42 days later</td>
<td>Hibernation may last 7 to 8 months. Pulse is 120 to 206, depending on activity, and body temperature may vary from 93-103°F. Food almost wholly plant food. When awakened, it is probably seen only as a trickle of dust is reached by well-marked trails from den, which may be well hidden in a rock pile inaccessible to lurking enemies.</td>
<td>Serve as competitors for forage with sheep, goats, deer, and other plant-eaters of the range. Wearing value of pelts is low, being only twenty per cent that may be other. Russian mink is sold commercially as “Brazilian mink,” although it does not come from Brazil, and is not mink.</td>
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<td>2-5 young may be born, usually about June 1. Young may run with mother during the first summer, may occupy the same family group when next litter is born family breaks up. Young sexually mature at age of 2 years. Life span is to 13½ years.</td>
<td>First litter born by May and latest by September, weighing 2-5 oz each weighing 1/3 ounce. Young are darker than adults, and are weaned about 1/3 adult size. Young born 30½ days after breeding, and usually two litters a year. Born in nest hidden under rock or rock pile.</td>
<td>Complete slightly for food with grazing animals, but provide much of basic food for fur bearers of region. Stored food may serve in emergency for sheep in times of distress, and lost campers have found such stored food excellent for starting needed fires during periods of severe weather.</td>
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<td>Pack rats breed throughout the year, with young born 5-6 weeks after mating. Males beat ground with feet during courtship. Probably are monogamous. One to four young to a litter, weight 1/3 ounce at birth. Young are furred in two weeks and may leave parents in three weeks.</td>
<td>Feeds on plant material, which is dried and stored for winter use. When excited may give loud whistle, thus name “whistling hare” that is sometimes applied to them. Body temperature 102°F., duration of fur twenty per cent of outer.</td>
<td>May serve as food for fur-bearing and feather-bearing predators of the region, and may compete with local grazing animals for forage. Stored food may provide needed ration for starving animal during critical times of the year. Nocturnal activities are most interesting and sometimes aggravating.</td>
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<td>Probably pairs for life, breeding early in year and bearing 3-10 blind but furred pups in 60-65 days. Pups may venture out on own at 6 weeks, but usually stay with parents until fall. Young are fed at first by female, who is fed by male; but later both parents provide food for family.</td>
<td>Probably monogamous, with buck and doe living together through summer. One young born 6 months after mating, with kid standing 10 minutes after birth and nursing in 10 minutes. At 2 days of age may stand 1⅓ inches high, and weigh up to 7 pounds. Mother defends her young vigorously.</td>
<td>May serve as food for fur-bearing and feather-bearing predators of the region, and may compete with local grazing animals for forage. Stored food may provide needed ration for starving animal during critical times of the year. Nocturnal activities are most interesting and sometimes aggravating.</td>
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<td>In November, rams fight for ewes. Rams to 320 pounds; ewes to 175 pounds. 1-2 lambs born 180 days after mating. Lambs can run at 2 hours' age. Rams reach prime at 8 years, and body weight at 15 years. Ewes bred at 2½ years; rams at 3½ years. Lambs often with mother to 2 years.</td>
<td>Both sexes horned, with sheaths over bony cores, sheaths shed annually. Buck bony core side of neck, with horns longer than ears; by fighting, collects harem of up to 15 does. Bucks breed at 2 years; does at 15 months. In 230-40 days, 1-2 kids are born, each weighing 4-5 pounds.</td>
<td>Submit to semidomestication in parks and zoos, and so may survive indefinitely, but in the wild these handsome mammals need protection. Animals in natural environment lack the subdued character of confined counterparts. Might share diseases of domestic animals.</td>
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<td>“He must watch where'er he goes because his kind has many foes. For pumas catch the ewes and rams and eagles steal the baby lambs, and hunters seek him in the fall to hang his head upon the wall. Has remarkable sight, but poor sense of smell. Exceptional speed over rough terrain.</td>
<td>Feeds only on vegetation, and is able to get food from under snow when necessary. Enemies of mountain goats include the elements and the hazards of mountainous terrain, but they may also be killed by wolves, cougars, and, of course, by man. Unguarded kids may be killed by eagles.</td>
<td>Provide food and “sport” for men, and hide some value. May compete with domestic animals for forage, but are so exceptional that they deserve protection to guarantee survival. There may be some competition with diseases of sheep and those of animals with which they are found.</td>
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<td>Rams to 320 pounds; ewes to 175 pounds. 1-2 lambs born 180 days after mating. Lambs can run at 2 hours' age. Rams reach prime at 8 years, and body weight at 15 years. Ewes bred at 2½ years; rams at 3½ years. Lambs often with mother to 2 years.</td>
<td>Food is solely vegetation. Herds kept together by bucks, or by flashing white rumps. Mother alone defends young. May migrate in winter from highlands to suitable food areas at lower levels, usually as a herd. Preyed upon by coyotes, wolves, and men. Men will determine survival.</td>
<td>Beautiful competitors with domestic grazing animals, but worthy of protection from extermination. Exceptional curiosity is a factor in their destruction by hunters. Flesh is excellent food. Original population may have been 40 million, now reduced to neighborhood of 100 thousand.</td>
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<td>Bulls anlers may begin to shed “velvet” in August, but rut is at height in September and October, when bulls may establish harems of 15-30 cows. From 210-62 days after breeding, 1-3 calves weighing to 30 pounds are born. May follow cow in 3 days, and start to graze in 4 weeks.</td>
<td>Bulls may mate with domestic cows at almost any time of year. Anlers shed about March, with new set starting immediately. Each succeeding year usually larger over 10 year period, with maximum to about 5 feet. May leap to height of 10 feet. Tracks, F 3 ½ x 4 ½&quot;, W. H 3 ½ x 4&quot;, 2.</td>
<td>May serve as competitor in grazing with domestic cattle, and bulls by serving domestic cattle may reduce normal number of calves. However, they are such popular “game” animals that they provide a profitable attraction for hunters, and bolster the economy of some low-income areas.</td>
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<td>In mating season, bucks do not maintain closely knit harems as do elk and antelope, but attempt to dominate a herd or drive ruling bucks away. Mating season may last two months, with 1-3 fawns born seven months after mating. May stay with doe 2 years. Life span to 7 years.</td>
<td>Herding in winter may create food crisis, with difficulty for the young animals that cannot reach browse. Starvation is common. Enemies include coyotes, bears, cougars, men, and feral dogs. Many of these deer are held captive, and may be seen in public parks and sanctuaries.</td>
<td>Useful game animals that in summer occasionally range upward above the timber line; but are essentially at home at lower levels. The expansion of the range in summer by the retreat of the snow line reduces competition during winter when the new generation of mule deer is being established.</td>
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<td>FAMILY ISODIDAE, GENUS DERMACENTOR</td>
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<td>Birds and mammals ranging through</td>
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<td>treeless areas above timber line may</td>
<td>be attacked by ticks. Female Rocky Mountain spotted-fever tick, D. andersoni, has body to 2 1/2&quot; long, reddish-brown. Male has body under 1 1/2&quot; long. Larvae live on small animals. Adults favor man, larger animals.</td>
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<th>ALPINE INSECTS</th>
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<td>Timber-line territory boasts many ani-</td>
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<th>GIANT SULPHUR BUTTERFLY</th>
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<td>Colias gigantea</td>
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<td>Wingspread to 44&quot;, Length to 23&quot;, Tail 9.7&quot;. Female commonly the larger. Weight to 3 pounds. Characterized by large size, white underwings (darker in western variety), black-tipped flight feathers, dark band across lower abdomen. Tail brick red. Commonly flies in high spirals. Call, a shrill &quot;kree-e-e-e-e.&quot;</td>
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<th>RED-TAILED HAWK</th>
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<tr>
<td>Buteo jamaicensis</td>
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<td>Length to 13&quot;, being our smallest ptarmigan. In winter, adults are pure white with only bill appearing black. In summer, back, neck, head, and breast are marked with brown, gray, and white, while the tail, most of the wings and lower breast are pure white or dark-flecked.</td>
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<th>WHITE-TAILED PTARMIGAN</th>
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<tr>
<td>Lagopus leucurus</td>
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<td>Length to 8 inches. Tail to 3.1 inches. Female smaller than male. Male brown above and on sides, with face and throat yellow, black across forehead, on side of head, and across throat. Shows black tail with white corners and contrasting white belly in flight.</td>
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<th>HORNED LARK</th>
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<td>Eremophila alpestris</td>
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<td>Length to 7 inches. Tail to 2.85 inches. Wing to 3.5 inches. Upper parts grayish-brown, with 2 buff bars with light edging on wings. Tail blackish-brown, with outer feathers mostly white and second feather white-tipped. Undertails are light buff, chin light. Chest is dark-streaked.</td>
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<th>AMERICAN WATER PIPIT</th>
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<td>Anthus spinola rubescens</td>
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<td>Adult male in summer with black bill and black crown, bordered behind and on sides by gray. Body deep chestnut brown. Pink tinge on belly, rump, tail coverts, and wings. Winter, with yellow bill tipped with black, and brown feathers edged with white. Female paler, duller than male.</td>
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<th>GRAY-CROWNED ROSY FINCH</th>
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<td>Leucosticte tephrococulis</td>
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| D. andersoni is found mostly in the northwestern part of the United States, commonly in mountainous areas. There are some sixty species of ticks in America, most of which are annoying, and some have been carrier organisms that produce diseases fatal to man and his domestic animals. Where world climatic conditions are similar, there are remarkable similarities in the animals to be found. Certain nights rule out an abundance of common night-flying insects. Soil freezes for long seasons interferes with the development of insects that spend much of their time underground. The Order Collembola includes springtails of the Family Sminthuridae, and snow Fleas of the Family Poduridae, with the former usually found in the drier areas. Achorutes nivicolus is the most conspicuous as a jumping gran- dote on the snow. Some members of the family lack ability to leap. These butterflies are found in the Rocky Mountain highlands as far south as the mountains of New Mexico. A number of species of Colias are alpine or arctic, and the related genera of Erebus, Genesia, and Bolorta may have many representatives to be found at or above the timber line. Six subspecies include Eastern, Florida, Krider's, Western, Alaska, and Fuertes'. In Western, throat is distinctly streaked. Red-tails breed through southeastern Canada to northeastern Mexico and north to tree-limit in Canada. Winters Kansas to N. Y., south through eastern Mexico. Ranges from central Alaska and north- ern Yukon intermitently south along the Rocky Mountains, from British Columbia and Alberta south into north- ern New Mexico. Six subspecies recognized, with three species in the genus including white-tailed, rock, and wil- low ptarmigans. One species and 21 subspecies in North America. Species ranges through mountainous areas of North America, most of Europe and much of Asia. In North America, south to Baja California, southern Mexico, and Texas to North Carolina. Representa- tives of the genus are found from sea level to alpine zone. Breeds northern Yukon to Green- land, Scandinavia, Europe, the Caucasus and southeastern Siberia. In winter goes south to southwestern Africa, Egypt, and in North America south to Florida, and Baja California to Guate- mala. From sea coasts to above timber line. Five closely related species. A sparrow that ranges through western North America, breeding in mountainous areas and above timber line in British Columbia, and the Yukon, south into Washington and Oregon, into Idaho, Colorado, and Utah. The gray-crowned winter in British Columbia, black-crowned in Idaho, Colorado, Utah.

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ECOLOGY

After fertilization, eggs are laid on the ground, and the young climb vegetation and rub off on the body of a passing animal. They feed on the blood of their hosts, and may become infected or die of starvation out of doors for several months, either as larvae or mature of either sex.

Reservoirs of infected blood may be found in many animals. The adult ticks can pass disease through eggs to another generation, but the disease cannot be transmitted from a diseased animal to a healthy one. Therefore, control is largely a matter of tick control, chemically, or by other means.

In general, insects with egg, larval, pupal, and adult stages survive alpine conditions better than those with incomplete metamorphosis. Exceptions may be the Colembella, considered immediately below. Where season for activity is short, surviving invertebrates must develop rapidly.

Young are much like adults, but the details of reproduction are not well known. Insects seem seasonally abundant, so there may be some relationship between climatic conditions and reproduction. While numbers are sometimes enormous, at other times insects are not to be found.

Because of the short season, there may well be only a single local generation a year. Males and females vary over the range, with northern specimens averaging more white females than yellow. Caterpillars of timber-line butterflies are commonly covered with fine, woolly hairs.

Nest is huge pile of coarse sticks, commonly placed high in a tree to 40 feet above ground, or on a cliff. Eggs 2-4, dull white, irregularly marked with cinnamon-brown, measuring 2.5 by 2 inches. Incubation is 28 days by the female. One annual brood. Young blind, slightly downy.

Nest on ground in a depression, in clods of bare or mostly exposed position, with some grass as lining, and often a few feathers. Eggs 8-15, dull cream-colored to pale red, usually marked with brown. One annual brood, beginning in May. Incubation period is 26 days.

Food of Colias caterpillars is largely the willow, and the insects provide forage for the horned larks and pipits that are sometimes to be found in the area in great flocks. In the Himalaya Mountains, some butterflies have been found at altitudes approaching 20,000 feet.

Food is largely plant material, such as buds, leaves, and wild fruits. In season, food may include insects and other small invertebrates. Excessive or crowded grazing by domestic sheep will disturb raising of family, and, of course, reduce the crop of young ptarmigan.

Food is largely waste grain and seeds, but also includes many injurious insects, particularly cutworms. Is an exceptional destroyer of weed seeds. Horned larks are often found in large flocks that take flight as a unit when disturbed. Flight speed may be to more than 50 miles per hour.

Food is largely small insects, including beetles, many of which may be blown uphill by strong winds to become numbed and conspicuous on the snow, where they serve as food for hungry birds. In severe weather, finches may go below timber line to seek protection for the night.

The role of invertebrate life of timber line is primarily that of feeding birds and insect parasites. Mites, ticks, and similar invertebrates are somewhat successful. A great proportion of timber-line invertebrates are brought up the mountainside from lower levels by winds—to die in the chill environment.

Snow fleas such as are seen on snow above timber line probably have no great economic importance. Their relatives living at lower levels may appear in enormous numbers during maple sugar time. Some Colembella are controlled by a Bordeaux spray mixed with pyrethrum powder.

The economic role of alpine and arctic butterflies is obviously small, since there are few plants and animals to be found in such localities that are of great economic importance. Butterfly larvae feed on timber-line plants, and in turn provide food for the birdlife of the timber-line area.

Useful birds, living in a rugged environment and perfectly capable of surviving conditions that would be fatal to most of our common birds. They may serve as food for the predators. They are highly popular with ornithologists and others who visit their range in the proper season.

ECONOMY

Persons hiking tick country or lying on ground in such areas should search bodies carefully, periodically, to locate and remove any ticks that might have become attached. Domestic animals and poultry may be hosts to ticks, which should be removed and destroyed when found.

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nature IN THE SCHOOL

IN SOME SCHOOLS, the pupils can see the timber lines of high mountains merely by looking out through their classroom windows. In other schools, the pupils must depend on books, magazines, and newspapers for their timber-line illustrations. Few pupils, however, have the opportunity to pay a visit to the actual timber-line territory, and to become acquainted with the climate, plants, animals, rocks, and weather to be found there. It is partly out of regard to the youngsters who may never be able to enjoy the offerings of the real timber-line territory that the main section of this special insert has been prepared.

During the summer vacation months, many Boy and Girl Scouts and other youngsters may have the opportunity to investigate timber-line country, and, as a rule, it would be time well spent. It is really not particularly exciting to view timber line simply by way of the printed page, and the same may be said of the possibilities, scenery-wise, of a fast-moving automobile. Timber line is always best approached through the medium of a perspiration-producing climb through timbered land.

In some respects, a visit to timber-line territory is rather like a visit to the outer limits of snowfall at lower elevations in spring or fall. In spring, the snow near the student’s home may be spotted with dark insects and other invertebrates. (The eighty-ninth issue of this series of inserts dealt almost wholly with such animals.) The student may see cabbage butterflies, or other butterflies, flying over early-spring snowbanks, just as he can see occasional yellow butterflies at the edge of the snow at timber line. He may find numbed flies, bees, or even spiders on a spring snowbank, much as they may be found at timber line during the early-morning hours of summer days. The lowland snowbank, in spring, may be marked by the tracks of horned larks, whose nests may even be found tucked neatly in a nearby tussock of grass.

Both the nest at timber line and the one beside the local snowbank may contain eggs, or even young birds. It might be suggested that, because of such points of similarity, if the student wishes to understand the natural activities of the timber line and above, he should be acquainted with those of the lowland snowbank.

Since the territory above timber line is usually exposed to strong winds, it might be well to study the animal activities of lowland hilltops, also. In such places, is there an abundance of loose, deep soil, or has the soil been washed or blown away? If it has vanished because of the action of wind or water, the pupil may better understand why there is often much loose rock above timber line.

If there comes an opportunity to study a locality that simulates timber-line conditions, do not be satisfied with investigating only that which you can see and feel without measuring instruments. Use a thermometer frequently and carefully, and notice if the differences in temperature at night and by day are greater than in forest or brush land. The student might also wish to study the water situation to see if the soil on the little mountaintop dries out more quickly than does that of lower levels among the trees. Such a study may aid in the understanding of the differences between low-country plants and those that live at timber line, or near it.

If the pupil lives in “hill country,” he may notice advance and retreat of the snow line on nearby hills, and he may get some notion of the effect that altitude plays in relation to temperature—and, of course, its consequent effect on the number of days in the year that are free from freezing conditions. The latter consideration is most significant in an understanding of the plants and animals of a given locality. Unless a plant or animal species is able to move about freely, it must be limited to areas in which there is a long enough growing season to complete breeding and development, and thus to guarantee survival. All such observations may help the student understand the interesting timber line that is pictured in books and seen through the window—or, it may be hoped, visited as opportunity offers.

Eggs or young of horned lark may be found near snowbanks.

IN the chart section there are several starred items: explanation, the references to teeth may include letters I, C, P, or M. These letters refer to incisors, canines, premolars, or molars. The numbers follow as 4/4, refer to the teeth found in each category, with the first number referring to the number of teeth of that kind on one side of upper jaw; and the other, to lower jaw. Track symbols are letters like F, H, and Sp. These refer to front feet, hind feet, and spread, with the number referring to the measurements of the tracks in inches. Track number that sometimes follows these measurements indicates the number of toes appearing in the footprint. “W” refers to the spread between paired tracks, the measurements being made in inches.

In the cases of a few of the mammals in the chart section, I have included some quotations in rhyme. They are from a book on American mammals by Dr. Newell, published some thirty years ago. I think they are well worth including, as lending a touch of color to those pages of the insert that must, by their nature, confine themselves to the strictly factual. I hope readers will enjoy them as much as I did.

Dr. E. Laurence Palmer, for many years director of Nature Magazine’s educational program, continues his special inserts in the pages of the combined magazines.
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The Awesome Bonebreaker

Quest for the myth-beset lammergeyer

By James Ferguson-Lees

SLOWLY, MAJESTICALLY, the huge bird dropped lower in the sky, not moving its long narrow wings but steadying itself with its wedge-shaped tail. Down below the tops of the mountain peaks it saile, until it was almost lost against the gray limestone crags, fifteen hundred feet above us. It leveled out in a long glide at the very face of a cliff, and suddenly disappeared into a tiny cave. In a moment it reappeared: shortly after, it vanished again. Then it repeated this performance. There was no question now, we had at last found a nest of the magnificent lammergeyer.

The lammergeyer, Gypaetus barbatus, is also known as “bearded vulture” or “lamb eagle” and is a creature with a fascination all its own. Perhaps no other bird in Europe has a background so muddled in legend and fact. It is still little understood, thanks to its rarity and the remoteness of its mountain homes. It is nearly four feet long and has a wingspread of between nine and ten feet. Streamlined contours give the bird an appearance of speed and dash that is wholly lacking in its cousins, the broad-winged vultures. The lammergeyer seldom seems to move its wings. But, occasionally, it gives one powerful flap that brings the wing tips so far under the body that they almost touch one another.

But it was the bird’s breast color that impressed us most—a rusty orange that gleamed like fire in the sunlight. The lammergeyer is mottled gray-brown on the back, wings, and tail.

Standing watch for the lammergeyer, scientists take a precarious position on a rocky ledge to scan opposite cliffs in attempt to discover position of nest.

The top of the head and back of neck are creamy white. A broad beak mask starts above the outer edge of each eye, dips forward over the sides of the beak, and ends in a tassel of long, pendent bristles.

The lammergeyer’s reputation is unfortunate, to say the least. It has been charged, for instance, with killing children and carrying them away. Undoubtedly this myth arose because of the bird’s great size. Actually, the toes and feet are so weak that it cannot carry very little in this manner. Instead, it perches on its strong beak. It also has been accused of throwing “mountain climbers to their deaths” — an event not too unlikely should one of the huge birds unexpectedly fly off a cliff.
A young bird, still with immature feathers, will eat several rounds of meat daily. Birds of this species nest only in remote mountain areas through parts of Europe and Asia, but one subspecies lives at very high altitudes in Africa.

Like other vultures, the lammergeyer is a carrion-eater, but its favorite food is bone marrow. It carries large bones high into the air, drops them to smash on the rocks below, digs, and picks out the marrow. From this habit comes its Spanish name of lebrantahuesos or "bonebreaker." One ornithologist who found a lammergeyer's ossuary in Kenya, wrote: "Over an area of some forty yards such way the bare rock was littered with white splinters of bone. In hollows they lay in drifts, I could have collected a dozen pailsfuls." Only larger bones are treated this way; small ones are swallowed whole.

The lammergeyer nests in Africa and southern Asia, as well as in Europe, but it is not a common bird, and in Europe it is now decidedly rare, being confined to the Balkans, Sicily, Sardinia, Corsica, Switzerland, and three areas in Spain. It was to the last of these countries that our expedition set out in the summer of 1959 to find, study, and photograph the bird in one of the wildest sierras in all of Spain.

Our first days were occupied with trying to locate a nesting pair of lammergeyers, but several former sites—reported to us by shepherds and keepers—proved to be empty. We were getting discouraged when at last we saw a pair of the birds in flight. However, they lived at the edge of a valley several miles long and over a mile wide, and we searched for two more days before we spotted one big bird as it disappeared into the cliff face.

The next day we set out for the nest. The first few hundred feet consisted of a climb up a very steep slope. Fortunately, pack mules carrying blinds and other heavy equipment could accompany us on this stretch. When we reached the sheer cliff, the mules were
Until this point, equipment had been carried up mountain by pack mules. Left behind, and we gradually made our way to a ledge about thirty feet below the cave. This last section could be scaled only with the aid of pick and mountain climbers' ropes.

In the nest—a mass of big sticks and wool—was a single grotesque and gawky youngster, apparently about two months old. The young lammergeyer, on the other hand, must incubate her two eggs for close to eight weeks and tend her voracious young for a month.
Dramatic feathering of giant bird includes a dark mask, which ends under chin in tassel of bristles. Full feathers on legs is a characteristic of northern lammergeyers, while legs of the African subspecies are usually not feathered.

Of three months or more. Lammergeyers in Spain breed in the mountain nows of January and the young fly out in the heat of June or July.

The single (or, rarely, two) young hatches from a large egg which can vary considerably in color. Some are chitish-yellow; others are brownish. Most are streaked or blotched. When first hatched, the young lammergeyer is covered with grayish-white down. Soon it is capable of taking in several pounds of meat a day and, because of its excessive weight, can barely move. Gradually, dark brown and reddish feathers appear and by the end of two months the bird is about two and a half feet in length, has a wing span of over six feet, and probably weighs around fifteen pounds.

Our young lammergeyer was put in a sack and lowered carefully to the ledge below, so that it could be photographed. It was not an easy baby to hold, and fought vigorously with its three-inch beak and sharp talons. In the parental nest were two sheep's legs, a donkey's hoof, a number of goat bones, and a dog's skull. There was also an old rope sandal. Such a collection of bones is typical of the bird's nesting material, rather than of any killing tendencies.

The grace of this mountain dweller, as it follows the major contours of a rock face or soars high over ravines, is beyond description. To country people in its native lands, the lammergeyer will undoubtedly always be feared as a menace—a vicious predator, a sheep-stealer, and a man-killer. Yet for all its might it is afraid of its vulture cousins, and waits until they have finished picking a carcass before coming down to feast upon the stripped and bloody bones. One authority has even said, with a certain sadness of tone, that the great creature is so cowardly that even a puppy dog can frighten it into flying away.
Parent usually has one young in nest made of branches, bones, and fur, above. Nestling, below, was put in a bag and brought down to study and photograph.
The wingspread of young lammergeyey is about six feet and, when bird is fully grown, may reach nine or ten feet. Its fierce-looking talons are actually remarkably weak, and so belie the myths claiming that the birds carry off children.
Children of the Forest

Economics and ritual link forest Pygmies with village Negroes

By COLIN TURNBULL

The BaMbuti call themselves the Children of the Forest with good reason. They live in close harmony with their environment (See Natural History, August-September, 1960). They make their huts of forest-cut saplings, and cover them with forest leaves; they have a wide choice of lianas and trees from which they can make bark cloth to dress themselves; there is ample deadwood for the fires that cook their forest game and keep them warm at night. Above all, the forest allows them time to relax and enjoy themselves; for the adults, this means singing and dancing.

Yet, at the root of this apparently free and easy, unsystematic adaptation to a generous but limiting environment there is in fact a system and a central authority—the forest itself. This hidden authority is most strikingly evidenced in the relationship between the indigenous forest dwellers, the Pygmies of Africa, and the various Bantu and Sudanic tribes who, three or four hundred years ago, were driven into the forest—bringing with them, for the most part, a plains culture—where they cleared land to set out plantations of bananas, cassava, rice, maize, and beans.

It is essential to understand not only to what extent the Pygmies are adapted to their forest and depend on it, but also the extent to which they love and trust it—with much the same affection that children bestow on their parents. Earlier I told of a youth, a flower in his hair, "...dancing to the Forest, dancing to the Moon." This is but one indication of the attitude these
simple people take toward the world around them: there are many more. If we understand this attitude, it is not hard to see how the BaMbuti first reacted (and still react) to the invading Negroes—whom the Pygmies often liken in their legends to the clumsy, great elephants that destroy the forest in order to live.

When the warring Negroes first arrived on the scene, they made use of the Pygmies as guides, spies, scouts, even as mercenary soldiers. Caught between a number of mutually hostile Negro tribes, the Pygmies had little choice in the matter. While acting as ancillaries, they had no time to hunt and gather, and came to rely on the products of Negro plantations for at least a considerable proportion of their food. When the Negro tribes became more settled and warfare was finally stamped out by the Belgians, this relationship came to an end.

The Negroes, now at peace, no longer had any need for the Pygmies. But the Pygmies had developed a strong taste for plantation food and still demanded to be fed. Each Negro tribe continued to give food to “its” Pygmies. In return for this, the Negroes expected a new service: meat from the forest. There has never been any fixed rate of exchange. If at any time a Negro is reluctant to give a stalk of bananas in return for the dubious possibility of getting some meat at a later date, the Pygmy simply goes to the plantation and steals the bananas. The Negro, on the other hand, is not a hunter, and does poorly securing meat if he is left to rely on the traps and pits he may put in the forest near his plantation.

The present situation, then, is one of ambivalence. Neither group depends on the other, but each finds the other convenient. The Negro demands meat and forest honey, and he is willing to give the Pygmy a stalk of bananas in return. The Pygmy is willing to do the angering and coming to the plantation and steals the bananas. The Negro, on the other hand, is not a hunter, and does poorly securing meat if he is left to rely on the traps and pits he may put in the forest near his plantation.

This is the second of two reports on the Ituri Forest Pygmies, with whom the author lived during three trips to Africa. Mr. Turnbull is now the staff of the American Museum of Natural History.
able to get the various woods, rks, saplings, leaves, and vines that needs without having to go into the rest himself. He attempts to get the gmy to do these chores for him in change for plantation foods, as well for the metal and cooking utensils which the Pygmy increasingly re- s. The Pygmy accepts what he is ven, or helps himself, and performs e chores he feels inclined to—but without any sense of deep obligation.

The Negro tries by various means to assert his authority and foralize the relationship: outwardly, he appears to succeed. There is scarcely Negro village in this whole area of Congo that cannot produce at least

**Masked dancer leads Negro initiation rites for boys. Influence of Islamic culture can be seen in the headgear worn by Negro at the dancer's left.**
a few Pygmies are the hereditary servants, not the slaves, of their Negro masters. But this is only an attitude—nothing could be farther from the truth. And it is certainly not the attitude of the Pygmies toward the situation.

When a Pygmy hunting group feels like a change from the forest—perhaps some palm wine to drink and tobacco to smoke—or when the hunting is not particularly good and the chase has taken them nearby, such a group will descend on a Negro village; usually the one nearest to the Pygmies’ hunting area and the one where these particular Pygmies have already established individual and group relations. They camp at the edge of the village and bring in gifts of meat, honey, firewood, or whatever else they may have to spare. They receive plantation foods in return.

But as soon as the Negroes begin to apply any pressure, or as soon as the Pygmies get tired of the village, nothing will stop them from packing up and returning to the forest. The

Negroes, unable to move about as quickly and silently as the Pygmies and not knowing the forest trails so well, are unable to pursue them. Any authority that the Negro wants to assert has to be something other than sheer force. So he encourages the Pygmies to adopt Negro tribal customs and to subject themselves to certain rituals. In this way, he is attempting to subject the BaMbuti to the super-

natural, the ultimate authority of Negro tribal lore. And as the Negro is de facto the only one qualified to perform these rituals, this makes the

BaMbuti still further dependent. Or it would seem at first glance.

To all of this, the BaMbuti sub-
generally enjoying the festivity—enjoying the ritual feasting involved in a death and the subsequent witch hunt. But any suggestion that sorcery was involved in death they react without enthusiasm. To the Pygmies, death is a perfectly natural phenomenon, to be greeted without particular despair when it comes to a person who is too old to enjoy life or to a child too young to have savored life’s pleasures. Only when death strikes some

Sister of the couple’s “patron,” despite her “superior” position, fans vine-tied banana leaves on which Pygmy bride will stand during wedding ceremon...
In the prime of life is it any cause for Pygmy concern and, even then, the only suggestion that sorcery or witchcraft has been its cause will come from the superstitious Negroes.

It may well be asked just what the Negro gets out of all this patronage of Pygmies in return for the time, trouble, and expense involved. What he hopes to get, anyway, is authority. In particular, he tries to invoke the aid of his tribal ancestors by going to the extreme of admitting young male Pygmies to Negro tribal initiation ceremonies, and initiating them along with Negro boys of the same age.

This initiation ritual, known as the nkumbi, takes place about once every three years. It involves the circumcision of boys between the ages of nine and twelve. The nkumbi signifies for the Negroes the symbolic death of the child as such, and his rebirth as an adult member of the tribe, instructed in tribal lore and subject to dread penalties (to be inflicted by the supernatural) if he transgresses the laws or divulges the secrets that he has now learned. The children spend several months away from any contact with the village, the women, or other uninitiated youngsters, and are strictly disciplined and instructed. At the end of that time, they are paraded through the village and introduced as adults; from that moment, they assume adult privileges and responsibilities.

When Pygmies are included in the ritual, they are often circumcised alternately with Negro boys. Each couple initiated in this way is bound by a special bond of mutual obligation and friendship. This helps strengthen the ties between the two peoples, but always the Pygmy is carefully placed in an inferior position. For instance, he is cut first, "to clean the knife." Although the Pygmy is then considered an adult and is able to join the Negro men in their village barazas, he is still not a member of the tribe and thus cannot become a ritual specialist in Negro tribal lore or conduct any of his own ceremonies.

The Pygmy is perfectly content with this, because none of these ceremonies, the nkumbi included, has the same significance for him that it has for the Negro. This was made very clear to me on one occasion when the nkumbi had to be performed—as it must be at regular intervals—and there were no eligible boys but Pygmies.
The Negroes tried hard to find at least one eligible Negro boy, but were not able to do so. They went ahead with the ceremony—the sole participants being eight Pygmy boys. The ritual was conducted exactly as always but, by the Negroes' own rules, only relatives of the boys to be initiated were allowed to stay in the initiation camp overnight. This meant, of course, that no Negroes were allowed to stay. They sometimes made short visits to see what was going on, but that was all they could do without risking supernatural punishment.

This circumstance gave me a chance to see the real attitude of the Pygmies, which was revealed significantly in the evenings, after the last Negro had left camp. During the day the boys, their fathers, and their elder brothers observed all the Negro restrictions on behavior, ate only prescribed foods, and paid due reverence to certain sacred objects (including a banana) hung from the roof of the initiation hut. If rain threatened, the boys all took shelter, because it is believed—by the Negroes—that to get wet at this time will bring death. For this and other reasons, the boys were not allowed to wash, and were daily smeared with white clay. At the sound of the bull-roarer, the boys covered in apparent terror.

But in the evening, when the Pygmies were left to themselves, the boys would leap off their beds, join the elders around the fireside, eat all the prohibited foods, play punch ball with the sacred banana, and openly mock all the other taboos. It was made quite clear that, for the Pygmies, the nkumbi held no magical or religious significance at all. They were not in the least concerned with the supernatural world of the Negro; they did not fear it and they wanted no part of it. They appreciated the fact that the strenuous discipline prepared their boys for the responsibilities and hardships of manhood but, even more important, they recognized that it put them on a footing of greater equality with the Negroes. To the Negro, an uninitiated male is a child, and is looked down on. The Pygmies are a proud people; they felt that, by undergoing the initiation, they were able to prove themselves equals in manhood to the Negro boys.

Upon following the BaMbuti back to their forest home after such a period in a Negro village, and in living with them there, I found the situation appearing in its proper perspective. The customs that the Pygmy adopts readily in the village, giving him the appearance of an acculturated person (the sophisticated, French-speaking Africans refer to the Pygmies as gens sans culture), are dropped though they had never existed. Birth, marriage, and death are met with characteristic Pygmy indifference to possible supernatural significance and the necessity for ritual protection. A marriage that has taken place under Negro auspices is regarded as no more than a flirtation until it has followed the traditional Pygmy pattern of exchange visits and reciprocal gifts. Still more significant, the initiated younger, who are accorded adult status in Negro village—are still regarded as children back in their hunting camp. They return to their mothers, and are certainly not allowed to take part in purely adult affairs. By the BaMbuti they are not considered men until they have killed some large game, prove themselves as hunters capable of supporting a family and helping to support the group as a whole.

There is more than a mere drop...
Village men begin initiation ritual by cutting series of sticks of various lengths. Each one has a different "tone" and, together, make a portable xylophone. Sticks are always played in concert and are basic part of initiation music.

Negro custom and ritual. The carefree attitude the BaMbuti assume in the Negro village—showing no sense of moral obligation toward the Negro, employing themselves for their own individual pleasure and amusement—also dropped. The Pygmies still feel a sense of moral obligation to their Negro neighbors but, once back in the forest, their existence as part of a cooperative group takes precedence over their existence as individuals or individual families. They still retain their immense capacity for enjoyment of life, but it assumes a more sober form, more directly related to their forest life and the reinforcement of forest values. Song, mime, and dance, the chief forms of Pygmy adult recreation, provide the most important instances of this relationship.

In the Negro village, the Pygmies borrow drums and dance wild, robust dances, to the delight of the villagers. But they never sing their forest songs. They pick up Negro musical instruments and play these, and sometimes sing with them, but what they sing is always a Negro song. In the forest, if the hunting camp is near a village and someone has managed to make off with one, a drum may occasionally be heard, but the effort is never serious. Forest music is purely vocal: tapping sticks provide sufficient rhythm for their purpose.

In the forest there is no counterpart of the village dance. Here the Pygmy dances are all associated with forest life, mainly with hunting and gathering activities, as are their mime, their molimo songs (the sacred songs of the great hunters, in which only adult males are allowed to take part), and the corresponding songs of the adult women. In a sense, all forest songs are sacred; all of them are to a greater or lesser extent in praise of the forest, and the forest itself is sacred to the BaMbuti, who recognize it as the giver of life, the source of all well-being.

The fact that the BaMbuti will not sing their forest songs in the village is an indication both of the sanctity of the forest and of the Pygmies' attitude toward the Negro village. This may, on the surface, seem a trivial point, but in fact it is the most vital factor in the life of the BaMbuti—dominating not only their everyday life, but also their relationship with the Negro tribes around them. For music is the mainspring of the Pygmies' religion.

Once the environment helps us to understand the contrast between forest and non-forest peoples. To the Negroes, who are people from the plains forced unwillingly into the forest, this world is harsh and hostile, dark, gloomy and full of hidden dangers, real and imagined. In their everyday life they find themselves continually brought up against the forest. It is hard work to clear their plantations, and then the Negroes have to fight a continuous battle to prevent the plantations from being overgrown. Under such conditions, the high incidence of magic, witchcraft, and sorcery is not surprising. The forest is regarded as a source of misfortune, a place peopled with evil spirits, something to fear and to guard oneself against with the greatest care.

But for the Children of the Forest this world is kind and good, always cool and fresh, supplying all their needs. As far as they are concerned, the dangers of life are few, and they have no reason to suspect the presence of malevolent spirits. The normal cycle of their life throughout the year—and from year to year—bears out their belief that the forest takes care of its own. Witchcraft is unknown to them;
Adults—in this case Negroes—slash at each other with long saplings, above, such as are used for building their houses. Ceremony symbolically “strengthens” boys for the ordeal and the drama is heightened by whips’ loud cracking noise.

Whips, now broken, are stuck in the ground, indicating boys are strong. At their base are piled gifts of food for all the initiates and their families.

Sorcery—the notion that one can will someone harm—is a concept utterly abhorrent in their eyes. Such local magic as they possess is of a sympathetic nature, based on the closeness of their identity with the forest. It is not aimed, as is Negro magic, at opposing and changing the natural current of events but, rather, at stimulating it.

In times of crisis, the two peoples react very differently. The Negro reaction to trouble is the immediate belief that someone—or some spirit—is causing the misfortune by witchcraft and, when located, must be punished, pacified, or placated. As life for the Negro is filled with misfortunes, it is also filled with accusations of witchcraft and sorcery. And magic is continuous.
When crisis strikes a BaMbuti hunting group—in the form of bad hunting (which is rare), serious illness (which is also rare), or the death of someone in the prime of life—the attitude is not one of suspicion, fear, or hostility, but rather of anxiety that something has gone awry in their normally good world. Being a practical people, the Pygmies' reaction is a practical one. All these occasions demand only one thing—that the adult males gather together and sing. I once had this explained to me by an old Pygmy in very few words: his explanation has been borne out many a time in subsequent observation and

After initiation, boys are dressed in bark cloth, belts, and beaded necklaces, and paraded in front of the villagers. Entire ceremony is in Negro tradition.
Pygmy workers help construct Negro house, above. Negroes also depend on Pygmies for meat and forest honey, for wood-cutting and water-carrying. Thus, reciprocal relationships are founded on both economic and ritualistic associations.

discussion. He said: “Our life is good because the Forest is good; it gives us everything we want. If something goes wrong, it must then be because the Forest is asleep and not watching over its children. We sing our molimo songs because the Forest will hear them and awaken, and all will be well again.”

There is no need to ask the forest for this or that, because the BaMbuti believe implicitly that a good, satisfactory life is normal; so long as the forest is awake and watching, all will go well. They are content to let the forest decide what is best—their job is simply to awaken it. And this is done in one of the most beautiful rituals, if it can be called such, that one may imagine—a form of communion between a people and their deity that contrasts sharply with the superstitious beliefs of the Negroes.

This ritual, known as the molimo, involves all adult males. The first step is to collect firewood and food from every Pygmy hut, thus emphasizing that the molimo concerns the group as a whole. In the evening, the men sit around a special fire until the women and children go to bed. Then the men start singing the molimo songs, never using drums but only the banja, split sticks that are tapped lightly together. There may be one or two mocking songs while the women and children are still awake but, after that, the tone changes. The songs become serious; quiet but intense. After a couple of hours there is a short break, and the men eat the food that has been cooked on the molimo fire. Then the singing starts again, with greater intensity and increasing volume. The songs vary a great deal in mood; some are reflective, others seem to be the expression of pure joy. But all moods are represented, regardless of what the occasion may be.

At a certain point, if the situation is a very serious one, the singers will stop and listen. From far off in the forest they will hear their song echoed back to them, and they renew their efforts. One of their number—usually a young man, but always a good singer—has gone into the forest a distance from the Pygmy camp and, as his fellows sing, he picks up their song, echoes it into a long, wooden trumpet, and passes it on deep into the forest so that the forest is sure to pay attention to the plight of its children. The singing thus becomes a deeply personal, yet still a co-operative communion between the BaMbuti and their forest, which is their god.
None of this will take place when the Pygmies are in a Negro village, and none of it even in the forest if there happens to be a Negro visiting the Pygmy camp. Before the molimo singing starts each evening, the trails to the village are ritually closed with fallen branches or logs. This is something that concerns the BaMbuti and their forest god alone, and the Ponde, non-forest world must be entirely excluded from the communion.

The Pygmies are fully aware that village ways have no practical application or value in the forest. At the same time, the very vigor and self-consciousness with which they reject village values perhaps indicates a sense of guilt or infidelity with regard to their forest life. There cannot be contact between the two people with-
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ADAPTING HUNTING BOW to jew's-harp, boy blows on string while tapping it with arrow. Sound is melodious, but range is limited. Until he returns to his beloved forest, Pygmy refuses to play songs relating to his people's ceremonies.
FACE FACTS: the first of October is by no means as comfortably distant from the Yule as it may seem. But we have a simple suggestion, and one that—if acted upon—will bring kind recollections of your holiday thoughtfulness throughout the whole year ahead.

What? What but a subscription to NATURAL HISTORY

Who knows better than yourself, by the honored rule that the proof of any pudding is in its eating, that the pages of this magazine bring to each reader a fresh delight in the whole, great realm of nature? These insights and understandings—adventures of the mind along the varied frontiers of today's science—can be your welcome gift to any (or many) of your friends this Christmas.

Too, this unique gift brings with it an Associate Membership in The American Museum of Natural History for every recipient. Nor is this honor without its tangible aspects—one example being the ten per cent discount for Members on all purchases (books included) from the Museum Shop—in person or by mail!

REVIEW (Continued from page 6)

The Wild Mammals of Missouri, by Charles W. Schwartz and Elizabeth R. Schwartz, Univ. of Missouri Press and Missouri Conservation Commission, $3.95; 341 pp., illus.

The Wild Mammals of Missouri is a book that belongs in every naturalist's library. Excellently illustrated, well written, and accurate, it should serve as an example for writers and illustrators who wish to produce a book on mammals for the amateur.

The introduction includes information on the characteristics of mammals, their habits in Missouri, keys to their identification, and a list of the wild mammals of the state. This is followed by chapters on each order, with a key to the species both by external appearance and by use of the skull. The species accounts start with an explanation of the scientific and English names of the animal and are followed by a description that includes information on color, size, teeth and skull, sex and age criteria and ratios, glandular voice, and sounds. The distribution in North America of each species and its abundance and distribution in Missouri is given, and a detailed description of the habits, home, and habitats follows. Food is discussed, and reproduction, mortality factors (under the caption "Some Adverse Factors"), economic and ecological importance, management and control, and selected references make up the remainder of the account.

Combined with the species accounts are some of the finest black and white illustrations we have of North American mammals; they were done by Charles W. Schwartz, who also illustrated A. Starks. Leopold's Wildlife of Mexico. A full-page plate, containing a view of an entire animal, details of the sole of its foot and hind foot, and views of its skull, accompanies the account of each species. These plates also include details of teeth, ears, feet, and skull, when such are needed for identification. Smaller illustrations in the text show tracks, burrow systems, young, and scenes from life.

The authors have avoided technical terminology yet preserved accuracy by superbly blending illustrations with text. The book is economically written but eminently readable, and the authors are to be commended for the production of the finest state mammal book of its kind.

The residents of Missouri are fortunate to have this work available; naturally in other states will find the book well worth purchase—particularly at the reasonable price at which it is listed.

RICHARD G. VAN GELDER
THE AMERICAN MUSEUM
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The Museum Shop presents reproductions of unique art objects from the collections of The American Museum of Natural History.

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Our National Observatory atop a Holy mountain near Tucson.

The Papago Indians of Arizona have been friends to the white man for more than four centuries. Recently, they have been called upon to co-operate with him in a project, which is doubtless unique in their history. Their reservation, in the midst of the Sonora Desert, includes the massive mountain known as Kitt Peak (6,877 ft.), forty-five miles southwest of Tucson. The mountain was sacred to their ancestors, who believed that it was the home of their gods. But in 1958 Kitt Peak was chosen as the site of a new National Observatory, which will be one of the largest and best equipped in the land. After consultation with the astronomers, the Papagos agreed to share the use of their land and Congress passed a special law to protect the rights of both parties in the agreement.

Modern astronomy requires not only large telescopes but much auxiliary equipment, designed and built to a high degree of precision. The cost of such installations places them beyond the reach of individual institutions. Yet, they are essential to the pursuit of basic research. The National Science Foundation (NSF), established by Co...
In 1950 for the promotion of scientific endeavor, a number of discussions in 1953 on the possibility—and timeliness—of creating a National Observatory, the Kitt Peak project evolved from these discussions.

This is by no means the first venture of the Federal government into the field of astronomy. It is true that, even President John Quincy Adams in 1825 proposed the erection of a National Observatory as a means of enhancing American prestige abroad, congressional guilts at his "lighthouse of the skies" echoed in all the states of the budding Union. But less than twenty years later, the need for navigational almanacs and instrument-testing facilities had already led the U. S. Navy to the establishment of the U. S. Naval Observatory. A few years ago, NSF undertook the construction of the new National Radio Astronomy Observatory at Green Bank, West Virginia, to provide much needed facilities for the observation of space radiation at meter and centimeter wave lengths.

Essentially, Kitt Peak Observatory will be the optical counterpart of the radio installation at Green Bank. This site was chosen for the steadiness of its atmosphere and the suitability of its climate. Dotting the crest of the mountain (aerial view, above), the principal structures have already been erected: telescope domes, machine shops, dormitory, dining hall, and office building. Still to be completed are the dome for the largest telescope, the sun tower, and a few auxiliary buildings. Administrative offices and a library are located in Tucson.

The principal telescopes intended for stellar research will be an 80-inch (photo, left) and a 36-inch reflector, both of Cassegrain design, the larger instrument being equipped also with condé focus. Another 36-inch reflector, belonging to the University of Arizona, has been moved to this site as well. The solar telescope has been designed to give a picture of the sun nearly a yard wide. That is to say that its focal length must be about three hundred feet, requiring a building some five hundred feet long to house its mirrors. The structure serves also as the polar axis of the instrument, so that it must be tilted to the horizontal by 32" (the latitude of Kitt Peak). For practical reasons, two-thirds of the building will be underground, so that its supporting tower will rise only a hundred feet above the surface of the sacred mountain.

The Observatory is administered for NSF by a corporation of nine major universities, but its research facilities will be available to qualified astronomers regardless of their academic affiliation. Nor has the visiting tourist been forgotten. A museum is planned, and the kind Papagos have reserved the right to market their handicrafts.
THE SKY IN OCTOBER

From the Almanac:

Full [Harvest] Moon: October 4, 5:17 p.m. EST
Last Quarter: October 12, 12:26 p.m. EST
New Moon: October 20, 7:03 a.m. EST
First Quarter: October 27, 2:34 a.m. EST

For the visual observer:

Mercury will be in the evening sky all month, reaching its greatest eastern elongation on October 15. But even on that date, it will remain close to the horizon and unfavorable for observation. Mercury will set in twilight forty-five minutes after sunset on October 1; one hour on October 15; thirty minutes on October 31.

Venus (—3.4 magnitude) will be seen after sunset low over the southwestern horizon. It will set one hour after the sun on October 1, one hour and a quarter on October 15, one hour and forty-five minutes on October 31.

Mars, in Gemini, will rise in the northeast at approximately 10:15 p.m., local standard time, on October 1; 9:45 p.m. on October 15; 9:00 p.m. on October 31. It will remain visible for the rest of the night and will be nearly overhead at sunrise.

Jupiter, in Sagittarius, will be west of the meridian after dark, setting in the southwest at 9:45 p.m. on October 1; 9:00 p.m. on October 15; 8:00 p.m. on October 31.

Saturn, also in Sagittarius, will be found approximately 15° east of Jupiter. Low in the southern sky in the early evening, it will set at 11:00 p.m. on October 1; 10:00 p.m. on October 15; 9:00 p.m. on October 31.

The Orionid meteor shower may be expected on October 20. The moon will be new on that date, a fact which should assure favorable observing conditions if the weather is clear. As many as twenty-five Orionids per hour have been observed in some previous years (by a single observer).

Constellation study:

From the standpoint of mythology, the constellations visible over the southern horizon on October evenings are perhaps the wettest in the whole sky. They are all rather faint, but the map, right, will help in locating them, and the Great Square of Pegasus may be used as a guidepost.

Pisces (the Fishes) and Aquarius (the Water-bearer) are both in the zodiac southeast and south of Pegasus, respectively. Cetus (the Whale) is low over the southeastern horizon and Piscis Austrinus (the Southern Fish) with its bright star, Fomalhaut, is found just below Aquarius.

As a matter of fact, the water theme continues below the horizon. Looking southeast of Cetus, an observer at the Equator or in the Southern Hemisphere would see Eridanus (a river of ancient myths) and the good ship Argo, which Jason sailed in his quest of the Golden Fleece.

The identity of Aquarius lies buried in a mass of overlapping myths. The most intriguing one suggests that he may be the legendary king Deucalion. This would commemorate the great Babylonian flood of the third millennium B.C., which is said to have occurred during his reign. The Babylonians believed that their goddess Ishtar had sent the flood; and since the legend of Ishtar closely parallels that of Andromeda, it is probably no coincidence that the latter is found also in this particular part of the sky.

The former Astronomy Editor for Nature Magazine, Mrs. Gossner, continues in that role for Natural History.
APHIDS, or plant lice, are serious pests in most agricultural countries. Each insect attaches itself to a plant stem or leaf and inserts its proboscis into the plant tissue. It then becomes a living pump, concerning itself with little more than sucking plant juices and producing aphid nymphs. Aphids are economically costly, not only because they directly weaken crop plants, but also because the winged migrants are vectors of plant virus diseases. Hence, experimental work that can lead to an understanding of the factors influencing the number of migrants and the reproduction of aphids, can be very worthwhile.

Aphids normally spend the winter in the egg stage and hatch in the spring. This first spring generation is unique, first because it is wingless and second because it is the founder of the succeeding summer generations, all of which are viviparous (giving birth to living young) and parthenogenetic (reproducing without mating) females. In a few days the progeny gives birth to more viviparous, parthenogenetic females, and so on throughout the summer.

In the fall a generation of males and oviparous (egg-laying) females appears. These mate and produce the eggs that will hatch the following spring.

In my experiment only viviparous (summer) females were raised. There are two forms of these—apterous (wingless) and alate (winged). In the black bean aphid (Aphis fabae Scop.), the apterae are also distinguished from the alatae by their darker color and larger size. The apterous female is usually black, and measures 2.5 millimeters by 1.6 millimeters. The alate female has a brownish-black or slightly lighter abdomen. The alate form usually measures 2.4 millimeters by 1.3 millimeters.

In each generation of viviparous females the number of young produced and the percentage of alatae (winged migrants) among the young vary. Several workers have tried to determine the factors that influence the change in reproduction rate and the ratio of apterae to alatae. Overcrowding was found to be one such factor. Reinhard demonstrated (1927) that overcrowding, more than any factor he tested, increased the proportion of alatae in Aphis gossypii Glover.

Temperature, humidity, length of day, intensity of light, plant water content, abundance and distribution of host plant species, diseases (specially fungus cases), and inherited characteristics have been shown to affect the reproduction of aphids and the incidence of alatae among them. Reproduction and alate numbers may also be influenced by synthetic and organic chemicals in the soil, plant sites such as minute solitary wasps, predator enemies, and quality or color of light. Regarding this last factor, it is, surprisingly, little or nothing in the literature on the effects of colored illumination on this important insect group.

Methods

In this experiment, aphids were reared on tall, single-flowering nasturtium. The aphid-infested plants were grown in a pot in each of four identical cages. Each cage was covered with a diffused-colored, gelatin-film filter. The cages were ten-inch cubes made of aluminum framework on an aluminum base plate. The sides were covered with fine-plastic screening. The tops were eighth-inch-thick glass plates that could be slid open. All cracks were sealed with weather stripping. The filters—red, yellow, blue, and gray (the control)—were selected so that each permitted the

YOUNG SCIENTIST

A study of the effect of wave lengths of light on plant lice

By Richard A. Applebaum

Under a microscope, a prepared slide of an aphid reveals the long proboscis, which sucks juices from plant tissues.
Richard A. Applebaum became a finalist in the Westinghouse Science Talent Search when he was a senior at Erasmus Hall High School, Brooklyn, New York. He is now a freshman at Columbia College. His paper is the third to be printed by Natural History in a program of reporting the work of young scientists. Dr. T. C. Schenkel, whose commentary follows Mr. Applebaum's paper, is Curator in the Department of Animal Behavior at The American Museum.

The four cages were supported on a sliding wooden frame (two feet square) set into a large wood cabinet (40.5 inches high by 28 inches by 26 inches). This movable frame supported, in addition to the four breeding cages, a dry and a wet bulb thermometer and a thermostat. In addition, the large cabinet contained (below the cages) an eight-inch-fan, a cone-type electrical heating element and a ventilating flue. Above the cages was a 22-watt cool-white fluorescent light. The light was switched on for seventeen hours, then off for seven. This was switched off fifteen minutes every four hours. Both were operated by timing motor-cam-microswitch system.

Temperature and relative humidity around the plants were recorded daily. The average temperature varied from 67.0°F. at night to 73.5°F. during summer afternoons. The average temperature was approximately 69.7°F., although the thermostat was preset for 68°F. This variation was due to the absence of a refrigerating unit, which would have insured a maximum temperature. The heating unit maintained the minimum temperature at 67.0°F.

Relative humidity was measured daily and ranged between 60 per cent and 71 per cent, with an average relative humidity of approximately 65.4 per cent. Relative humidity was calculated from the difference in temperature readings between dry and wet bulb thermometers, using psychrometric tables (U.S. Weather Bureau, 1953).

The planting schedule consisted of: (1) preparing a 2:1:1 soil mixture and filling four 5-inch-diameter plastic pans with the mixture; (2) planting twenty tall single-flowering nasturtium seeds in concentric circles in each pot; and (3) watering, placing the flat containing the four pans in a greenhouse and covering with newspapers. The plants were raised here for twelve days, then removed from the greenhouse and colonized with black bean aphids. The aphids were reared on nasturtium for one week, after which they were counted. Meanwhile, a second crop of young nasturtiums was grown, and the aphids were transferred to these.

The first part of the transferring schedule consisted of inspecting the offspring increases, above, but number of wingless offspring decreases, below.
cages and old plants for alatea; watering the new plants; cutting off the old nasturtium plants at the soil level and counting apterae and nymphs on them. The second part of the schedule started with isolating cut plants having adult apterae clustered at the point where the main stem branches into three smaller ones. This section with the apterae was cut out so it resembled a short, three-pronged fork, then inverted and placed over the same point on the new plant. The living stem was thereby held between the prongs of the old fork. Several more apterae-bearing forks were transferred to the young nasturtiums until a predetermined number of adult apterae had been transferred. Finally, all surplus insects either were discarded, or were fixed for later microscopic examination. The new pot now replaced the old one in the first cage, and the entire process was repeated with the other pots. This is the most straightforward technique I have found for transferring the apterae in predetermined numbers without damaging the delicate proboscises, which are normally imbedded in the plant stem.

A uniform number of individuals was removed from the old plants in each "colored" cage and placed on new ones destined for the same cage. Thus the transfer made possible a continuous experiment. A "series" was a four-time repetition of the entire schedule. One series extended over a four-week period.

**Results**

Statistics that I accumulated are presented in Graphs I and II. In Graph I, which shows the appearance of alatea, it can be seen that the aphids under the blue filter consistently produced a larger percentage of alatea than those under the gray (the control). A later under yellow light produced fewer alatea among their offspring than those under gray filters. Aphis under the red filter, however, produced the smallest proportion of all groups.

In reproduction rate (Graph II), the alatea reared under the red filter far surpassed all others, while the apterae under blue light had the lowest reproduction rate. Gray produced the most stable rate and its line is the smoothest on the graph. Yellow was only slightly higher than the gray, and even fell just below the gray one week, as the graph shows. I noted that whenever fewer apterae were transferred, the reproduction rates in all cages rose (although in different proportions). The reverse occurred when larger numbers of apterae were transferred.

**Discussion**

In experiments of this nature it is usually difficult to distinguish direct effects of environmental factors on an aphid from the indirect influence on the aphid through its host plant. However, the final effect of the factors is the one that will show up in field studies, and the effect usually measured.

Several environmental factors have been shown to control the tendency of apterae to produce males and oviparous females, instead of parthenogenetic males. Marescot (1924) found that "short" (less than fourteen hours) or "long" (more than sixteen hours) daylengths stimulated the production of the sexes. Davidson (1929) demonstrated that low temperatures (less than 66°F.) tend to increase the number of sexual appearing. These effects were more convincingly demonstrated by de Finslau (1950). The period of light (seventeen hours) and pre-experimental temperatures (above 68°F.) in my experiments were selected to prevent the appearance of sexuals. These would have produced eggs instead of live aphids; thus interfering with the accuracy of data on reproduction rates and appearance of alatea. Through the experiment no case of apterae producing sexual offspring was noted.

A number of workers have investigated the ecology of aphids. Ackerman (1929) using the grain aphid, and Smith (1933) using mealy little aphids, found reproduction rates rose with surrounding temperature. Weed (1927) found in Macrosiphum euphorbiae, that an increase in reproduction and population accompany a rise in relative humidity and temperature. A. Franklin Shull, who has done much work in this field, found several factors in addition to overcrowding, relative humidity and temperature that influence wing production in aphids, observed more wings in Macrosiphum solani during continuous light than alternating light and darkness.
SUMMER generations of the black bean aphid, a serious pest, are usually atherogenetic (reproduce without mating) and viviparous (give birth to live young). In an experiment with equipment of my own design, I found that both red and yellow light stimulate reproduction in the wingless viviparous aphids, but inhibit the production of winged offspring. Blue light apparently inhibits reproduction while encouraging the development of winged offspring.

COMMENTARY

Aphids, both for their evident economic importance and their significance for several types of basic scientific investigation (e.g., of biochemical, metabolic, and ecological phenomena involved in aphid associations with plants and with ants), are fascinating in themselves. Mr. Applebaum has chosen an aspect of aphid biology that is relatively new to research. The problem is significant, and it is important to note that his work constitutes a preliminary one, as the plans to continue the research.

Concerning the method, the fact serves emphasis that aphids are "long-lived" insects, which, under daily photoperiods of sixteen hours or more (as in summer) continue to reproduce viviparously and parthenogenetically but, under shorter photoperiods (e.g., of twelve hours daily, as in the fall) produce an egg-laying generation. This differential effect of the amount of daylight explains why a daily photoperiod of seventeen hours was used here.

Although the independent variable was the wave length of light, this investigation may be classed as one of the open type, carried out under heterogeneous conditions, because (as explained) other conditions such as temperature and humidity were also nec-
essarily varying. Daily variations in these dependent variables were not great, however, and it is unlikely that they figured more than incidentally in the results reported.

Because wave length was the independent variable, intensity of illumination was a major factor for control, and the experimenter carefully selected his four filters so that all of them transmitted light of equal energy. The reader is not informed, however, about a related point. Mr. Applebaum was careful to transfer the same colonies to the respective filters for further tests in the series, but he does not state whether the differently filtered cages were set down each time in the same pattern or were changed according to a chance design. Incidentally, the experimenter deserves commendation for his well-devised procedures in the transfer of aphid colonies to new plants and the control of populations.

The results are reported with appropriate caution as indicating that with the shortest of the three wave lengths, production of a late aphids increases and that of wingless, viviparous reproductives falls off, both opposite to the effects of the two longer wave stimuli used. It is for visual differences that the differential effect is mainly a visual one. To establish this for aphids, however, visual controls will be needed. For the honeybee and certain other insects, there is evidence for a differential effect of the long and the short spectral waves on behavior and also on metabolism, with the possibility that different receptor mechanisms function in the two cases. On the short wave end, hypersensitivity to ultraviolet radiation is fairly common. That factor is a possible one in aphids but, here, it was probably excluded by the glass cage covers.

Mr. Applebaum realizes clearly that the quantitative and qualitative aspects of reproduction in aphids, as affected by environmental and organic factors, represent a highly complex matter. He has a promising method for investigating these phenomena—one with good potentialities for more sensitive testing of group differences in the comparison of visual and other factors—and he should find interest in continuing this work, in a manner to the advantage of science.

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COVER: These artifacts, from the relatively recent slate ulu, or woman’s knife, and bone arrowhead, top row, of the Western Thule culture and proceeding clockwise through Ipiutak, Notched Point House, and Palisades finds, bottom, trace human life in northwestern Alaska over a span of more than 5,000 years. Aiding greatly in the temporal analysis of the region’s cultural leavings is a stratigraphy that derives from the orderly sequence of ocean beach crests. It permits application to archeology of beach ridge dating. A search for traces of early Arctic man and artifacts uses this approach is described in detail starting on page 10. Photo by Lee Borden.

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Arabian Sands, by Wilfred Thesiger. E.P. Dutton. $5.95; 326 pp., illus.

Today the Empty Quarter, as the Arabs who do not live in it call it, or The Sands, as the ones that dwell in it do, is nearly as well known to those who are interested in the world’s mineral resources as are the deserts of Nevada and Utah. Self-contained crews of geologists and oil prospectors camp in it, supplied once every few days by airlift from the north. The fabled Rashid and Murra tribesmen, who have long gained a living in The Sands by precarious camel-breeding, now guide workmen for the oil companies, and some are even to be seen in office buildings that have sprung up in Dhihran and Dammam.

Thirty years ago two Englishmen crossed the Empty Quarter, Bertram Thomas from the south and Harry St. John Philby from the north. Because Philby’s permits were delayed, Thomas made it first, but Philby’s was the harder crossing. Seventeen years passed in which no one tried it again, until, in 1947, Wilfred Thesiger added his name to the list of explorers who struggled over The Sands with camels and Arab companions. He was the last, because after him the age of vehicles and airplanes dropped the curtain on an epoch.

Thesiger not only crossed the Empty Quarter, but he crisscrossed it and traveled along all its borders, exploring as well the virtually unknown interior of Oman. Between 1945 and 1950 he made nine separate journeys. At the end he had so disturbed the various governments controlling the edges of the desert that he could not have gone on with his explorations in Arabia had he wanted to. This limitation gives him a great literary advantage. Not having to worry about future visas, he has been able to tell the truth.

Bertram Thomas was essentially a political officer, who served many years as adviser to the Sultan of Muscat. He traveled by camel from Salala on the Dhufar coast, in territory belonging to the aforesaid sultan, across the middle of The Sands to end up in Doha on Qatar Peninsula, another British protectorate, thus avoiding the settled part of Saudi Arabia. His adventure won him enormous publicity, from which he profited in a lecture tour and in the extensive sale of his excellent book, Arabia Felix. He retired to live in Tangier with his grand piano and his golf, and came to Cairo shortly after World War I.

Philby, in contrast to both Thomas and Thesiger, is essentially a scholar, undoubtedly the greatest living authority on the geography of the Arabian Peninsula. After serving in the British army in Mesopotamia in World War I, he became a Moslem and an associate of late King Ibn Saud of Saudi Arabia, which is why Thomas who traveled without advance notice, made the crossing first. Philby went from al-Hasa on across The Sands to the well of Manam
the southern edge of the desert, and when looped back, after one false start, to Sulaiyil, in the southwestern corner of the Saudi realm, the land of the red Dawsar, some of whose kin now work as skilled oil operators and contractors in al-Hasa province.

While Thomas's adventure was one of tour de force, and Philby's a well-camouflaged part of a lifelong program of systematic geographical work, Thesiger's differed from both in motivation and in execution. Shunning publicity, he did not want to map the desert and its bordering lands, but most of all he wanted to get away from modern life and live starkly and austerely with an intimate handful of Bedu friends in the timeless wastes that to them were home.

"All my life I had hated machines," he says (p. 259), and "I would not myself have wished to cross the Empty Quarter in a car. Luckily this was impossible when I did my journeys, for to have done the journey on a camel would have made the venture into a stunt." (p. 260). So bitter was his hatred of automobiling that one night, on his way into Lai-rom Sulaiyil, Thesiger saw the lights of a car stuck in the sand. "Resenting cars, especially in Arabia. I was never pleased that it was in trouble," he writes. Later the car arrived at Ta'a, bearing Philby, who had secured Thesiger's release from arrest at Sulaiyil and had come to help him.

Both Thomas and Philby, particularly the latter, became masters of Arabic. Thesiger admits candidly that his Arabic is far from perfect and that in some regions he has trouble understanding what is said. Philby long ago became a Moslem, and is respected, if not revered, wherever he goes in the Arab world. Like Thomas, Thesiger made no secret of being a Christian, and had several narrow escapes in consequence. Thomas had a smattering of anthropology and was particularly interested in the Mahri-Socrotan-speaking tribes of Dhaufar. But he measured the lengths of these people's heads incorrectly and made them into a breed of short-headed microcephalics, an error which Thesiger, among other writers with less excuse than he, repeated. I have since measured some of these men in Dammam; they are no different from other Arabs in head form. Thesiger has made one original and trivial error; he calls groups of three small stones set together in bunches "trilithons." A trilithon is a large three-stone replica of the Greek letter φ. Everything that Philby does is meticulously correct.

It would appear that Thesiger had little if any training in anthropology at Oxford. In a sense this omission was an advantage. Not being burdened with preconceptions born in armchairs, nor fenced in with erudite jargon, he relates exactly what he saw, heard, and felt, and he is an extraordinarily keen observer. The result is a straightforward and detailed account of his life with the men of many tribes bordering the desert on all sides, a much more valuable document than a conventional ethnography. His description of the circumcised ceremony in the Tihamah of Hejaz is a masterpiece of narrative. In giving the details of blood feuds and camel-raiding and case histories of who kills whom for what reason he has explained the Bedu system of interpersonal relations and code of honor better than anyone since Musil, and in a much more readable manner. In short, Thesiger is not only a keen observer, but he is also a gifted writer. On top of all that, he is a photographer of high professional rank. The illustrations are incomparable.

While heredity should not be downgraded in this or any other case of high achievement, environment must also be invoked to explain the personality and accomplishments of Wilfred Thesiger. He was born in 1910 in Addis Ababa, the son of the British Minister. Brought up among Amharas and Gallas, he saw victorious armies armed with shields, spears and swords march in and out of the capital, and he heard warriors capped in lion manes shout and act.
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out their victorious combats before the throne. He was an intimate of the Cheeseman, the roving British corn, who chased slavers over the north of Ethiopia and who had, in his youth, explored Arabia. When he was twentv-five, at Cheeseman's advice, he traveled down the Awash River into the unexplored Danakil Desert, inhabited by some of the world's most ferocious tribesmen, to find the gold that water failed to reach the Bedouins. He found that it ended in a salt plain covered with blood-red algae and festooned with pygmy crocodiles. This proved a major feat of exploration, a high-ranking "first"; a handy thing for a two-thousand-year-old on holiday from Oxford.

In 1935 he joined the Sudanese postal service and worked first among the Berber and Arabic-speaking nomads of the Darfur area, and then among the naked cattle-herding Nuer of the swamps of the south. Between times he embarked on a trip across the Sahara and the Nile to the Tibesti. Then she returned to England, and after World War II he became a soldier eventually joining the Wingate's force that brought Haile Selassie back to Addis Ababa via the Sudan and Egypt. He spent a year in the Sudan, mostly in Jabal al-Druz; then he moved on to Egypt and the Western Desert of the R.A.F., and spent the last of his career in Ethiopia as a political adviser.

With this background and experience, crossing the Empty Quarter, Ethiopia, and the Sudan was a natural goal for a thirty-five-year-old who had nothing else to do. At this point, his discovery of locusts and locusts in Ethiopia, for some ten years, was duplicated in India, Iran, the Middle East, and Africa. The swarming locusts are the same species as the solitary grasshopper. Now and then, solitary grasshoppers develop gregarious habits, probably due to crowding, and change to small flocks so that they look like a different species. After some season of good farming which they multiply astronomically, a dry season comes along, and they migrate by the millions of dollars worth of crops. Eventually, disease attacks them and then once more there are only solitary grasshoppers in the world.

For some time there has been a national Locust Commission, with a headquarters in Rome, and a research station in London, headed by Dr. Uvarov. At present, 80% of crops are eaten by locusts which can be spotted before they do extensive damage. In 1931, the locust swarm, which attacked the wheat crop, was a matter of critical areas for locust control. When they are spotted early, they can be destroyed before they do serious damage. In 1934, the Sahara locust was a matter of critical areas for locust control. When they are spotted early, they can be destroyed before they do serious damage.

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W ould have been a fine prize indeed if they and others from the south had not raided Saudi territory, Saud had gone to the Yam — the next tribe to the north — an open season on anyone coming from the south. Over on the western side of The Sands, other rivalries and hard- ship created equal difficulties. Most of Oman itself is ruled by two men: Sultan, in Muscat, who controls the coast; and the Imam, in Ibrī, who rules most of the interior. Still a third, if not local potentate, Sultaniam bin Ham, controls Jabal al Akhdar, the “Green Mountain,” which awaits exploration.

As a result of all this anarchy and confusion, Thesiger took with him, besides his hard core of loyal Rashid, many other tribes. They protected him or tried to do so, against their own people and allies. The basis of this protection is the old tribal system, by which members of a given tribe or clan conducts travelers through his own territory, turning him over to the next guide or protector at the border. One suspects that this custom goes back before the coming to the ancient days of hunting, warfare, gazelles, oryx, and ostriches about on the desert, for it was in use among their primitive Veddas of Ceylon — humans who resembled the South Arabs physically, but dwelt in caves—while still controlled much of the island.

To the ancient pattern of tribal feuds, Islamic fanaticism added its complications. Two kinds of puritans made trouble for our traveler, the Wahhabi Akhwan of the Aljāf region, from Sułaylīy to Don and Laila. At Sułaylīy, Thesiger’s companions were put in stocks, and he was kept prisoner. It then that Thesiger secured his release. Nevertheless, as a Christian, Thesiger was treated like a leper, spat on, and reviled by children. The other puritans were the members of the Ihādā-see of Khawrijī, living in the interior of Oman. It is they who fall under the rule of a fanatical Imam. They, too, found the presence of a Christian intolerable.

On his way up from the Hadhram to Sułaylīy, Saif al Islam al Hussainī, of the sons of the late Imam Yahūd of Yemen, heard of Thesiger’s presence in the desert and sent out two parties of Dālm to kill him. Before they arrived, Thesiger shot at a bull oryx and hit it, much to his chagrin, but he found out later that if he had stopped to skin and dry the meat, the Dālm would have caught and killed him.

In this review, I have tried to give a background of what Thesiger is like, insofar as one can tell from the rest of his writings, for of the three crosses of The Sands, he is the only one whom I have not known. An attempt has also been made to describe the conditions he had to face. If th
A Saharan explorer once said to me, “Work in the desert would be easy if there were no Arabs.”

In Thesiger’s case, this statement is both intensely true and intensely false. He did not go for the Arabs living in the desert, but he was not prepared to face heat and cold, rock and sand, wind and sun, spiders and scorpions, the scarcity of water, and the ability of camels to go without it. Much of what he had to depend on was his own physiology, psychology, and mental stamina. These he did, but had it not been for the particular Arabs who risked their lives to go with him, he could not have succeeded, double-crossed, crisscrossed and veiled round The Sands.

The narrative of his first crossing is dramatic and exciting. The leaking of well skins, the floundering of camels strung out over dunes, the search for wells and discovery of bitter water, hunger, exhaustion, and dreams of food——— this is an old but ever-fresh story of man’s struggle against the forces of nature, the waste places and high deserts of the world. We have heard comparable tales of heroic endurance from desert, desert, several mountains, and high poles. Had that been all Thesiger’s story to write about, he would be just another of the explorers.

luckily for us, it was far from being so. The day-by-day account of what his companions did and told us are about the life, mentality, and attitudes of the southern Bedu than anything else that I have seen in print, or likely to see. These people live in a world with few possessions. Their speak everything as a meal; when one man’s has rosted, they draw lots for the meat to eat in pairs, and they eat it little heed. They share everything between them, with each other; when someone has shot a gazelle, they draw lots for the meat to eat in pairs. And this is not all. When I met the Mosaic laws of a law for a faith. They consider themselves noblemen, compared to the Arabs who dwell in all the deserts, and so they are.

After living among the Rualla, T. E. Lawrence found it hard to adjust to life at home, and Thesiger’s uncompromising statements about his contempt for the Western world suggest a similar cultural. Since then, he has traveled in other lands and taken some marvelous pictures. If he never writes another book as good as _Arabian Sands_, it will not be his fault, but that of our present-day world, which those of us who care about such things are forced to live in.
An arctic archaeologist's dream is a huge, frozen mound of human leavings, so deep that the entire prehistory of the region may be read like a book from top to bottom. Some of the mounds that have been discovered in Alaska, especially those at the ends of peninsulas and on islands, come near to providing such a record. The Kukulik Mound, on St. Lawrence Island in the northern Bering Sea, for example, contains the deposits of 2,000 years of almost continuous Eskimo occupation, including houses, rubbish heaps, food caches, and burials. Not even Kukulik may be read like a book, however. Every generation of occupants of this mound had dug additional pits for storage and leveled new, subsurface house floors, and, in doing so, had thrown out the old to be mixed...
Traces of the Arctic

...with the new in a sometimes rather perplexing fashion.

Until quite recently, analysis of this sort of vertical stratigraphy was the best means available to Arctic diggers for ranging this region's cultural leavings in a correct time order. Now, a more promising method of sharply separating Arctic cultural succession is emerging from a new kind of stratigraphy. This new method is based upon the seriation of ocean beach crests and makes possible the application of "beach ridge dating" to archeology. Wherever found along the shores of western Alaska, an ocean beach ridge is a boon to man and beast. These ribs of sand or gravel—each presumably thrown up by one severe storm, or by the heaviest seas of successive years—offer uniformly raised ground surface on which people may...
Western Alaska sites are shown on enlarged map of area marked on inset.

camp or move without resorting to the boggy tundra, to the mud banks, or to the rocky slopes exposed by the beating of waves against the land. Most of the village sites, isolated house pits, and simple camping places of the coastal Eskimos are found on this kind of stable beach ridge.

Here the frost leaves the ground early, providing quite dry footing and offering a digging place for the many Eskimo needs that cannot be satisfied in permanently frozen ground. Eskimos invariably choose the high spots on such beaches, from which they have easy access to the sea. The most predictable sources of food lie in the water. Seals and white whales swim near the beach, where they may be secured by an alert hunter; fish are netted close to the shore. The boats used for sea hunts may be protected from wind and waves by hauling them onto the slope. The shore line is, in all seasons, the passageway of friend or foe—traveling by boat in summer or by sledge on the inshore ice during winter. These and other reasons for choosing a beach crest over any other terrain, if one is to remain at the shore rather than beside streams or lakes of the interior, are so compelling as nearly to exclude the use of any other kind of camp site.

Those of us who work at archeology in Alaska have long been accustomed to searching the most favorable parts of such ocean beach ridges, as have also been aware that some of the older archeological sites are located behind the beach crest of today, on an older beach that has somehow been bypassed or sealed off in the processes of shore-building. At Gambell, St. Lawrence Island, both the location of village sites at distances away from the sea, which roughly corresponded to the elapsed time, and the succession of former beach lines, were specifically pointed out by Henry Collins of the Smithsonian Institution as early as 1932. Again, when Fredrich Rainey (then of the University of Alaska), Helge Larsen of the Danish National Museum, and I discovered an enormous old site of house pits called Ipiutak at Point Hope, in 1939, we were aware of the existence of the site on beach ridges far removed from the present seashore. Elsewhere, both north and south of Bering Strait, older sites have been identified far enough from the shore to suggest strongly that the sea has locally retreated. The thought that successions of beach ridges might be used as dating criteria was impressed upon the members of our field party, in 1956, at Choris Peninsula.

Choris is a good sea-hunting point at the eastern margin of Kotzebue Sound (see map, left). There we discovered, on the innermost of nine substantial beach ridges—lying parallel to one another for as much as a mile in length—the pits and floors of three very large oval houses of a form previously unknown in the region (chart, right). The building of these houses, we felt, must have taken place approximately 3,000 years ago. This span of time was indicated in part by a comparison of artifacts (photo, pp. 16-17) with those of known sites elsewhere in western Alaska. But it was further confirmed by the presence of varying forms of archeological leavings on and in the beach ridges between the Choris site and the current ocean beach ridge (which is the site of several Eskimo house pits ranging from the contemporary period to at least as old as 500 years).

Growing evidence that some Alaskan beach ridges were built by orderly procedures in nature, rather than by vagaries of wind and ice, led me to propose a specific study of beach ridges for the season of 1958. Supported by grants from the American Philosophical Society and the Arctic Institute of North America, our party from Brown University set out early in the summer to search the shores of Kotzebue Sound for series of beach ridges such as might offer
a continuous series of archeological sites of considerable time depth.

Place names we encountered were German and Russian ones bestowed by Von Kotzebue (in 1815 and 1816 on his voyage of discovery in these waters) in honor of his sponsors and members of his ship's crew. We traveled by skiff and outboard motor round the 250 miles of the Kotzebue Sound shore line. One important fact emerged from this close search of the seacoast. Those points of land at which successions of beach ridges would be left intact for centuries, despite storms and currents, are relatively few. Where hundreds of miles of beaches may have existed at some period in the past, by far the greater majority will have been swept away. Besides the sequence of old beaches at Choris Peninsula, however, we did find beach ridge sequences containing a range of archeology both at Cape Espenberg, on the south side of Kotzebue Sound, and at Shesualek and Cape Krusenstern on the north side.

Cape Espenberg forms the eastern limit of a sand beach stretching continuously from Bering Strait. The fossil beaches at the Cape lie parallel to the one currently being formed in a succession two miles across. One can walk on a single ridge in an almost straight line for as great a distance as fifteen miles. The present ocean beach is only lightly covered by vegetation because of continuously blowing sand that piles up in dunes of some magnitude. The half-underground houses of recent Eskimo inhabitants are partly exposed where sand has blown away from some of these dunes. In a rather limited search of intermediate beach ridges, we saw some signs of earlier Eskimo archeological remains. We concentrated, however, on a substantial beach ridge more than a mile and a half inland, with a crest width in places of as much as one hundred feet. Potsherds and flints that were recovered from depressions—from which wind had removed sand and in which it had concentrated heavier materials—were characteristic of the old Choris Peninsula culture.

Still farther inland, and separated from the Choris beach by a wide stretch of swamp, lay another substantial beach crest. Materials here, while including an occasional Choris piece, were predominantly those of the oldest archeological horizon.
known at that time in western Alaska, the Denigh Flint complex. Indica-
tions are that the Denigh flints—as we knew them from the strati-
ified typesite at Cape Denigh in the Bering Sea area—were no less than
4,500 years old. The Cape Espenberg
beaches, then, seem to range from an
earlier crest—a bit more than 4,500
years old—to a currently forming
beach of similar proportions. Cape
Espenberg seems to include a promi-
sing series of archeological sites.

The archeology of stable, gravel
beaches in Alaska, however, is
far more inviting than that of the
Espenberg dunes of shifting sand. A
succession of gravel ridges on the
northeast side of Kotzebue Sound
proved to be ideal for excavating.
Shesualek is the Eskimo name of this
spit, which is made up of more than a
dozen beach ridges. Here, at least, for
one hundred and fifty years of rec-
corded history, Eskimos have gath-
ered in the springtime and remained
most of the summer to fish and to
hunt beluga as well as to meet visitors
in a great trading fair. Today, the vil-
lage of tents is located—as it was rec-
corded to have been in the 1930's and
earlier—on the outermost beach,
which faces the water. People may
open their tent flaps and see at a
glance the condition of their boats,
drying racks and nets, or search the
water for signs of seals passing by.
We were pleased to find that cache
pits and other remains of earlier
camps were present on each of the
older beaches for as much as a mile
behind the present village. A large
house pit on the innermost large
beach ridge was chosen for excava-
tion. This site was judged from the
surface to have the essentially rec-
tangular shape most usual in houses
of the western Arctic. An entrance
passage was indicated. The house
floor and walls lay within a sub-
stantial mound of earth that contained,
also, an accumulation of bones, arti-
facts, and other debris of a once
long-inhabited underground dwelling.

Styles of many artifacts and the en-
graving art of this Shesualek house
excavation were new to us, although
in general the house could be class-
ified with the Western Thule cul-
ture (which follows the Birnirk culture
that part of the Arctic). The floor
three or four feet below the origin-
sal surface of the ground, was part-
covered with split logs or planks.
A long entrance tunnel joined the ho-
use at a considerably lower level than
that of the house floor. To the left of
the tunnel entrance, another pass-
aged into a small, rectangular kitchen. The floor surface in this area
was thickly covered with ash, char-
gon, bones, and broken pottery, in-
crating a long occupancy. Most of the
flaking implements, as could be ex-
pected in a house of this period, were
of highly polished slate, although
flint objects were more prominent
here than in the contemporary home
more to the south. The typical smak
ulu, knife used by women, was recov-
ered in abundance (see cover).

A large number of key artifacts in this excavation tells us that the
house was built about 1,000 ye-
ars ago. The Shesualek beach ridge
sequence was then considerably smaller than it is today. If, as one may
suppose, this beach represents what
nearly the waterfront of its time,
some eleven to thirteen beach ridges
have formed during the last mil-
ennium. By the time of our visit
Shesualek, our Eskimo helpers—
particular Almond Downey, who
boat we used—were acquainted w
FADING OF BEACH RIDGES is the result of wave action, which carries gravel to the beaches from cliffs a hundred miles away. Waves move gravel slowly along shore at slight angle to beach until it accumulates at curve in coastline.

Geology and understood our hopes of tying down archeology to specific beach ridges. They told us of a much more extensive series of beach ridges sixty miles farther west. This place called Aniyak in Eskimo and variously described as “portage,” “berry-picking place,” and “sealing point”—proved to be the expansive series of each ridges at Cape Krusenstern. We worked there for a few days in 1958, and returned in 1959, accompanied by Dr. Hans-Georg Bandi, of the U.S. National Museum, and two own University students, William Monos and Samuel Friedman. In August, we were visited at the site by Dr. Henry Staehle, some of whose photographs are seen on these pages. Our work in the summer of 1959 was assisted by a grant from the National Science Foundation.

The sense of discovery that one feels continuously at Cape Krusenstern is not easily described by ordinary archeological standards. Most archeologists know, after a few days or weeks at a site, the limits to which they may expect to range. At Cape Krusenstern, however, more than a hundred beach ridges lie parallel to one another, although sometimes obscured or broken in places by what geologists call “unconformities.” It seems probable that all hundred ridges contain remains of human beings.

The extent of the ridges is enormous, as the aerial photograph on pp. 10-11 attests. An observer standing on the crest of the currently forming seashore ridge can turn his back to the sea and walk from one and a half to three miles before he has crossed all the ridges. Or, beginning at one end of a ridge, he can walk its crest for as many as seven or eight miles. We estimate more than three hundred miles of beach ridge at Cape Krusenstern. While the Cape seems never to have been the site of a large village, it gives promise of containing the substance of cultural phases spanning some 5,000 continuous years.

Periods of culture about the shores of Kotzebue Sound appear to be indexed, as though by file cards, in the series of beach ridges at Cape Krusenstern. The number of distinct ridges, as we reconstruct them from aerial photographs, is 114. The sites change from those of completely modern Eskimos—on the present ocean front or the next beach behind it—to sites of the Western Thule culture between Beaches 9 and 20.

We excavated a house pit on Beach 10 that proved to be culturally like the one at Shesualek. This buried house had been composite. A large room with a small kitchen at one side lay at the end of a twelve-yard tunnel, while a cross-tunnel from the main passage led to a smaller house floor. By recent Eskimo standards, this would have furnished housing for a large family with two heads of household. Engravings in ivory were somewhat more elaborate than those of the Shesualek house. Not only was there more decoration on the artifacts than we had expected of Western Thule culture, but also two pieces of pictographic engraving were found (one is shown on pp. 16-17, top), which forced a change in our previous view that this art form was recently introduced into Western Alaska.

These realistic figures, though few in number, provoke speculation. The figures on a four-sided ivory bodkin, along with typical geometric design elements of the period, are of two men standing on land, a man sitting in a boat, and a caribou. As we interpret the drawing, the men are hurling darts with spear throwers. A dart project from the shoulder of the deer. The spear thrower is not known to
have been used by Eskimos hunting on foot, although it has been widely assumed to have been so used by early American Indians. Rather, among the Eskimos, the spear thrower has been a means of propelling bird darts or sealing harpoons as elements of sea-hunting in kayaks.

The engraving holds still more surprises. Upon closer examination of the boat, one finds that both bow and stern project vertically above the gunwales. This is reminiscent of the large, birch bark canoes made in the Kobuk River region and in the Athapascan Indian country of the Alaskan interior until quite recently. But it is utterly unlike any depiction of an umiak or large skin boat in known Eskimo engravings. Since the present campers at Shesualek and Cape Krusenstern are mainly Noatak River people who come out to the coast only seasonally, it might be supposed that we are seeing in these engravings a bit of the life of river dwellers of a thousand years ago.

A series of wide, shallow depressions, nearly half a mile inland from this house site and located on Beaches 28 to 33, all proved to be house sites of the Ipiutak culture. The five house pits thus far excavated on these beaches seem to represent as many periods of time, yet the artifacts recovered are in nearly all cases identical to those from the Ipiutak site proper. The two largest houses had a form quite unlike that of the others known from Kotzebue Sound excavations and different in some respects from old Point Hope Ipiutak forms. These pits revealed large rectangular floors two or three feet below the original surface, marked by four, evenly spaced posts set in from the corners, and four more posts outlining a central, rectangular fireplace area.

Absence of a passageway indicates roof entry, and the central floor area suggests occupation of the house by many more people than would normally have occupied an Eskimo house in recent times. Unlike the Western Thule and later people, who had hunted whales successfully and incorporated whale bones into their architecture, these Ipiutak builders appear to have done little whaling, although a whaling harpoon head was found in one of the houses. The absence here of polished slate, lamps, and pottery further distinguishes the Ipiutak culture at Cape Krusenstern from both the later and earlier cultures there and show its close relationship to the Ipiutak remains at Point Hope.

On Beaches 39 to 45, behind the Ipiutak series, were found occasional camp sites containing the pottery and other artifacts of Norton and Choris cultures. This raises again the question of why Ipiutak people insisted the essentially Neolithic idea of polished stone, pottery, and lamps when these had been present before and were to be used extensively again in the same locality.

An unexpected turn of the 1959 season came with the discovery on Beach 53 of a house pit (there seem to be two others as well) containing only chipped flint stone work and resembling in its particulars none of the cultures either earlier or later in Kotzebue Sound. The house was walled by upright, driftwood posts forming a floor outline with a round

Artifacts from Choris Peninsula, below, include dart head of bone with a flint tip, a linear stamped potsherd, center, and assorted cutting tools and projectile points of flint, chert, and slate, probably about 3,000 years old.
To contrast to a cornered front, a short entrance passage opened directly before a large fireplace in the center of the main room. Another doorway led to a small room paralleling the passageway. This appears to have been a sleeping room, rather than a kitchen, for it lacked ash and rubbish deposits that go with a storage cooking area.

Flint work here was remarkable for the form of the projectile points that probably fitted arrows and spears. These were notched in the sides for hafting, after a fashion well known in more southerly archeology but previously unheard of in this region. Other flints include notched end scrapers, notched knives, a large, flaked, semilunar knife unlike the polished ulus of Eskimos (see cover), and a series of straight-based, broad, bifaced points that closely resemble in size and shape the inlet points of whaling harpoon heads. The presence of whale bones—both within the house and in a series of camp sites elsewhere on the beach ridge on which the site was located and others adjacent to it—leads us to think that whaling was practiced successfully and persistently by the people who made these notched points. The sizable number of bones recovered from this house are those of seals, whales, and birds almost exclusively, marking this as a camp of sea hunters rather than hunters of forest game. The presence of whaling, and a culture distinct from all others in the region, on a time level estimated to be between 3,000 and 4,000 years ago, creates a problem for future excavation to solve.

On the beaches landward from—and hence earlier than—the notched point house, we have found to date only a few flints back as far as beaches 101 to 103. These particular beach ridges, however, contain both distinctive small flints of the Denbigh complex and hearths accompanied by these flints. It is difficult to say much about the makers of the Denbigh flints, for the evidence that they have left along the coast—beyond the delicate and remarkable stone artifacts themselves (photo, below)—is meager.

Nothing distinct from the artifacts of the Denbigh Flint complex, estimated to be at least 4,500 years old at the time of the last deposits, was being made at Cape Krusenstern when the first beaches began to form there during the thermal maximum, when the ocean reached its highest postglacial level. Evidence of the complex's considerable duration is seen in the presence of microblades, side blades, and other Denbigh-type artifacts, on a 200-foot-high bench across

**DELICATE WORKMANSHIP and small size of Denbigh flint pieces, below, are apparent when compared with the Choris artifacts. All pieces are shown true size. The collection includes both small and large points, gravers, and blades.**
the lagoon in back of the beach ridges at Cape Krusenstern. This area would have been desirable as a camp site, it appears, only when the sea lay at the foot of the slope. On this same mountainside, we had yet another surprise in store, for careful search on a higher terrace—approximately 500 feet above the present level of the sea—disclosed a chipping place and the camp site of perhaps a number of distinct peoples down through an undeterminable number of centuries.

Artifacts here include only one or two like those of the beach ridges. All the others are of kinds previously unknown in coastal western Alaska. The most distinctive of these are, again, side-notched points. However, these are stubby, with con-

cave bases; they are relatively crude as compared with the notched points of Beach 53 (see cover). Their distinctiveness, together with the fact that they are both patinated and encrusted with lime, sets them sharply apart from other artifacts in the region. Along with these—and indistinguishable as to time of deposit because all are equally at or just below the surface of the eroding bedrock at this point—were two large axlike flints, perhaps designed to be hand-held, and other coarse artifacts and fragments—originally made of chert but now exposed long enough to have changed chemically into a hard substance. Since the bench was subject to glaciation after the third or Illinoian, period (ending an estimated 100,000 to 300,000 years ago), these coarser objects may well have been deposited on the site during a remote period of time.

While it is much too soon to say whether or not the hearths of the earliest men at Bering Strait will someday be found, we see a clear-cut archaeological goal. The orderly bench ridges, with their many cultural inclusions, and the charcoal from hearth fires (to be analyzed in radiocarbon dating) afford an uncommon opportunity for exhaustive study of material things made and used.
human beings whose generations seem to reach continuously back from that of the present-day Eskimos for at least 5,000 or 6,000 years.

The task of finding well-preserved records in the ground is greater as one leaves the beach ridge sequences and moves to the hillsides. Surface collections, valuable though they are, can never take the place of buried levels upon which people have walked and on which they have dropped belongings. If the more permanent camp sites of these early, "highland" people are ever to be isolated, it will be in the high country of the interior, for their traces at former ocean shore lines of the Bering Strait region would probably now be far below the sea's present level.

High terrace, below, yielded surface finds that predate even Denbigh flints. Frozen earth over a house site, top, was stripped off to expose ground plan.
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WILD TURKEY’S RETURN

By Dean Amadon

The turkey is sometimes regarded as the most typical of North American birds, this despite the fact that very name derives from a mistaken notion that the first ones to enter Europe had been brought from Turkey. Indeed, some of the founding fathers thought that the turkey, not the bald eagle, should be the emblem of our young nation. Truth to tell, they have their good and bad points.

If, at times, the eagle seems a cowardly scavenger, the male turkey is a rather vainglorious and even ludicrous fowl as he struts about, tail fanned, gobbling out his challenge.

Be that as it may, the wild turkey is one of the shyest of all birds and there are few who ever see him in the throes of courtship. Rather, it is the fortunate woodsman, walking quietly through the autumn forests, who may be rewarded with a glimpse of the bronze, streamlined turkey as it picks its way among the wild grape and scarlet ivy in some long-abandoned orchard. A twig cracks and the bird is gone, running silently and swiftly down the aisles of the forest.

The pilgrims found wild turkey in the New England woods and, from this northeastern outpost, the birds ranged south to Florida, west to the
Mississippi bottoms and, in suitable areas, west to Arizona, and south over the plateau of Mexico. From much of this range they have long since disappeared. Massachusetts has its Mount Tom but the old gobbler after which it was named, the last of his tribe in that state, went to his reward about the middle of the last century.

Some wildlife disappears because its habitat is destroyed, some because it is hunted for food or for sport. Unhappy the creature whose ranks are depleted by all these factors, but such is the turkey. Calling forth all the skill of the sportsman, it is, once secured, a culinary prize without a rival, unless this be the Chesapeake Bay canvasback. Small cause for surprise that the range of the turkey has shrunk alarmingly. Furthermore, in the wilderness to which it retreats, game laws are not always strictly observed. The Okies, the crackers of the Florida or Georgia glades, the hillbillies of "Yoknapatawpha County," find it easier to shoot a turkey off its roost as it crouches silhouetted against the moon, or to pot the gobbling males in the spring, than to follow them in fair hunt during the fall or winter.

The disappearance of the chestnut tree struck a blow at the sustenance of the turkey. The cutting of forests of white oak and other mast trees also contributed to the problem faced by such a non-migratory bird of this size in surviving the winter. In the South, deterioration of the game range as a result of overgrazing, burning and clearing has been equally disastrous. Nevertheless, Meleagris gallopavo, as Linnaeus called our bird, finds its present stronghold in the brakes and swamps of our southern states. It is in such scenes, in South Carolina, that the sportsman and amateur ornithologist, Dr. Carnes Weeks, secured the remarkable photographs that illustrate the article on these pages.

Here the hen turkey hides her nest in the depths of a palmetto thicket. At daybreak she stealthily enters it to lay a large egg, which, unlike that of the pheasant or chicken, is flecked with reddish spots. This is repeated each morning until the full clutch of eight to fifteen eggs has been laid. Then begins the hazardous twenty-eight days of incubation. If, by the end of that period, the eggs have not been detected by wandering possum or coon, the young turkeys emerge from the eggs and follow their mother.

Audubon, who was able to observe the wild turkey in the days of its abundance, penned the following eloquent description of this scene:
DROOPING TAIL, drooping wings of male turkey, foreground, may preface conflict, perhaps death struggle, between males for possession of "harem." Gobblers apparently use display as warning and challenge to rivals and to attract females.
“Before leaving the nest with her young brood the mother shakes herself in a violent manner, picks and adjusts the feathers about her belly, and assumes quite a different aspect. She alternately inclines her eyes obliquely upwards and sideways, stretching out her neck, to discover hawks or other enemies, spreads her wings a little as she walks, and softly chucks to keep her innocent offspring close to her. They move slowly along and, as the hatching generally takes place in the afternoon, they frequently return to the nest to spend the first night there. After this they remove to some distance, keeping on the highest undulated ground, the mothe overtaking them in their turn, which is extremely dangerous to the young in this tender state, when they are only covered by a kind of soft hairy down of surprising delicacy.

“In about a fortnight the young birds, which had previously rested on the ground, leave it and fly at night to some very large low branch where they place themselves under the deeply curved wings of their kind and careful parent, dividing themselves for that purpose into two nearly equal parties. After this they leave the woods during the day and approach the natural glades or prairies in search of strawberries and subsequently of dewberries, blackberries, and grasshoppers, thus obtaining abundant food and enjoying the beneficial influence of the sun’s rays.”

In the northern states large tracts of farmed-out hills have reverted to woodlands, or have been reforested. The turkey, because of its feeding requirements, has benefited less from this trend than have, for example, the deer, the porcupine, or the piliated woodpecker. Notwithstanding, there are now enough oaks, beech, and shagbark hickories in some of this second growth to support turkeys and they are beginning to spread, for example, from Penn’s Woods, West into the southwestern tier of New York State: Allegany and Cattaraugus Counties.

Known for his popular and scientific writing, Dr. Amadon is Chairman of the Department of Ornithology at The American Museum. Dr. Carnes Weeks, a notable amateur of birds, made the accompanying photographs.

Undisturbed by crow, a gobbler feeds unconcernedly while a more wary companion keeps watch. Hens hide nests from crows, but latter will often follow them to nests and wait until hens have left again, then steal and eat eggs.
RONZE FEATHERS GLEAM as turkeys take sun in a clearing edge of the woods. Reforestation in northern states and re-stocking may help wild turkey spread north. Problem remains of keeping wild birds free from domestic strains.
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FLIES MATING: A PICTORIAL

A species of fruit fly, Drosophila paulistorum, occasions some...

BY LEE EHRMAN AND MONROE W. STRICKBERGER

Petri dish in which experiments were conducted is held in Dr. Ehrman's hand; dense matter on bottom is cereal used as food by fruit flies. Dr. Dorothea Bennett and Mr. Char Morlang both helped the authors in taking the photograph.
The genus *Drosophila*, the fruit fly, has long been considered ideal for the study of genetics in the laboratory, largely because of the awesome reproductive capacities of these tiny creatures and the ease with which they may be raised in cultures. Then, too, the number of species within the genus is large, so frequently hybrids are readily obtainable. In our work at Columbia University, we were led to study one species, *Drosophila paulisteri*, in order to analyze the behavior of its subgenus, *Sophophora*, one of the seven that comprise the *Drosophila* family.

For the purpose of our study, newly hatched flies were separated by sex, and aged from four days to one week. They were then placed, without etherization, into glass observation chambers, with a small amount of food. Flies of the opposite sex were then introduced. The flies photographed were all belong to the Amazonian subspecies from localities in northern Brazil, this geographic group being selected for the rapidity with which population occurs after introduction.

Sexual recognition is a trial and error affair among *Drosophilids*. Males will court females of any species, and will immediately repeat courting and mating. Courtship itself consists of four distinct elements.

In the first stage, that of *circling*, the male approaches the female, attracts her attention, and, at the same time, units her movements by running round her. He never completes the circle, but turns round, reversing his direction about every 330°.

Next he begins a *tapping* action—an important aspect of courtship in this species. The male lightly touches the legs and the abdomen of the female. At first, only one leg of each fly is involved. Since many taps are neces-
Approach begins as male, on left, draws near a female and begins circling motion. In Drosophila paulistorum, there is no difference between the two sexes as regards pattern bands on abdomen, but the male is smaller than the female.

Sary before it is established that the male has located a female of the same species, the male continues to circle between contacts. Here, the question of the female’s receptivity is settled.

Licking and wing vibrating occur next, both as a prelude to mounting. As one authority, H. T. Spieth, has described it, the male “goes to the rear of the female and assumes a slightly crouched position with the tip of his abdomen slightly curled. Having positioned himself, he extends one wing 70° to 90° and vibrates it periodically, twisting his body on the longitudinal axis as he vibrates, taps (uppercuts), and occasionally licks or attempts to lick the female.” In licking, the male proboscis contacts the female genital—and this is a reliable sign that the male is about to rush in for the mount.

In D. paulistorum, wing vibrations are not so important a part of courtship in some of the other species. The one wing that is vibrated is used for leverage as the male raises himself on the body of the female.
The first "tap" is given as male, left, touches the female with preleg. By this action, the male establishes the fact that he has located a female and, in addition, one of the same species. Contact also offers female her first chance to reject male.

Mounting and insertion seem to be accomplished simultaneously. A portion of the male reproductive organ is used in a clasp manner and, after mounting, the male secures his position on the female by placing his forelegs on top of her slightly spread wings. This additional support is imperative because copulation lasts a fairly long time in this species (an average of 17 minutes and 12 seconds). During the copulatory period, the female may turn about or walk round; and she may even find herself having to fend off other males.

When copulation is nearly over, the female attempts to dislodge the male by vigorously kicking and swinging her body from side to side. The male loses his hold on her wings when she snaps them together, and seconds later he falls off backwards. Thereafter, the female repels all sexually excited males by raising the tip of her abdomen, making her genitalia inaccessible.

Hereewith, the photographs we took of this sequence of mating behavior.
“Licking” is shown, above, and excited male then vibrates one wing and begins to mount, below. In *D. paulistorum*, the vibration is found only at this stage.

Mounting the female, below, the male is held between female’s slightly spread wings and uses their bases to support forelegs. Mating lasts some 17 minutes.
Fermination of mount occurs when female snaps wings shut, forcing male to tilt backwards. She then shakes her abdomen vigorously, and the male soon falls off. During copulation, female may walk about or even have to fend off other males.
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Basal leaf production may permit the survival of certain plants

By Dr. E. Laurence Palmer

It is quite possible that the 108th and 109th units in this series of educational insets may be criticized for their unorthodox approach to the understanding of their unorthodox approach to the understanding of...
Examine with care as many basal leaf structures as can be located at this time of year. The investigator will find that many are generously covered with spines, prickly hairs, or other devices, which might tend to discourage destruction by grazing animals. It is true that some plants, like winter cress, new dandelions, and even garden lettuce, furnish tasty and edible leaves; but in some cases these developments are due to cultivation, and not to the vagaries of nature. The leaves commonly lie close to the ground, assuring the plant suitable growing conditions, and also offering protection against any animals that might seek them as food.

The leaves of many weeds provide a reserve of food that the plant can use when it is time to put up a flower stem. Such nutritive wealth is naturally an invitation to grazing animals; but protection may be afforded to some species of plants because of their distasteful leaves.

The question of survival from animal attack may be highly critical during the late season, when available plant food supply lessens. Then, any green plant may be an invitation to a herbivorous animal. Fortunately for some plants, it is not easy for certain mammals to harvest plants that hug the soil. A cow, in feeding, would
tongue around erect vegetation, pushes it back into her mouth, and with her lower teeth pushes it up against the pad on the upper jaw. She then breaks the plant by raising her head slightly, and finds herself with a mouthful of food. This method of feeding is of little avail where foliage is close to the soil. Sheep, with smaller jaws, can graze vegetation closer than can cows; and horses, with biting teeth on both jaws, can crop vegetation even more closely. Even horses, however, may find difficulty getting a mouthful of food if the plant is very close to the soil and rooted to it on the under surface. Plants, of course, do not intelligently solve this survival problem; but a combination of circumstances may save many basal leaf clusters to produce flowers and seeds for the following year’s generation.

There seems little doubt that, in some plants, flowering can be induced by changing the hours of available light. Strangely enough, it seems that the continuity of the daily dark period may be more important than the total periods of light or darkness, and that exposure to light for a minute — or even less — during the normal dark period may have a remarkable effect. Florists use a knowledge of this fact to control the bloom of flowering plants, so that blossoms may be at their best and
most abundant when market values are at their highest.

The development of plants in fall—and, of course, at other times as well—is greatly affected by the nutriment available in the form of natural or artificial fertilizers. The introduction of extra nutriment into the soil at a time when it is naturally decreasing finds an expression in plant growth. Animals may also affect plant development, both naturally and under controlled agricultural conditions. In the North, for example, snowy owls commonly feed on rodents. These little mammals are captured by the owls, who usually take them to a nearby perch to be eaten. After the meal, the birds may discharge their droppings before setting off on another hunt.

Other birds feeding over the same territory may rest and fertilize the same spot, with the result that the soil becomes richer for the plants growing there—often conspicuously so. Mice collected over a considerable territory may thus enrich the soil of a limited area.

Observant persons who visit pastures where domestic mammals are allowed to forage know that, where there are cow droppings, a rich growth of plants is likely to appear, particularly if cows are the only mammals present. Cows apparently do not relish plants that have recently grown from their own excrement. Horses behave in the same way in their own pastures. If cows and horses are allowed to graze in a common field, the cows feed readily on plants nurtured by the manure of horses, while horses feed readily on plants nourished by cow droppings. It seems likely that the habit of avoiding contact with one's own body wastes is bound up with the fact that many animal parasites are freed by the waste. Many such parasites are specific, and animals that avoid their own discharges are therefore less likely to become infected with their specific parasites.

A study of the varied growth of plants is often of value in plant management practices. As we already mentioned, rosettes and other unusual plant developments may be due, in part, to undernourishment. Because of this, the plants lie flat; and, because they are flat, they cannot be cropped by grazing animals. Suppose we reverse the situation. What happens? If pasture land is enriched, the plants grow more vigorously. The neighboring plants also develop, and competition ensues. The plants become so crowded that they can no longer lie flat, for lack of the necessary room. The leaves are forced into a more erect position. As a result of this, the grazing animal can then feed on the plants. The weaker plant cannot stand the competition, and it disappears. This may help explain why plants with basal leaves rosettes appear so commonly on less productive land.
Many weeds make basal leaf structures that compete too successfully with more desirable plants. Along the edges of most sidewalks may be found the sprawling mints of knotweeds, spurge, and similar plants whose roots have spread out over the bare concrete. Often they form mats that can be easily lifted from the side walk, although the aboveground parts of the plants are usually attached to a deeply penetrating root system. This type of root is able to penetrate far into the ground during periods of drought, and because of this the weed survived while many of its associates perished.

Such weeds may provide food for some of the smaller birds, like sparrows. Their deeply penetrating root systems may permit water to seep through layers of otherwise impenetrable soil. They may also serve to slightly reduce the temperature of the soil in which they grow, and thus in some measure may reduce the loss of soil water during extremely hot weather.

The underground parts of plants composing the vegetative blanket are most important. They penetrate the soil, breaking it up to admit water, plant, and animal litter to enrich the soil. Underground parts of plants may survive fires, floods, the impact of herds of migrating animals, sudden increases in the abundance of destructive insects and fungi, or even the cultivation practices associated with agricultural management. A fire that burns the aboveground parts of a plant leaves the dried parts still rich in food, and capable of developing through the top that in summer was so necessary. Thus, a plant is not easily destroyed. This underground cistern is a remarkable refuge in time of trouble for plants, and because of its unusual wealth of food resources it is also a treasure house for animals that are able to make use of it.

We see, therefore, that during the fall there is a blanket of plant material on the surface of the soil, and another blanket of stored food just beneath the surface. It is because of these reserves that flowers bloom with the melting of the snow in spring, and vigorous plant growth springs earlier from germinating seeds.

With a knowledge of the problems and the nature of the basal leaf- or rosette-producing plants, and how they may be encouraged and discouraged, it is possible to control their development to man’s advantage. We know when it is best to harvest underground root systems. We understand not only why fires may be helpful in destroying insects and weed seeds, but also how the destructiveness of a fire may be controlled. We may observe the role of the vegetative cover in providing food and shelter for animals, and, if we are ingenious, we may find both commercial and entertainment values in such plants. Many of them are of great value because of their beauty; others have played parts of greater or lesser importance in the arts, industry, and medicine.

Politicians and sociologists may argue the merits of the “one world” idea, but biologists and naturalists recognize the fact that there are many worlds that we must understand and control if mankind is to survive. Few of these smaller worlds can be profitably ignored.

Rosettes often lie flat on poor land from undernourishment. On better soil they grow more erect, so can be grazed off.
<table>
<thead>
<tr>
<th><strong>DESCRIPTION</strong></th>
<th><strong>RANGE AND RELATIONSHIP</strong></th>
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<tbody>
<tr>
<td><strong>Sheep Sorrel</strong></td>
<td>Order Polygonales, Family Polygonaceae, including rosette-forming curled dock, <em>R. crispus</em>; smooth dock, <em>R. alitismulatum</em>. <em>R.</em> alitismulatum* found in temperate parts of Old World. Hollyhock is of world-wide distribution both in cultivation and as an escape, and is a native of China.</td>
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<tr>
<td><em>Rumex acetosella</em></td>
<td><strong>Blunt-leaved Hepatica</strong></td>
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<tr>
<td><em>Hepatica americana</em></td>
<td>Order Ranunculaceae, of about 40 genera and some 1,500 widely distributed species, including such common plants as the buttercups, anemone, celandins, cowslip, pansy, clover, wild columbine, peony, larkspur, locoweed, and baneberry. <em>Hepatica</em> found from Alaska to Florida.</td>
</tr>
<tr>
<td>Basal leaves appear on branching, tough rootstocks at intervals. Leaves grow to about 5 inches long, but usually shorter; long-stalked, with blade somewhat like arrowhead, to 1 inch wide, smooth, sour, with veins grooved; annual or perennial. Stem slender, erect, smooth, to 1 foot high.</td>
<td>Basal leaves, with old leaves surviving winter to be replaced in spring by new set. Leaves with long, hairy stems and leathery blades which are 3-lobed, with lobes pointed. Leaves to 2½ inches broad, which, when mature, rest on ground. Apparently stemless. Roots fibrous and profusely branched.</td>
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<tr>
<td><strong>Celandine</strong></td>
<td>Order Papaveraceae, Family Papaveraceae. With about 26 genera and more than 400 species native of north temperate America and Eurasia. <em>Celandine</em> ranges from Quebec to Georgia, and west to Iowa and Missouri. Relatives include herbs and shrubs; also poppies, bloodroot, and the prickly poppy.</td>
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<tr>
<td><em>Chelidonium majus</em></td>
<td><strong>Early Saxifrage</strong></td>
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<tr>
<td><em>Saxifraga virginensis</em></td>
<td>Order Papaveraceae. <em>S. papaveraceae</em>. About 80 genera and over 1,000 species in the family, highly cosmopolitan but at best in temperate and arctic areas. Family includes hydrangeas, mock orange, bishop's cap. <em>S. virginensis</em> ranges from New Brunswick to Georgia, Tennessee, and Minnesota.</td>
</tr>
<tr>
<td>In fall and winter leaves are flat on ground, are up to 6 inches long, almost twice compounded into 3-9 segments with basal units opposite but leaves alternate. Veins large and conspicuous. Stem to more than two feet high in summer. Plant rich in yellow juice, which has some poisonous properties.</td>
<td>Conspicuous basal leaves crowded together in spring. Leaves to over 3 inches long, with narrowly margined petioles, irregular margins, and conspicuous midribs. Stems to 1 foot high, but usually lower and branching above to form flat-topped clusters. Roots matted and usually buried in wet earth.</td>
</tr>
<tr>
<td><strong>Winter Cress</strong></td>
<td>Order Rosales. <em>S. rosales</em>. About 350 genera and over 2,500 species; many closely associated with agricultural crops as weeds, but some of recognized agricultural value either as food or as sources of commercial products of value in arts and sciences.</td>
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<tr>
<td><em>Barbarea vulgaris</em></td>
<td><strong>Cinquefoil</strong></td>
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<tr>
<td><em>Potentilla canadensis</em></td>
<td>Order Rosales. <em>P. canadensis</em> ranges from New Brunswick to Georgia and west.</td>
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<tr>
<td>Winter basal leaves close to the ground, conspicuous in winter and in spring. Leaves in winter and spring bright green, with terminal lobes much the largest and the secondary lobes of 1-4 usually opposite pairs. Leaves are alternate with lower well-petioled. Stem to 2 feet high in summer and fall.</td>
<td>Bunches of leaves arise from points where the sprawling horizontal system touches the ground and where it may take root. Runners may be over 2 feet long. Leaves of 5 leaflets, each sometimes to over 1 inch long and over ½-inch wide, with saw-toothed margins, usually lighter on undersides.</td>
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<tr>
<td><strong>White Clover</strong></td>
<td>Order Rosales. <em>P. rosales</em>. Mustard family includes over 350 genera and over 5,000 species in the family, of which some 300 are in the genus with some 215 in North America. Family includes roses, most orchard fruits, and many herbs, shrubs, and trees. <em>P. canadensis</em> ranges from New Brunswick to Georgia and west.</td>
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<tr>
<td><em>Trifolium repens</em></td>
<td><strong>Herb Robert</strong></td>
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<tr>
<td>Sprawling plant that roots freely at stem joints and forms dense mass of foliage not necessarily in rosettes but in rather solid turf. Leaves of 3 small leaflets, smaller than those of alskite, red, and other clovers, with glossy undersides, margins finely notched, tip slightly notched, and petioles long.</td>
<td>Plant may sprawl or stand erect, and in late fall may be conspicuously beak-covered and with blade of bright red color, sometimes covering the ground. Stem height to ½ feet. Plant strongly scented, and with sticky hairs. Leaves finely cut and with 3 obscure parts, sometimes 5, with America, Africa, and South America. Range: Nova Scotia to the Southwest.</td>
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<tr>
<td><strong>Hollyhock</strong></td>
<td><strong>Herbs</strong></td>
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<td><em>Althaea rosea</em></td>
<td>Order Geraniaceae. <em>G. geraniaceae</em>. Family includes about 11 genera and some 650 species, with wide world distribution, varied habits; includes herbs, shrubs, and other woody annual or perennial plants. <em>G. robertianum</em> found in Europe, Asia, America, Africa, and South America. Range: Nova Scotia to the Southwest.</td>
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<tr>
<td>Conspicuous, fall basal leaves are formed. Leaves also borne along erect stem, which reaches height of 9 feet. Leaves are long-petioled, rough, deeply veined, 5-7 lobed or with wavy margins, alternate, in general round to heart-shaped blades. Root system is deep and, usually, quite heavy.</td>
<td>Dual Malvales, Family Malvaceae. Included in family are cotton, jute, and rose of Sharon; in the order are coca and kapok. About 15 species of the genus found in temperate parts of Old World. Hollyhock is of world-wide distribution both in cultivation and as an escape, and is a native of China.</td>
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<tr>
<td>REPRODUCTION</td>
<td>ECOLOGY</td>
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<td>Stamineate and pistillate flowers borne on separate plants, blooming May–September, in small clusters on terminal branches. Pollen windblown; chromosome number 42. Fruits tiny, brown, obliquely 3-angled, partly calyx-enclosed. From seed to seed in a few months, but seeds are hardy.</td>
<td>Used as an index of acid soil, and does well where there is little water. Seeds and plants survive drought well, and plants may grow on soil that will support few other plants. May be controlled by enriching soil with fertilizer, applying lime, or drying roots.</td>
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<td>Flowers, attractive long-petioled stamens to 1 inch across; blue, purple, or white—flowering from December through May, often under the snow. Petals are about 1 inch across, up to 15 colored sepals and a few green, sepal-like involucre bracts. Stamens and pistils distinct and numerous, with 1-seed fruits.</td>
<td>Favors acid soils, while the blunt-lobed <em>H. acutiloba</em> favors limy soils. Tannin extracted by alcohol from full-grown leaves has slight astringent value, but its reputation for stirring up the liver in spring is not well founded. No medicinal value is now recognized in preparations made from this plant.</td>
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<tr>
<td>Flowers of celandine are yellow, to ¾ inch across, borne on loose, open clusters on slender, branching stems tending to become erect. Sepals 2. Petals 4. Stamens many. Fruit a slender, 2-inch capsule, which opens to free many shining, crested seeds. Flowers from April through September.</td>
<td>Chromosome number usually 12. Plant common in old gardens and cemeteries, along old paths, in sun or shade, and common around abandoned country homesteads. Considered as ornamental by some, with reservations. Once established, it may be long persistent, but yields quickly to cultivation.</td>
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<td>Flowers about ¼ inch across, with 5 greenish-white petals, 10 stamens, and 2 carpels in fruit, and with petals about 2 times the length of the sepals. Yellow in the axils almost as conspicuous as white of petals. Common reproduction by spreading underground parts, so plant occupies a small, dense area.</td>
<td>May mat dry ledges in ravines where the rocks are not calcareous or where there is sandstone, clay, or gravel; but not lime. May sometimes be found in open woodland. Pollination is caused by insect visits, probably most commonly from March through May, or into early summer.</td>
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<tr>
<td>Bright yellow, ¼ inch flowers appear near end of developing stems, with the youngest at the top. Each borne on stout, individual stems, in cluster; and producing a fruit that is roughly six times as long as supporting stem. Stamens 6. Fruit to more than 1 inch long, splitting open to free seeds.</td>
<td>Grows vigorously in warm periods in winter to form conspicuous rosettes, which are edible as early as December, tasting like good dandelion greens. May be repeatedly boiled and salted to remove bitterness and to suit individual taste, but should be eaten soon after preparation to be at best.</td>
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<tr>
<td>Flowers are yellow discs, to ½ inch across, composed of 5 petals, 5 sepals, and many stamens and carpels. Flowers are usually singly from bases of leaves' axils, and appear to be bunch of dried &quot;seeds.&quot; May reproduce by separation of parts of the runner. Seed from June through September.</td>
<td>A poor competitor for more useful plants, and so may be common on such poor soil as cannot support good forage crops. Considered by many as an indicator of poor soil fertility and of sour soil, and an indication of soil not suitable for forest plantings. Almost always survives drought well.</td>
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<tr>
<td>Flowers in small, whitish, globelike clusters, to ½ inch long, with corolla 2 to 3 times as long as the calyx; flowers sometimes pinkish. Chromosomes, 32 or 64. Flowers from May through December, and when pollination is effected the flowers drop off. Pods, each with 2 or more yellow seeds.</td>
<td>Usually wild white clover used in pasture, for soil enrichment, or for soil anchorage. Wild white clover may last 3-6 years, but plant is low with deep taproot. Ladino white is largest and may survive to 6 years. Dutch white may produce abundant forage, but may last only one year, so treatment varies with need.</td>
</tr>
<tr>
<td>Flowers appear from May through September—pale pink to magenta to white, to ¾ inch across, with petals ½ times as long as sepals. Stamens 10. A fruit with sharp point and length to 1 inch splits from base to free seeds which are hurled into air. Fruit is almost smooth; looks like cranberry bil.</td>
<td>Chromosomes. 32. Related storksbill, <em>Erodium cicutarium</em>, is occasionally used as a salad, but for most part the geranium family is probably best because of the unusual strong odor—even cattle avoiding the musky plants as food. Except as ornamentals, few of this family are economically important.</td>
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<tr>
<td>Flowers are showy and to more than 3 inches across, with many stamens united in a tube through which the tips of the pistils are thrust and around which they fuse, ½ inch across, with petals ½ times as long as sepals. Stamens 10. A fruit with sharp point and length to 1 inch splits from base to free seeds which are hurled into air. Fruit is almost smooth; looks like cranberry bil.</td>
<td>May be annual, biennial, or perennial but rarely annual, blooming in July to September or later. Is self-sowing. Young plants need a protective mulch under severe weather conditions. Seeds may live to 5 years when dry, and may germinate in 5 days. Plants are highly susceptible to fungus attack.</td>
</tr>
<tr>
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| **Evening Primrose**  
*Oenothera biennis* | Conspicuous fall and winter basal biennies leave up to 6 inches long and to 1½ inches wide, pointed at tip and with clasping base. In the winter, with the midrib characteristically pinkish, the leaves turn partly red at complete maturity. Stem is to more than 6 feet tall; slightly, or not branched. |
| **Wild Carrot**  
*Daucus carota* | Lacy basal leaves in fall, which are finely dissected, alternate, strongly scented when crushed, usually a pale green, with the smaller units conspicuously saw-toothed on margins. Erect mature stems to 3 feet high and crowned with flat-topped flower cluster, repeatedly compound. |
| **Garden Primrose**  
*Primula polyantha* | Basal fall leaves are most conspicuous, with leaves to 6 inches long; narrow, with winged petiole, wrinkled, with impressed veins and inconspicuously uneven margins. Mature plant in summer may be to 1 foot high. Basal leaf clusters show in the late fall and in the early spring of the year. |
| **Pansy**  
*Viola tricolor* | This common annual or short-lived perennial produces masses of leaves which may persist under the snow, and many of the species bloom often at the very edge of the snow. Leaves, long-petioled with heart-shaped blades. Stem leaves are narrower. Height of stem is about 6 inches. |
| **Heal-all, Selfheal**  
*Prunella vulgaris* | Underground rootstock produces branches of leaves near ground which may have rosette functions, qualities. Leaves are opposite, to 4 inches long, petioled, with larger leaves above. Stems are square, sometimes branched, rooting at joints to form clear stand, crowding out competition. |
| **Mullein**  
*Verbascum thapsus* | Fall rosettes of densely furry, pale green, alternate leaves with broadly margined petals, each to 1 foot long and half as wide, in summer and fall lying close to ground. Stem is erect, to 8 feet tall, and longitudinally flushed by leaf bases that extend down the stem. Erect stem forms second year. |
| **Teasel**  
*Dipsacus sylvestris* | Large, spectacular basal leaves appear in late summer and fall. Leaves are opposite, bright green, joined at bases to form cups on the stems. Leaves are prickly on midvein beneath, and rosette leaves may be to more than 1 foot long. Root system penetrates deeply and coarse stem is to 6 feet high. |
| **Narrow-leaved Plantain**  
*Plantago lanceolata* | Conspicuous fall basal leaves: crowded, narrow, and heavily veined—each to 1 foot long, at least 1 inch wide, being usually widest above the middle. Stem above ground is short or apparently absent, and fed by numerous fibrous, seemingly shallow roots that are difficult to pull up and may break. |
| **Dandelion**  
*Taraxacum officinale* | The rosette of leaves, close to the ground, arises from a deeply penetrating taproot. The leaves are highly variable, and up to 10 inches long. Their margins may be almost entire, but are usually deeply toothed. The common name refers to a fancied resemblance of leaf-teeth to lion teeth. |

Order Myrtales. Family Onagraceae. Included in the order are eucalyptus, fireweed, water milfoil and myrtle, and bay. There are some 30 genera and 600 species in the family. Evening primrose, *O. biennis*, ranges from Labrador to Florida and west to the Pacific, with close European relatives. 

Order Umbellales. Family Umbelliferae. Commonly called Queen Anne’s lace. Order includes poisonous water hemlock, parsnip, and celery, all in Family Umbelliferae. And the dogwoods in a closely related family, *Daucus* is native of Asia, from Coast to Coast. Genus has 25 species. 

Order Primulales. Family Primulaceae. The family includes, in addition to the primroses, such ornamentals and otherwise economic plants as rock jasmine, cyclamen, shooting star, loose-strife, and pimpernel. The family includes about 90 genera and 800 widely distributed species. A hybrid. 

Order Violales. Family Violaceae. The family includes, in addition to the violets, the begonias. The family includes herbs, shrubs, and even trees, belonging to some 15 genera and more than 400 widely distributed species. Many pansies may escape from cultivation and survive for a while “on their own.” 

Order Polemoniales. Family Labiatae. Family includes the mullein, which in turn includes herbs and shrubs of about 160 genera and some 3,000 species, exclusive of horticultural forms. Heal-all is native to Europe, but widely established in most of North America, where it is probably native. Also Asiatic. 

Order Polemoniales. Family Scrophulariaceae. Order includes the borages, mints, verbenas, and such economic plants as potatoes. The family includes about 190 genera and some 3,000 species of herbs, shrubs, and trees with alternate or opposite leaves that are widely distributed over the earth. 

Order Rubiales. Family Dipsacaceae. Order includes coffee, gardenia, honey-suckle, and other plants. Family includes the teasel and Scabiosa. The teasel family includes some 7 genera and 140 mostly Old World species. Some now established on world-wide basis. Teasel includes 13 species. 

Order Plantaginales. Family Plantaginaceae. Only one family, which includes about 10 genera and 2,600 species of little economic value: some pennisetaceous weeds. *P. lanceolata* is native of Europe, Asia, and is found in America from New Brunswick to Florida, west to California. British Columbia. 

Order Campanulales. Family Compositae. Order includes families in which gourds, bellflowers, and lobelias are found, as well as the composites. Composites include herbs, shrubs, few if any trees. There are likely 800 genera, 20,000 species. Authorities claim 50 to 1,000 species of *Taraxacum*.
REPRODUCTION

Flowers are showy, pale yellow, opening at dusk to 2½-inches across, and with elongate basal tube. Sepals, 4; petals 4, ½-inch long, of equal length to that of the pistil. Pollination is effected by visiting insects or by self, with chromosomes numbering 14. Seeds are abundant, and are freed slowly.

Flowers small and borne in compound formation that is to 4 inches across, which opens and closes with change in humidity. Some of the rays may be more than 4 inches long. Stigmas may be a central flower—black or deep purple. Fruits are oval, lopsided, bristly-streaked, to 1/5-inch long; hardy.

Flowers are broad “facelike” structures to 2 inches across, usually in blue, yellow, white, or mixed colors. A spur is associated with nectar sought by insects that help effect pollination. There are 26 chromosomes. Some flowers do not open but remain close to ground, and are self-pollinated.

Flowers are borne in compact, erect spikes more than 1 inch long and to ½-inch thick. Individual flower is to ½-inch long, and may be blue, purple or white, backed by green or purplish calyx. Fruit is brown and pointed. Many hardy brown seeds with a small point at one end. Chromosomes, 32.

Mullein is a native of Europe, Asia, and is well-established in America as a weed from Maine to Florida, west to California, and to the north. It is a biennial, with flowers borne in crowded spikes at end of erect stem, flowering from July through September and producing a host of small seeds.

Flowers of D. sylvestris borne in prickly spike, with those half-way up to flower and mature first. Corolla is pale blue to purple, to ½-inch long, 4-parted with attached calyx. Fruits are dry and four sided, and are protected in part by spiny spike which in related species has commercial value.

Flowers borne in short, dense spikes at end of long, flexible, slender, stems that may exceed 1 foot in length. Stamen mature after the pistils, appearing in older spikes and parts of spikes. Pollination is by wind or insects, and two boat-shaped seeds are freed from mature capsules. 12 chromosomes.

Flowers borne in compact heads bound by green involucral bracts, on a broad receptacle at end of hollow stemlike scape. Flowers are yellow, straplike, of a kind, each bearing a pistil and set of stamens bound in circle by anthers. Pollen may be sterile; pollination not needed to produce seed.

ECOLOGY

Basal leaves flatten with the shortening of the days in latter part of year. Usually “rosette” is formed first season and tall plant the second year. DeVries used the related O. lamarkiana as an important basis for his theory of evolution, which involved mutants as highly significant phenomena.

Insects may assist in pollination and may possibly be attracted by odor of the whole plant. Chromosomes number 18 or 22. Wet leaves may cause dermatitis and may kill five or more years, and their production should be prevented. Cultivation and hoeing may help in control.

Seeds sown in greenhouse from February to May may bloom Christmas. Seedlings do best in half-leaf-mold and half-sand mixture: 3-leaved seedlings may be set in 2½-inch pots, and in August reset in 6-inch pots with rich fertilizer. Plants held at 45° F. may be forced into flower by warming.

For spring blooms, seeds are sown in frames in August and seedlings are transplanted to 3 inches apart. Flowers should be picked if flowering period is to be prolonged, and flowers picked in early morning before insect pollination do not wilt so quickly. For fall blooming, sow seed February to June.

Reputed medicinal properties implied by common names are probably wholly imaginary. Neither is the plant recognized as having food value to man or beast. It is not as fragrant as many of its relatives. It may become a most unsightly weed in the yard, particularly in areas protected from the sun.

Pollination is effected by bees or by self, and is effective. Hairs may cause a pink blister to form on the skin or may make plant distasteful to livestock who avoid it to the profit of the plant. Low fall rosettes are not convenient forage even if they were attractive to stock. Favors sunny exposures and dry lands.

Chromosomes, 34 or 36. Ability of the deep taproot to reach water helps plant survive droughts fatal to competitors. It has sometimes been considered of medicinal value, but this is questionable. Plant may swaalm with minute, almost black, thrips, which crawl about actively in the felt of hairs.

Related D. fullorum was formerly used extensively in carding wool but has been replaced by superior metal substitutes. Plant has a rugged beauty that is not appreciated by farmers, who prefer that their fields yield superior crops and who resent the competition. May be a sign of poor farming methods.

Flowers of Echteria in compact heads bound by green involucral bracts, on a broad receptacle at end of hollow stemlike scape. Flowers are yellow, straplike, of a kind, each bearing a pistil and set of stamens bound in circle by anthers. Pollen may be sterile; pollination not needed to produce seed.

A most persistent weed that can be controlled by better weed sprays, or in part by digging, or by salting the crowns. Because of new seedlings, vigilance must be kept every year. Young vigorous tops are used to make greens, and dandelion wine is well known. Chromosomes, 16, 24, 32 or 48.

Few fields of biology cannot find in the dandelion a series of interesting problems, whether concerning plant economy, food value, genetics, distribution, anatomy, or chemistry. Few plants have more unsolved problems for botanist, farmer, and layman, and few plants are so misunderstood.

ECONOMY

Roots of early spring leaves may be collected and cooked to form a parsnip-like edible dish, but it may be necessary to use two or more changes of water to get rid of the bitter taste. Properly prepared, it is a good food and well liked by some. Best roots are second year roots, sliced and boiled.

Edible garden carrots may be considered a variety of the type species. They have high commercial value and affect the soil chemically. Guerrin at 100 tons of commercial carrots may remove 100 pounds of potash, 32 of nitrogen, and 18 of phosphoric acid from the soil. Yield is low from acid soils.

One species, Primula obconica, may cause dermatitis if the leaves are handled. P. malacoides may be sold as a cut flower. Most common use of this plant is for borders in open gardens, where it is not likely to be burnt out and for similar purposes. Well-rooted manure used as a fertilizer stimulates superior blooms. Pollination in nature is mostly by visiting bumblebees, but pollination is not necessary for some purposes.

Sprays of iron sulfate and 2-4-D are recognized as effective controls even when used at low concentration, although some contend that badly infested lawns may be dug up and started again. It is doubtful, however, whether such a rigorous control measure is actually a necessity.

Chromosomes, 34 or 36. Ability of the deep taproot to reach water helps plant survive droughts fatal to competitors. It has sometimes been considered of medicinal value, but this is questionable. Plant may swaalm with minute, almost black, thrips, which crawl about actively in the felt of hairs.

Control is by common weed sprays, by cultivation, and, of course, by hoeing and grubbing. Fruiting spikes are often able to survive passing lawn mowers, and they provide a welcome source of seed food to some birds late in the season. Seeds are a recognized impurity in grass seed.
nature IN THE SCHOOL

School programs are full of suggestions designed to help the students understand things that happen in autumn in the vegetative cover of our earth. There was a time when most schools put a large part of their time in studying seed dissemination—and then more seed dissemination. There is really such an abundance of things to observe that there should be only minor duplication and no monotony, and what is done may be both fun and profitable in many ways. We will not repeat here things that may well be found in the average school outline. We will confine ourselves to observations about herbaceous plants and associated phenomena.

The plant cover most obvious to the average school is the lawn that covers much of the earth outside. This may be a veritable gold mine of things to be observed. The average lawn in fall is unevenly covered with vegetation. Why are some spots bare and others well covered with plants? Find a bare spot and make a simple map of the plants that are found along its borders. Are these plants alike and do they resemble plants found most abundantly a yard or so from the bare spot?

In all probability any school lawn will be rich in basal leaves or rosettes, some of which were emphasized elsewhere in this insert. The most likely forms would be dandelions, broad-leaved and narrow-leaved plantains. A few of these may be marked by simple markers in the fall before the snows come. Reports may then be made in the spring as to how many of them came through the winter successfully. If pegs bearing numbers are driven into the ground beside these rosettes, it may be determined whether the plants survived a few months, a few weeks, or a year or more. It is worthwhile knowing how these basal leaves and rosettes develop, too. A few marked plants may prove to be better teachers than many textbooks are. It might be well to select two or more rosettes—perhaps of dandelions—of equal size and apparent vigor. Try pulling off half the leaves of one plant and all the leaves of another. See if this does much to weaken the plant by spring or, if you wish, in a longer or shorter time. Then try cutting off the head of the plant just below the surface of the ground. Notice if the underground system grows a vigorous new rosette in a short time, or if it produces more than one such head, or if it is killed by the treatment it gets. Then try digging out the deeper roots to see if this does the job of elimination. What you learn by these activities you have learned by your own efforts, and what you find should be convincing evidence to you.

You might be interested in getting some information on the number of weeds that have substantial underground systems. You might see how many of these plants that have their aboveground portions killed by the winter come back vigorously in the spring, owing in part to the use of the food that may have been stored in those underground areas. Just select any half-dozen fall rosettes or basal leaf clusters, mark them and see how many produce vigorous plants in the spring. Not a few will leave a pattern of their fall leaf forms on the ground as decayed leaves, but will produce a healthy leaf structure in the center of this pattern. Evening primrose and dandelion do this spectacularly sometimes.

In late fall, grass fires may be frequent. Make some record of the plants whose tops get burned and yet whose underground portions go unscathed. It is often interesting to go along the border of some stream whose banks become flooded and notice how many times rosettes or basal leaves of weeds appear conspicuously under the water. Mark a dozen of these with sticks, and after the flood has passed—or the following spring—notice how many of these plants were killed by being flooded. Is what you observed true of all such leaf forms? Is the deciding factor the "rosette" or the kind of plant?

You may be interested in the effect of temperature on the seeds of plants. The weed tops of many common weeds behave variously in winter. Some may be bent over to the ground and covered with snow and trash relatively early. Some may stand erect through the winter. Others may stand erect even through a vigorous grass fire. Collect some seeds from seed pods of these three categories and try to germinate them to see if the freezing, the roasting, or the protection they received made any difference. A simple way to test this germination in a day or so might be to sprinkle some paper toweling with the seeds, using a separate towel for the seeds of each category. Soak the toweling and put it away in a reasonably warm place where germination might be expected. Check each day to make sure the towels have not become thoroughly dried; this would interfere with the development of the seeds and seedlings. Do you find that any of the seeds that apparently had been well roasted by a passing fire are still able to germinate?

Does freezing kill one season's seed crop?

Extremes in temperature may affect other qualities in the herb cover of unwooded lands. Freezing may improve the flavor of a number of kinds of "greens," and of course, may affect their crispness. Some plants improve by such treatment; others deteriorate. If you are of a genuinely experimental nature you may wish to learn more about why animals select or reject weeds in pasture lands. Take a small piece of mullein leaf and touch it to your lips or tongue. Does it affect your mucous membrane in any way? Dry some of the leaves and rub a little of the dried fuzz on the sensitive skin between your fingers. Does this affect the surface of your skin in any way? It may or it may not, but if it does you may understand one reason why these weeds persist in pastures that are otherwise grazed clean.

Weed rosettes frequently provide safe retreats for many insects that may, when times are better, feed on more valuable plants. You may not be able to make a careful study of this situation, but it might be fun to make a series of collections showing the kinds of insect that may be found on different kinds of rosettes or basal leaves in late fall, winter and spring.

Instead of trying to get much information about many kinds of basal leaves and rosettes, some of you may prefer to make more exhaustive studies of some one kind. I would suggest that ordinary oxeye daisy basal leaves might be most useful—and possibly surprising. Taste the basal leaves at different stages of their maturity. At some times they are delicious, at other times rank, so it is not safe to say simply that they are edible or inedible. Any study such as this might make you reserve judgment or even reverse former judgments and may be helpful in developing the scientist that is in all of us to some degree.
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**DUCRRAFT**

Dept. N-11, Duen Bldg., Plainfield, N. H.
Fast-growing lions at six months: the trio of cubs—Elsa, Lustica, and the Big One—lounge in the sun near the Adamsons’ home in Isiolo.

Elsa, Adamsons fe would be easy to train not only for life their home, but also as traveling companions on their frequent safaris.

LIONESS OF TWO WORLDS

After three years as a pet, Elsa was taught to survive freedom.

Photographs by George and Joy Adamson

Whether fact or fiction lies at the root of tales that credit the Assyrians with having trained lions, as cheetahs, greyhounds, or retrievers are today trained to hunt in co-operation with man, the Adamsons (George, a game warden, and his wife, Joy) can certainly claim to be the first for several thousand years to have made an approach to achieving that result with a lioness—and that, not by any deliberate attempt to do so, but merely by allowing the animal to grow up in their company and never permitting her nature to be subjected to the tensions of being confined in any manner.

The history of the lioness Elsa, reared from earliest fancy to three years old and finally returned to a wild life forms a unique and illuminating study in animal psychology—a subject to which the last half-century has seen wholly new approach. Partly, no doubt, in revolt against the tendency of nineteenth century writers to attribute to animals anthropomorphic qualities of intelligence, sentiment, and emotion, the twentieth century has seen the development of a school of thought according to which the springs of animal behavior are to be sought in terms of “conditioned
flexes," "release mechanisms," and the rest of a wholly new vocabulary, which is regarded as the gateway to a clearer understanding of animal psychology. To another way of thinking, which cannot reconcile that mechanical conception with the diverse character, intelligence, and capabilities exhibited by different individuals of the same species, that gateway to understanding seems as far removed from truth as the anthropomorphism of a previous generation, and more apt to raise a further barrier to a sympathetic understanding of animal behavior than a revelation of it.

To whatever way of thinking the reader of Elsa’s history may lean, it provides a record of absorbing interest depicting the gradual development of a controlled character that few would have credited as possible in the case of an animal as potentially dangerous as any in the world. That such a creature, when in a highly excited state with her blood up after a long struggle with a bull buffalo and while still on top of it, should have permitted a man to walk up to her and cut the dying beast’s throat to satisfy his religious scruples and then lend her assistance in pulling the carcass out of a river, is an astonishing tribute no less to her intelligence than to her self-control.

If the most fanciful author of animal stories of the nineteenth century had drawn the imaginary character of a lioness acting in that manner, it would assuredly have been ridiculed as altogether "out of character" and too improbable to carry conviction—and yet Elsa’s record shows that it is no more than sober fact.

If in her growth Elsa has made her own commentary both on the "anthropomorphism" of the nineteenth century and on the "science" of the twentieth, she has not lived in vain.
When cubs went into the bush, they often had adventures. Once, five donkeys approached dozing cubs, who woke up and charged together.

This first stampede delighted cubs so much, when Adamsons' forty donkeys and mules later came near house, the cubs, left, drove them off.
Wistfully gazing down road, Elsa sees sisters leave for Nairobi to fly to a zoo in Holland. It was impossible to raise three growing lions.

George Adamson gives a lesson in retrieving to Elsa. She was unafraid of sound of shot and she learned to associate blast with the dead bird.
affes amused Elsa, one day she glimpsed them. She slowly liked them. But she med annoyed as beasts ignored her.
Perched in limbs of a tree, Elsa rests, taking in the breeze, during visit to Lake Rudolf. While lions rarely range far, she took long treks with...
Stretched on Land Rover’s canvas top, Elsa is ready for a ride. She often seemed unwilling to walk if car was near.

A long drink was a welcome treat for Elsa later in the Lake Rudolf trip as water holes were difficult to find.
Trained for future return to the wild, Elsa killed a half-ton water buffalo. To help drag victim from the water, she tugged at tail.

Now living as a wild lioness, Elsa is finally free. Yet she still recognizes the Adamson who had given her a life in two worlds.
While playing the lead in the Broadway musical "Greenwillow," the distinguished American actor Mr. Anthony Perkins phoned us from New York. We learned that he had used telescopes since boyhood, has a 4-inch refractor and had practically memorized our booklet. He asked some questions and in June took delivery of a quartz-mirrored Questar. When asked how he liked it, he said, "Your booklet does not do it justice." We asked if we could quote him in this space. "Indeed yes," he replied, "but change that to read 'no catalogue could do it justice.'"

**LAY THAT BURDEN DOWN**

When you finally get tired of lifting and carrying your telescope in and out of doors, tired of setting it up and taking it down in chilly darkness — When you've had enough of heavy loads, of quivering tubes and images, enough of drives that falter and slow-motions that fall short — When you finally realize that it has become too much trouble to use your telescope any more because it only gives you an aching back and a pain in the neck — when you've had your fill of the whole unhandsy contrivance — send for the Questar booklet!

The Questar booklet will tell you how to lay your burden down. No more lifting, no more toting, no more setting up of heavy, clumsy parts. Questar weighs but 7 pounds. It is always assembled, always ready to use. It will tell you how Questar stands alone, the only thing of its kind, with the latest kind of optics, the mixed lens-mirror system of the new catadioptric optics. How Questar's folded focal length keeps it fabulously short, how so short a telescope can be as stiff and rigid as a great observatory instrument. It will tell you how Questar's images are as rock-steady as a microscope's, how its controls are ready to your fingertips, and how its 360° continuous slow-motions have a battery smoothness with absolutely no backlash at all. It will tell you of finer performance than was ever dreamed of from only 89 mm. of aperture, and prove that point by the amazing resolution of the photographs it takes.

But hold on — let the booklet tell you this — let us use this space to tell you other things. Let us speak, for example, of investment value. Questar costs no more than ordinary 'scopes would if they were so well mounted as to be equally solid and vibration-free. But let's face it — Questar optics cost more by the extra hours of human labor required to make, for example, mirrors that must be 16 times more accurate of figure than the ordinary kind. Questar's mounting, too, has over 235 separate parts, each one of the best procurable alloys down to the last small stainless-steel screw.

So let us tell you what we have found out — that Questars are so greatly in demand that the few which reach the second-hand market depreciate an average of less than 7½% per year! Imagine this — telescope 5 years old may bring 80% of their purchase price! We know of few manufactured products with such amazingly high value at resale.

Remember then, that if you too become a Questar owner, you will be making the most conservative investment possible. We firmly believe that it will cost you less per year to enjoy a Questar.

Questar, as illustrated, still costs only $995 postpaid, in handmade velvet-lined English leather case. Terms are available. May we send you the booklet?
SKY REPORTER

Dürer’s woodcuts of the sky

SIMONE DARO GOSSNER

From earliest times, the principal function of constellations was to provide an easy way to refer to a given area of the sky and to locate celestial objects. “The ear on Orion’s knee” and similar expressions were in common astronomical use until the start of the seventeenth century. Thus, when corresponding mythological zubes were drawn for scientific purposes, they had to conform to conventional attributes of the particular animal or demigod, so they might be recognized; but, most all, the subject had to be shown in the prescribed pose so that individual stars might be identifiable. For example, Orion would be depicted in hunter’s garb according to the artist’s taste, but his leg would be bent always in the same way to accommodate the star on his knee.

Such restrictions were of little concern to illustrators of classical literary works dealing with the mythology of constellations. A case in point is the charming edition of Aratus’ Poëtica Astronomica printed at Venice in 1532 by Erhard Ratdolt. The anonymous artist—perhaps Ratdolt himself—who designed the woodcuts adorned the zubes with a fanciful array of stars bearing no resemblance whatever to the actual constellations.

Offhand one would expect an artist to prefer the relative freedom of this non-scientific approach; but, strangely enough, the most beautiful examples of astronomical illustrations are celestial maps drawn for the specific purpose of showing the exact positions of stars. All astronomers know Bayer’s Uranometria (1603) and Flamsteed’s Atlas Coelestis (1729), both of which exist in several editions and are found in the libraries of major observatories. Asked to name the oldest printed star map, they would probably mention the Planisphere of Apianus (1536) which, although very rare, has been reissued in facsimile (1927) and is mentioned occasionally in the astronomical literature. Yet, Apianus’ map is a poor second, chronologically and aesthetically, to woodcuts showing the Northern and Southern Hemispheres, which the great German master Dürer (1471-1528), completed in 1515.

It is hard to explain why Dürer’s maps have received little attention in astronomical circles. Perhaps it is because they were issued separately rather than in a scientific book. Apianus’ map, which was printed first as a roadside, might have fared just as poorly had it not been included in a later treatise of the same author.

The circumstances that led to the execution of Dürer’s maps are not known in detail. According to the inset on the lower left corner of the southern map, they were planned by Johannes Stabius, professor of astronomy at Vienna and part time resident of Nuremberg, and the stars were noted by the astronomer Conrad Heinfogel, also of Nuremberg. Dürer, of course, drew the constellation figures and the ornamentation. A resident of Nuremberg

**HYDRA constellation** design from 1569 edition of Aratus published in Cologne imitates Dürer’s Hydra seen on p. 61.
Celestial map of Northern Hemisphere is rendered in a woodcut by Albrecht Dürer, dating from 1515. This map and its companion piece, facing page, are to be found in the Rosenwald Collection, National Gallery, Washington, D.C.

Although Stabius is credited with planning the maps, historical evidence gives more importance to Heinlégel’s role. Another set of maps, drawn on parchment, was discovered in Germany about twenty years ago. Dated 1503, they also originated in Nuremberg and bear Heinlégel’s name along with names of two other scholars, Dietrich Ulsen and Sebastian Sperancius. Contemporary correspondence indicates that Heinlégel had secured accurate star positions a few years earlier; thus, presumably, he had plotted both the 1503 map and Dürer’s. The constellation figures of this earlier set generally resemble those drawn by Dürer, but there is an unevenness in the quality that suggests more than one hand. Dürer may have used them as a guide and perhaps completed a few himself. In any case, the similarity of design is too great to leave any doubt that he had access to this set.

Discovery of the 1503 maps raises an interesting question about the circumstances that led Dürer to take part in the Stabius-Heinfogel project. Heinfogel was a friend of the aging Nuremberg astronomer Bernard Walther, who had been patron and disciple of the great Regiomontanus (1436–1476). The latter is known to have used a manuscript map of the heavens in two hemispheres dating to the first half of the fifteenth century. The fate of the
Southern Hemisphere star map by Dürer bears inset in lower left corner that names Johannes Stabius as planner and Conrad Heinfogel as astronomer who plotted stars. The Hydra figure is more delicate than is the copy in Aratus.

The influence of Dürer's work on subsequent star maps is difficult to assess. The many resemblances that are noted in Bayer and Flamsteed, among others, could be attributed to the fact that similar designs are found already in the Arabic manuscripts of Ptolemy, and the block books of the Renaissance. The problem is obscured further by the total lack of reference to Dürer even by the most callous imitators. A notorious example is the edition of Aratus' Phainomena published at Cologne in 1569 by one Theodor Graminæus. The author, who gives himself full credit, illustrates each constellation separately (see picture of Hydra on p. 59), but uses in every case an almost exact copy of the appropriate Dürer design. However, it is not in such similarities that the influence of the German master must be sought, but in the new standards of elegance so apparent in celestial maps of the next century.
THE SKY IN NOVEMBER

From the Almanac:

<table>
<thead>
<tr>
<th>Event</th>
<th>Date</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full Moon</td>
<td>November 3</td>
<td>6:58 A.M., EST</td>
</tr>
<tr>
<td>Last Quarter</td>
<td>November 11</td>
<td>3:48 A.M., EST</td>
</tr>
<tr>
<td>New Moon</td>
<td>November 18</td>
<td>6:47 P.M., EST</td>
</tr>
<tr>
<td>First Quarter</td>
<td>November 25</td>
<td>10:42 A.M., EST</td>
</tr>
</tbody>
</table>

For the visual observer:

Mercury will be in inferior conjunction on November 7 and will transit across the sun's disk on that date (see below). It will be in the morning sky for the rest of November. Favorably placed for observation during the last two weeks of this month, it will rise approximately one and a quarter hours before the sun on November 15. On November 24, it will reach its greatest western elongation and will rise one hour and three quarters before the sun. It should be visible low in the southeastern sky for several days before and after elongation.

Venus (−3.5 magnitude) will be very conspicuous in the evening sky. In the southwest at nightfall, it will set at about 6:45 P.M., local standard time, on November 1, 7:00 P.M., on November 15, and 7:15 P.M., on November 30. Mars, in Gemini, will brighten steadily from −0.3 magnitude on November 1 to −0.9 on November 30. Although its nearest approach to the earth will not be reached until the following month, it will be only 62 million miles away at the end of November. It will rise at about 9:00 P.M., on November 1, 9:00 P.M., on November 15, and 7:00 P.M., on November 30. Several degrees south of the twins (Castor and Pollux), it will pass nearly overhead a few hours after midnight and will remain visible until sunrise.

Jupiter (−1.5 magnitude) will be found in Sagittarius, low in the southwestern sky after sunset. It will set at 8:00 P.M., on November 1, 7:15 P.M., on November 15, and 6:30 P.M., on November 30. Except for the first few days of December, this will be the last opportunity to observe the planet Jupiter until the latter part of February.

Saturn (+0.3 magnitude) will also be in Sagittarius, east of Jupiter. It will set at 9:00 P.M., on November 1, 9:00 P.M., on November 15, and 7:00 P.M., on November 30.

Interference by the full moon may reduce appreciably the number of Taurid meteors that will be seen during the first week of November. The Leonids, on November 16 to 17, should give a better display with an expected rate of fifteen meteors per hour (for a single observer).

Transit of Mercury:

On November 7, Mercury will be seen passing across the lower portion of the sun's disk. This transit will be visible in North and South America (except the northwestern tip of Alaska), western Europe, Africa, New Zealand, and Antarctica. The time at which the phenomenon begins and ends will depend principally on the standard time zone of the observer. At New York City, the phenomenon will begin at 9:35 A.M., EST, and end at 2:12 P.M., EST. For other cities of the Western Hemisphere, it will be sufficient to allow for the difference between the local time zone and Eastern Standard Time. In Denver, for example, ingress will be at 7:35 A.M., MST and egress at 12:12 P.M., MST. In some areas of the West Coast and of the Pacific northwest, the transit of Mercury will be in progress at the time of sunrise.

Mrs. Gossner, a Belgian-born astronomer who studied at Harvard, regularly prepares the Sky Reporter column.
MAGNITUDE SCALE
* -0.1 and brighter
★ 0.0 to +0.9
★★ +1.0 to +1.9
★★★ +2.0 to +2.9
★★★★ +3.0 to +3.9
★★★★★ +4.0 and fainter

TIMETABLE
November 1 10:00 p.m.
November 15 9:50 p.m.
November 30 6:00 p.m.
(Use Standard Time)
Fossil Bonanza

Geisel Valley lignite is rich in fossil vertebrate animals

By Georg Zappler

The wealth of invertebrate and lower vertebrate fossil material from the middle Eocene lignite beds of the Geisel Valley has already been described (Natural History, October, 1960). We have seen the niches each family occupied in the over-all economy of animal life and the changes each underwent as it spread to new geographical regions. But to round out any picture of these times, a survey of the mammals and birds is necessary.

Descended from mammal-like reptiles of the early Mesozoic, the mammals of today fall into two main categories, marsupial and placental, both of which were independently derived from a common, primitive, mid-Mesozoic mammalian stock, the pantotheres. The egg of reptiles—completely "terrestrial" and providing an artificial aquarium stocked with food (the yolk) for the developing embryo—permitted complete independence from an aquatic environment for the first time in vertebrate life. Now, this land-adapted germinal unit became, in mammals, modified for retention within the mother's body.

The degree to which the change from an egg-laying to a live-bearing mode of reproduction occurred is different, however, in the two lines of descent represented by the marsupial and the placental mammals. Among the former, the fertilized, shell-less eggs, retained in the body, contain some yolk and the embryos derive a small amount of additional nourishment from the mother's blood for a very limited period. They are then born alive—as tiny, larval young. These immediately crawl into a special pouch, the marsupium, where they attach themselves to the mother's milk glands located within, remaining there for several weeks. Only after this period of residence in an "external incubator" are the young capable of any independence.

The other mammalian lineage, the placentals, have gone still another step beyond the reptilian level in their reproductive modifications. With them, the young are born in a

Middle Eocene land fauna from the Geisel Valley includes opossums and lemurs in the tree, primitive insectivores and carnivores in foreground—an early horse and tapirs behind them. Ground-dwelling bustards and cranes are seen at rear.
comparatively advanced stage of development. The placenta—the structure that enables the embryo to derive nourishment from the mother’s blood during this extended period of retention—is developed to a much greater degree than among the marsupials, the egg being almost yolkless. Placentals have no pouch, and their milk glands are exposed on the surface of the skin. However, both marsupial and placental mammals are characterized by live birth and by the possession of skin glands that have become specialized for their offspring.

From the last period of the Mesozoic onward, we find fossil remains of both marsupials and placentals. At present, the former are a dying group, with only the opossums—now confined to North and South America—seemingly well able to withstand placental competition. At the beginning of Cenozoic times, opossum-like forms were cosmopolitan in their distribution, having reached all the major land masses before the close of the Mesozoic. However, only in the isolated situations provided by South America, during most of the Cenozoic, and by Australia, since the close of the Mesozoic, were the marsupials able to undergo any great degree of adaptive radiation. With the re-emergence of the Panama isthmus, permitting a southward surge of North American placentals (Nature, History, October, 1959), and with the coming of man and his introduced placental to Australia, the fate of the previously successful, but now “inadequate” marsupials became sealed. South America has already witnessed the disappearance of most of its native pouched animals and the extinction of the varied marsupials of the Austral region seems but a matter of time. It is, at any rate, no strange to find a middle Eocene opossum among the Geisel Valley mammals that represent the first, but now “antiquated,” post-Mesozoic radiation.

The insectivore finds can also be put under the heading of “archaic” in the general evolutionary scheme. However, the specimens from the Geisel deposits were already specialized beyond the level of the primitive and generalizing insectivores of the late Mesozoic that provided the basic stock from which all the orders of placental mammals are derived. One specimen, a fairly complete skeleton, was that of a small animal about four inches long including the tail, and, to judge from the construction of its arms and legs, particularly the grasping, unclawed hands—arboreal.

Today’s insectivores include the ubiquitous shrews and moles, tenrecs from western Africa and Madagascar, the solenodonts of the West Indies, and the now strictly Cretaceous World hedgehogs. The Geisel Valley forms do not appear to be directly related to any surviving insectivores, but they are closely linked to equally “aberrant” types dating from the same epoch and found as fossils in other parts of Europe and in North America.

Considering their aerial habits, it is remarkable how well represented the bats are in the Geisel Valley collection: there are numerous skeletal remains, sometimes with preserved fragments of wing membrane, muscle, cartilage, and hair. The fossil history of bats is a very thin one. Descended from a primitive insectivore stock, their most obvious specialization involves elongated fingers of the forelimbs, to afford support to a flight membrane stretched between. The Geisel Valley bats, together with contemporaneous but not closely related finds from other parts.
Europe and North America, mark the first appearance of these, the only flying mammals in the fossil record. Unfortunately, the relationships of Eocene bats to living genera are not at all clear. Still, it seems that these fossil forms belong to the generally small-bodied, insectivorous assemblage rather than to the fruit-eating group. Whereas the former, if mainly tropical, are cosmopolitan and attain even the remotest land areas, the larger fruit bats and flying "foxes" have never reached the Western Hemisphere.

By the middle Eocene, rodents had already been gnawing their way for some time toward the tremendously successful way of life that has made their modern descendants the most varied and populous order among all mammals. The Geisel Valley fauna included—on the basis of identifiable isolated teeth—several members of the primitive family that is believed to have provided the ancestors of all the various rodent lineages. By this time, the stock had already yielded the sewelleds (the mountain beaver of northwestern North America is a modern survivor), primitive pocket gophers, and forms related to the kangaroo rats of our southwestern deserts. True squirrels, beavers, mice and their allies, and the porcupine group (including the South American pikas, chinchillas, and cavies) appear to be a later development. Ancestral rodents were globally distributed in early Cenozoic times, except for Australia and possibly South America, which they are thought to have colonized later by "rafting" across the Caribbean.

While we are still dealing with the "archaic" mammals, it is fitting that the primate discoveries of the Geisel Valley excavations should be mentioned. Apparently, the early Cenozoic saw a tremendous radiation of stem primates—an order that now includes lemurs, tarsiers, monkeys, apes, and men. Very closely related to the protoinsectivores, these creatures, which resembled tree shrews, gave rise not only to the ancestors of the modern lemurs and tarsiers but also to many side branches, now extinct, included in those groups. In addition, this initial primate radiation presumably produced the direct ancestors of the monkeys—unfortunately not yet found as fossils—and the more recent stock that, in middle-to-late Cenozoic times, diverged to yield modern apes and man.

The Geisel Valley finds—small forms measuring about two inches excluding the long tail—include several lemurs and tarsiers belonging to genera that were common to other parts of Europe and had close relatives in Asia and North America at this time. The last-mentioned continent apparently ceased to play a part in the evolution of the primates soon after the close of the Eocene, there being no later record of any members of their order, and future developments leading to the higher primates probably took place in the Old World, for it is there that we find fossil monkeys, apes, ape men, and early men. Lemurs and tarsiers, as such, disappear from the fossil record after the Eocene, not showing up again until Pleistocene times. Today, there is a haven for lemurs in Madagascar (which they probably reached in the early Cenozoic) and their relatives, the lorises and pottoos, are spottily distributed throughout tropical Africa and southeastern Asia, including Java and Borneo. Tarsiers are presently restricted to a single genus, living in the East Indies and the Philippines.

Thus far, in our review of the Geisel Valley bonanza, we have dealt in the main with lightly constructed members of the animal kingdom—organisms that seldom
leave fossil clues to their past evolution and distribution and that are, therefore, of exceptional value wherever they are discovered. The relative frequency of such types of fossils from the Geisel Valley is one thing that makes this locality such an interesting one: but the lignite beds’ yield of more solidly built mammals, although neither particularly frequent nor particularly unusual when compared with such fossils from other discovery sites of the same epoch, also deserves mention.

Herbivorous hoofed mammals; they survived into the middle Cenozoic. Note sharp cheek teeth for cutting and shearing.

Here, the mixture of “old” and “new” becomes striking. Although the carnivores among the Geisel Valley fossils belong to archaic types, the herbivorous ungulates are a few members of the two major modern orders of hoofed mammals—the perissodactyls and the artiodactyls. The former—which now includes only horses, tapirs, and rhinos—was once much more diversified—are often referred to as the “odd-toed” ungulates, for in all of them the weight-bearing axis of the foot passes through the middle toe with a concomitant trend toward elimination of the second toe in the course of their evolutionary history.

The artiodactyls, or “even-toed” ungulates—comprising the swine, hippos, camels, deer, antelopes, cattle, and all their relatives—have become, since the latter part of the Cenozoic, the dominant group of hoofed mammals, successful in replacing many of the odd-toed perissodactyls as the latter have declined. The even-toed order is characterized by having the axis of the foot pass between the third and fourth digits, which may be the only ones, or which may be flanked by two others beside.

All these limb modifications, particularly the degree of toe reduction, can be related to ecological “needs.” Depending on whether a forested, swampy terrain or the open grassland was the particular habitat to which the various groups became adapted, limb structures favoring locomotion over one or the other type of ground would tend to evolve. Generally speaking, the forest dwellers retained padded feet with several small hoofs, while the gallopers of the plains developed elongated, springy limbs terminating in large hoofs formed by the tips of the central toes—the third digit in the perissodactyals, the third and fourth in the artiodactyls.

Now the beginning of the Eocene is marked by the sudden appearance of both these orders in Eurasia and in North America. Both are believed to have evolved independently of each other from a generalized stock of stem ungulates called condylarth, which in turn derived from...
ancient insectivores. The perissodactyls were represented by numerous lineages from the very beginning of their appearance in the fossil record; by middle Eocene times, they had become highly diversified. The artiodactyls, on the other hand, appear to have been less common at the beginning, not really becoming numerous until the latter half of the Eocene. But by then, they, too, were quite varied.

In contrast to most of the families of the various orders discussed previously—whose distribution indicates extensive interchange between North America and Europe via Asia—the middle Eocene families of both artiodactyls and perissodactyls were somewhat more restricted to one or the other continent. This has led many paleontologists to postulate a temporary submergence of the Bering connection (the situation that exists now) at about that time. The postulate is reasonable; a break of this nature would tend to produce greater differences among the rapidly evolving ungulates on two separated land masses than it would within the "archaic" groups, which were already more stabilized. The zoogeographical dichotomy among the families of hoofed mammals was partially evened out later when the land bridge between North America and Asia reappeared toward the close of the Eocene.

The Geisel Valley ungulates illustrate these marked, middle Eocene differences very well. Among the odd-toed herbivores, we find numerous lophiodonts, a group of primitive animals resembling tapirs (but without proboscises), about eight feet long and three feet high. They were apparently restricted to Europe and Asia, but had contemporaneous perissodactyl relatives in North America. True tapirs, which appear to have always been forest dwellers browsing on relatively soft vegetation, are descended from one or the other group among these early forms, which, in later Cenozoic times, were widely distributed in both the Old and New Worlds. They disappeared from northern continental regions quite recently and are now restricted to southeastern Asia (the Malayan region), and Central and South America, a continent they penetrated toward the end of the Cenozoic after the re-emergence of the Panama isthmus.

A more familiar group of odd-toes, the horses, also show a striking zoogeographical separation between the Western and Eastern Hemispheres. The first true horses had, by middle Eocene times, become restricted to North America—the greater part of horse evolution then taking place on this continent. But a side branch, closely related to them
at the outset, developed into the paleotheres of the Old World. Several of these were found preserved in the Geisel Valley lignite beds. One specimen in particular was remarkable for its completeness—a relatively small animal, under three feet long and about one and one-half feet high. However, to judge from other localities, most paleotheres were large, bulky creatures almost the size of modern rhinos. The paleotheres survived only into the beginning of the next epoch and all future Eurasian—as well as African and South American—horses derived from stocks originally developed in North America. That continent saw the extinction of its endemic horses a few thousand years ago (the South American equids had already died out) and it was not until the coming of the mounted Spanish conquistadores that horses were re-introduced.

AMONG the even-toes, the Geisel Valley fossils include representatives of some of the distinctively European groups characteristic of the middle Eocene. There were several small anthropotheres—primitive piglike animals with four-toed feet—which are thought to contain the ancestral population that, toward the end of the Cenozoic, gave rise to the hipparion. For the Eocene, anthropotheres have been found only in European and Asiac deposits but they invaded North America some time during the next epoch, to become extinct in this region soon after. Anthropotheres themselves died out during the Pleistocene and the hipparions that stemmed from them, formerly widely distributed in Eurasia as well as Africa, now survive only in the aquatic habitats provided by the latter continent.

What about the "archaic" carnivores that preyed on these relatively modern, herbivorous ungulates? The Geisel Valley has yielded a number of these, typical of their time. They were creodonts, stem carnivores, among which one group—the miacids—gave rise to our modern carnivores. The creodonts date from the earliest Cenozoic and are derived, like all placentalts, from primitive insectivores. They were highly successful until the end of the Eocene, when they were replaced by modern carnivores: the dogs and cats—to speak broadly—including bears, raccoons, and weasels under "dogs"; civets and hyenas under "cats."

The creodonts evolved along several lines, distinguishable by differences in the appearance and arrangement of their teeth. All of them developed some sharp cheek teeth for cutting and shearing, instead of the uniformly squared-off "grinding mills" of the herbivores: but the exact type of modification and the particular jaw position of the molars varied from lineage to lineage. In over-all appearance and diversification, however, these groups paralleled one another fairly closely with small, medium-sized, and large animals occurring in each line—all of them showing extensive interchange between Eurasia and North America from the very beginning of their history. (Isolated South America developed its own peculiar beasts of prey—marsupial "wolves" and "cats" instead of placental carnivores). The middle Eocene does not seem to demonstrate any particularly marked zoogeographical differences among creodonts and this can be explained by the fact that previous migrations had already established highly diversified but similar stocks on both continents. Thus, a break in Bering Bridge, which was "mended" soon after, would not have the same evolutionary effect on the creodonts as was the case in the more recent ungulates.

The Geisel Valley creodonts belonged to two families. One of them was represented by relatively large carnivores called hyaenodonts, well able to tackle the ungulates of the time. The others were miacids. These were small and weasel-like in appearance; forest dwellers of somewhat arboreal tendencies, they presumably preyed on contemporary rodents. They were "progressive" in dentition and also in their relatively large brains, setting the evolutionary trend for later carnivores in those two features.

Whereas they themselves, as well as most of the other creodonts, became extinct at the end of the Eocene, the first family referred to—the hyaenodonts—continued on into mid-Cenozoic times both in North America and Eurasia, apparently well-enough adapted as beasts of prey to compete successfully with the descendants of the miacids.

The complexity of diversification and dispersal routes of these, the modern carnivores, preclude our presenting an uncoherent picture in a brief discussion of this kind. Except for Australia (at least until the arrival of man), the
A brief word may now be said about the birds. By early Cenozoic times, birds—originally descended from the same reptile group that spawned dinosaur and crocodilian—had become fully “modernized.” The toothed birds of the middle and late Mesozoic had become extinct, and a majority of today’s orders and families apparently were a existence. The Geisel Valley offers evidence on this point. Bird remains, although relatively rare, do exist. In some instances, scraps of skin with attached feathers were preserved together with isolated but identifiable bony parts. A relative of the condors—now to be found only in the New World—appears to have soared aloft over Germany during the middle Eocene. Fragments of heron-like and wader-like forms, some fairly good specimens of primitive cranes and what has been tentatively identified as a hornbill somehow managed to be preserved in the lignite beds. Cranes are cosmopolitan today, but the hornbills occur only in the tropics of Africa, Asia, and Australia.

One almost complete bird skeleton has been identified as one of the bustards, ground-dwelling birds—apparently confined to the Old World—which occupy the grasslands of Europe, Asia, and Africa. This is the earliest known bustard record. The bird in question had even better developed legs for running than do recent forms. Interestingly enough, its wing skeleton shows a mended break, perhaps due to the sort of courtship battle characteristic of present-day male bustards—violent wing-flapping and wing-beating constituting their main fighting method.

From this inventory, it is certainly possible to get a feeling for the diversity of life that, during a given “moment” of time, occupied the particular part of middle Germany where the Geisel Valley lies today. Actually, from the rates of deposition of the various layers of lignite, we can calculate that these strata cover a span between 200,000 to 400,000 years. Fossils are restricted mainly to the middle layers of this vertical “column,” although fossil insects are more widely dispersed. Even so, the fauna was not strictly contemporaneous. This situation usually holds true for any fossil deposit, but if we bear in mind the relative stability of natural patterns, whose gradual estab-
lishment and further change involve years measured in the millions (at least, before the active interference of man) we can still think of all these animals as living together in a single ecological community.

What were the various situations available? A general habitat picture was given in Part I of this article (Natural History, October, 1960), one that appears based on good evidence. Also, if we accept the premise that close relatives of today's animals would tend to lead the same type of existence as do their descendants—such an assumption being corroborated by the presence of anatomical features evolved for a particular way of life, whether for climbing, running, or swimming—then the Geisel Valley community of the middle Eocene was one typical of the warmer, forested parts of the world today. It is true that, since animal lineages are known to have extended into different climatic zones than those occupied by their ancestors, evidence based wholly on invertebrate or vertebrate remains is somewhat doubtful. But if the whole community—and particularly the vegetation concerned, plants being much more "conservative" than animals—adds up to yield a framework into which all the component parts can be fitted without contradiction, we can assume to have deduced a past environment correctly.

As has been true from the beginning of life, the primary users of the sun's energy—the plants—passed on their self-manufactured carbohydrates and proteins to the animals that fed on them; these, in turn, providing nourishment for their predators. Organic decay, through the action of bac-

Preserved fruit from Geisel Valley brown coal deposit is shown magnified twenty times in these photographs. The pine cone seen here was remarkably well preserved and has come down to us entire. Reproduction is almost natural size.

Needles from a pine tree are shown above. Pines grew in clumps on savanna that bordered more swampy river valley.
The entire region was lush and subtropical in vegetation during the middle Eocene, although the rainfall was only seasonal. Termites, completed the cycle of life and death, returning necessary elements to the soil and the atmosphere. Although the roles have been fixed from life's origins, the players and their costumes change through time. The company we have studied here "played" middle Germany about forty million years ago. The scenery was a liana-hung, subtropical forest enclosing many shallow lakes and a few deep water holes. Swamps overgrown with rushes merged in from the right and, in the background, the tall grasses of an adjacent savanna were occasionally topped by clumps of trees growing near streams.

Although the climate was warm enough to produce an essentially tropical flora, rainfall was seasonal. Thus, the over-all environment might best be compared to the monsoon forests of southeastern Asia today, where periods of drought will alternate with conditions that are characteristic of tropical rain forests the year round.

Unobserved except for their work of organic decay and dissolution, bacteria flourished in soil, water, and air. Small invertebrates—worms, snails, crayfish, and insects—consumed the plants, each other, and microorganisms. Water dwellers included carnivorous and insectivorous fishes, permanently gilled salamanders and other amphibian larvae—many of which were herbivores before they took to preying upon worms and insects on shore or in the trees. Aquatic turtles, actively pursuing prey, feeding on vegetation and carrion, or lying submerged on the bottom, ready to snap at any passing morsel, shared pool and stream with crocodiles and alligators—to whom any

DERMIS of one of the savanna grasses, well adapted to a relatively dry climate, is shown above, magnified 400 times.

POLLEN GRANULES, densely distributed throughout lignite beds of Geisel Valley, are shown at magnification of 1,000.
Leaf impressions—probably of a member of the wax myrtle family—are seen slightly larger than natural size in the photograph above. The fossil leaves shown at right reveal even the very fine details of their venation and structure.

kind of meat, living or still, was welcome. Others among the reptiles—such as the ground- and tree-living lizards—bit-players left after the collapse of an impressive Mesozoic production—were mostly chasers after insects and their larvae. High-domed land tortoises, of very catholic tastes, trudged along the damp forest floor and probably also in the neighboring drier grasslands. Constrictors rested along low-lying branches, coils flexed to be thrown around any small passing mammal. These, the insectivores, the insect-, fruit-, and grub-eating lemurs and tarsiers, and the mainly herbivorous rodents, were also stalked by weasel-like and civet-like early carnivores. The huskier creodonts preyed on primitive tapirs and bulky forest horses—both of which, although primarily interested in the soft forest vegetation, ventured out occasionally to graze on the harsh savanna grasses.

During the day, the aerial realm was filled with chattering, screeching, gaudy birds; most of them were insectivorous, but some ate fruits and others depended on small reptiles and mammals. The marsh-dwelling wading birds speared fishes and tadpoles. Ground-nesting bustards hunted in the tall grasses of the uplands. At dusk and through the night, bats winged between the trees, avoiding obstacles and capturing night-flying insects. And, year after year, predator, prey, and plant fell in this lush setting, to be preserved by the seep of calcareous water through the valley's developing lignite beds.

In closing, it should be emphasized that the Geisel Valley certainly fostered many other animals beside those that have been uncovered as fossils. Yet, these excavations give us a remarkably complete picture not only of the biotic community, but also of the climatic and physical conditions prevailing during middle Eocene times in central Germany. The recently renewed work at those deposits has yielded a great deal of new and as yet largely undescribed material. No doubt, our knowledge of this region and of our capacity to reconstruct the picture of this particular period with added detail will be greatly increased in the future.

Fossilized leaf of a parasitic plant from mistletoe family is seen here. Geisel Valley fossils were so well preserved because destructive humic acid given off by plant decay was neutralized by calcium present in ground and surface water.
Photographs are possible because the light rays reflected by the subject are concentrated and "resolved" by the lens into an image that is a miniature reversed copy of the original. For every subject visible in front of the lens—there is a corresponding image behind the lens—upside down and backwards. It is also reversed in a third dimension—an object close to the front of the lens will project its image farther behind the lens, while the image of a faraway object seems closer to the back of the lens.

Behind every lens is a miniature world of images, which reproduces the outside world that the lens "sees." These images are all there, suspended in space, as long as the lens is open. What we do when we "focus" a camera is simply to decide which of these many images will be intercepted by the film at the point where they are resolved or "sharp."

This can be demonstrated by taking the lens from a camera (or using a magnifying glass) and propping it on a table so that it points toward a window. Shutter and diaphragm should be open. Put a white card in the position usually occupied by the film, and one can see on the card the images projected by the lens. It may be necessary to shade the card from any light not coming through the lens, so the projected images will not be washed out.

If one starts with the card well behind the normal film position and moves it slowly toward the lens, the images of nearby objects will appear first, followed by those of objects farther away. The images of distant objects—the view outside the window, for example—appear last, as the card is brought closer to the lens. Finally, a point is reached at which images disappear.

The point where the images of the most distant objects are resolved is called infinity: the distance from that point to the lens is the focal length of the lens. The conventional "normal" lens is one with a focal length approximately equal to the diagonal dimension of the film. The field of the lens is circular, even though the film is rectangular. Thus, this diagonal is actually the diameter of the field that the lens forms.

Focal length is a built-in characteristic, determined by the lens design. Other lens characteristics—such as "speed" (or light-gathering power) and angle of view—must be designed into the lens in relation to its focal length.

The quantity of light that a lens can gather and can project onto the film depends on how big the lens is. A lens of longer focal length will produce a larger image, but the lens must be correspondingly larger in diameter to produce the same brightness. In other words, the speed of a lens—the measure of the brightest image it can produce—is determined by its diameter in relation to its focal length. This is expressed in a ratio called an "f number," because the letter "f" is used to stand for the focal length, in a sort of shorthand fraction. An f/1 lens is one whose maximum opening is the same as its focal length (f divided by 1). An f/2 lens has a maximum opening one-half of its focal length (f divided by 2), and so on. Since the f number is really the bottom part of a fraction, a large diameter is represented by a small number and vice versa.

The maximum aperture and focal length of a lens are usually engraved on its mount. I should say "effective maximum aperture," because modern lenses are so complex that these elementary rules are subject to some exceptions. On European and Japanese lenses, the values are generally given thus: "1:2.5 = 5.6 cm." An English or American lens would probably be marked "35mm. f/2.5." Both designations mean the same—the lens has a focal length of 35mm., and its maximum aperture is 1/2.5 of that distance, or 14 mm.

The notion that fast lenses are better than slow ones is a currently widespread misconception. It simply is not true. Actually, a fast lens is a good investment only if one uses it fairly frequently, and its maximum diaphragm opening.

Film is flat in most cameras, but the field of a lens is not naturally flat. The designer has had to make it flat within certain limits. These limits determine the lens's angle of view. Thus, a lens designed to render a broad angle of view on a flat plane is called a wide-angle lens, while a lens that flattens only the narrow angle is called a long-focus (or telephoto) lens. The latter is simply a longer lens—such as one would use in a camera that takes a large-sized film—but in telephoto applications only the center part of its field is used. A 100mm. lens on a 35mm. camera is a telephoto lens, while a 100mm. lens for a 2 1/4 x 3 1/4" camera is a "normal" lens and a 100mm. lens designed for a 4 x 5 camera is wide-angle. The lens-to-film distance and image size are the same with the three: the difference is in how much of what they see is projected flat.

As described above, a lens will project a flat object (the "subject plane") as a flat image (the "focal plane") within certain limits. Objects in front of or behind, the subject plane will be vi
David Linton's by-line has appeared under photographs in all the nation's leading magazines. His camera column is a regular feature on these pages.

If you have ever noticed that some objects in a landscape photograph were sharp while others were not, you were observing the effect of sharpness in the focal plane. Sharp objects in the focal plane will be sharp, but their images will not be sharp: these images are "out of focus." It is possible to make such images sharp by moving the focal plane toward or away from the lens, but to do so will throw the principal subject out of focus. If the size of the lens opening is reduced, however, these unsharp objects can be brought into focus without disturbing the sharpness of the subject plane. This procedure is called "stopping down." It gives us, instead of a narrow subject plane and focal plane, a "zone" of sharp focus at the film. The middle of this zone is the sharpest, but the difference in sharpness will not be noticeable for a certain distance in front and in back of that point. If a fixed value of unsharpness, measurable with sensitive instruments, is taken as a limit of tolerance, we can make up a table showing the size of this zone of acceptable sharpness—or "depth of field"—for every combination of working distance and lens aperture.

Such depth of field tables are published for every lens, and scales are engraved on the lens mount or around the focusing knob on most cameras. It is surprising how few people know how to use them. A glance at one of these scales will show that, as the working distance increases, the zone of sharpness at any given lens opening increases in size. Also, the zone of sharpness always extends about twice as far behind the plane on which the lens is focused as it does in front of that plane. A handy way to visualize this is to draw two lines in pencil across a heavy rubber band and then make a mark one-third of the distance between the two lines. Stretch the band and see the zone of focus (the region between the two lines) grow as the focal point (the mark) moves away.

Many people believe that the right way to bring a camera into its best focus is, first, to focus on the subject and then to stop down the lens to make the image sharper. This procedure conceals two assumptions, neither of which is always correct. Unless the object being photographed is flat and faces the camera squarely (like a billboard), it may be best not to focus on it. Rather, one should first locate the nearest and farthest objects that should be sharp (the closest and most distant people in a picnic group, for example), and then focus in between these points.

Great distance from lens to ground in aerial photography assures deep zone of sharpness without use of small aperture.
This technique of zone focusing is easiest to use with a range-finder camera. Optical range finders were originally developed for measuring distances rather than for focusing cameras, and they may still be so used. Simply focus on the farthest object and note the distance to it as shown on the rangefinder scale. Next, focus on the nearest object and note that distance. Then set the camera so the same aperture marking is opposite each of these distances. This is the maximum aperture that will bring both extremes into the zone of sharp focus; it is usually the one to use. The shutter speed needed for both the film being used and the amount of available light can be read opposite this aperture on a light meter. If the speed one finds by this method is impracticable, it may be necessary to use another aperture, change film, or eliminate something from the picture.

Stopping down farther will not make the image any sharper. To be sure, it will make the zone of sharp focus deeper, but this is not always useful. Furthermore, it may make the image less sharp, especially with a fast lens. Fast lenses are admirably designed to do a good job at maximum aperture, but they pay for this by beginning to lose sharpness when stopped down beyond a given point. This point varies from lens to lens, but is usually about two-thirds of maximum opening. Slow lenses (those with smaller maximum openings, represented by larger f numbers) are likely to be sharper than fast lenses stopped down.

Zone focusing, as described above, can be used to advantage even on subjects that will not stand still long enough for one to read off nearest and farthest distances. If, for example, the object is to photograph the finish of a horse race, the camera may be set to include in the zone of sharp focus everything on the finish line from the near rail to the far one. One is then reasonably sure of catching the winner in this zone of sharpness.

The folly of unnecessary stopping down is particularly obvious when everything in the picture is far away, as is the case in pictures taken from a distance or photographs of distant landscapes. It does no good to have a deep zone of focus if there is nothing in the zone. Similarly, there is no point in stopping down when the zone of focus already extends to infinity. It is true that stopping down will bring the foreground into focus, but for every foot of depth gained in front of the focal point, the sharp zone will also include two feet behind it—wasted when everything behind the subject is already in focus.

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EARLY FALL brings the Museum's practitioners of the natural sciences back to desk and laboratory from a great variety of summer activities, which take them to deserts and jungles, plains and mountains in many parts of the world. Summertime is their extended research time and some of them may extend their research to the top of a mountain in Arizona or all the way to New Guinea. Many combine their vacation period with field research. A true herpetologist cannot be happier than when hunting frogs, turtles, or snakes and, no matter where an ornithologist goes, he seldom puts birds out of his mind.

When you ask most people what they did during the summer, you get the usual answers concerning boat trips and fishing, cabins in the mountains, or sojourns at the seashore. But ask a museum scientist how he passed his summer and you are likely to get a startling answer. This fall, members of the American Museum’s scientific staff had some ready answers—but the answers frequently demanded further explanation.

James A. Oliver, Director, and Charles M. Bogert, herpetologist, reported that they had been down to Costa Rica hatching turtle eggs. Amplification established that they had not been hatching the eggs themselves but had gone down there to members of the Brotherhood of the Green Turtle, an organization devoted to re-establishing that threatened animal throughout its former range in the Caribbean.

The green turtle was to the Caribbean what the buffalo was to the western plains. Early explorers and the shiploads of settlers that followed slaughtered them for their meat. In time they were wiped out over much of the area. Islands where thousands once came to lay their eggs know them no more. For their part in the movement to bring them back, Oliver and Bogert made arrangements to send hundreds of baby turtles from hatching sites in Costa Rica to the Lerner Marine Laboratory, the Museum’s station at Bimini, Bahamas. There the little turtles will be released at various ages in hopes that, as adults, they will return to Bimini to lay their eggs. If the plan works, the big turtles can be brought back to their former range, much will be learned about their life history, and an economic resource will have been renewed.

Malcolm C. McKenna, paleontologist, went out West in his Cessna airplane to look for fossil bones. He explained that he doesn’t see the bones from the airplane but that the view from the air is a great way to locate formations in which fossils are apt to be found.

“It’s wonderful for finding outcrops,” he said. “You can see the color of formations; you can tell whether a ledge is eroding rapidly or whether there is a farmer somewhere around with a shotgun.”

McKenna and his co-workers settled on a site in western Wyoming where for two months they toiled at digging up 130 tons of sediments, transporting the rocks to a creek where they were washed in screened boxes. The result of the summer’s work was 20,000 usable specimens, including over 2,000 mammal remains, among them some shoulder blades of Multituberculata.

Richard G. Van Gelder, mammalogist, passed the summer on the West Coast measuring skunk skulls. For three months he measured skunk skulls in museums all the way from Victoria, B.C., to San Diego, taking about 30,000 measurements on 850 specimens. He also took some 500 photographs of the skulls. To some this might seem a dull way to pass the summer but to Van Gelder it is an important part of a long-term undertaking. He is in the midst of a three-year project involving the classification of the skunks of the world or, rather, the skunks of half the world for there are no skunks in the Eastern Hemisphere. He will do it again next summer.

Brooks F. Ellis, micropaleontologist, was out taking sediment samples from the bottom of Long Island Sound as part of another long-term study. Robert L. Carneiro, of the Anthropology Department, was off to Peru to study a group of Indians and won’t be back for a year. Other staff members went to the Museum’s various field stations to study everything from embryonic frogs and toads to pine trees. Still others were at scientific conferences here and abroad.

On the whole it was a splendid summer. A good time was had by all scientists. They brought back lots of data and material for subsequent interpretation. Now for the winter months, devoted to the equally important, if less exciting, aspects of the natural sciences in office and laboratory.

The American Museum is open to the public without charge every day.
A Christmas survey of the year in children’s science books

In presenting their first annual survey of children’s science books, the editors of Natural History are focusing attention on one of the most significant developments in American education: the rise of science to a prominent position in the school curriculum.

Such a review would have been impossible a generation or so ago. Then, there were far too few books to justify the effort. One widely used list of that time, a list prepared especially for teachers, included only about two dozen titles—and it covered a five-year publishing period, from 1930 to 1935. Contrast that dearth of material with the situation today. The thirty-nine books reviewed below represent a selection from over one hundred and fifty titles received from publishers, all appearing during an eleven-month period. This is a trend that has accelerated sharply during the past few years: editors refer to it, quite correctly, as an “explosion” in the publication of science books for children.

I can think of a number of reasons for this notable change. Not the least important is the startling impact of the launching of Sputnik I in 1957. We are heavily indebted to the Russians for accomplishing that feat, which had the effect of arousing us from a long somnolence and emphasizing to people, who should have known it all along, the vital role of science education. Since then, it has become increasingly obvious that the nation’s welfare involves not only advances in the glamorous fields of space exploration, electronics, and other applied sciences but also involves the training of investigators devoted to basic research—upon which, in the last analysis, all technological progress depends.

In other words, the marked rise in the demand for children’s science books is one sign of a new and somewhat belated concern with the quality of American education. The demand is certainly not being met in a systematic or completely satisfactory way. Scientifically sophisticated publishers are about as rare as scientifically sophisticated Congressmen, industrialists, or advertising executives. We would be much better off if some of the vacuous books currently on the market had never been written and there is plenty of room for pointed and outspoken criticism, such as that to be found among the reviews in this survey.

But this picture also has a bright side. The book trade stands up rather well when we consider what is going on in other areas presumably devoted to the public interest. Take commercial television, for example. Last year, buried under a mass of shows in which practically everything was cheap but the production costs, we had only a smattering of science. The list included one-hour programs sponsored by the Bell Telephone Laboratories and “Conquest,” a series of twenty half-hour programs on the Columbia Broadcasting System. As far as time devoted to basic science is concerned, this year’s offerings will be even more meager. The Bell programs are still with us for a grand total of two hours. But “Conquest” has been killed because, although it satisfied many persons (audiences of ten million or more), it failed to satisfy sponsors and TV officials in search of more lucrative programs.

Viewed from this broader perspective, the publishers make up a comparatively distinguished group. Among them we can see the profit motive working in a relatively effective manner—to the advantage of all concerned. They are sensitive not only to the mounting demand for more children’s books about science, but also to the need for setting higher standards of quality in writing and production. For a full appreciation of the progress that has been made, it is necessary to compare the best books of the 1930s, books like Romping Through Physics, Talking Wires, and Television Today and Tomorrow, with today’s publications. When it comes to presenting young students with serious and accurate accounts of scientific achievements, we already have a reasonably wide choice of well-written books—and the choice will be wider in the near future.

Nonetheless, a considerable proportion of children’s science books today is clearly not up to par—and for this we cannot always blame the publishers. The need for articulate and literate science writing is perhaps more urgent than it has ever been before. Yet the number of writers who are at once scientifically trained and skilled in the art of presenting science to nonscientists is pitifully small. A hundred persons would be a most generous estimate. For this reason, among others, the National Association of Science Writers has been working actively with universities and publishers on steps designed to increase the supply of such writers, while the National Science Foundation is considering how it can best help promote the public understanding of basic scientific research.

Book publishers are obviously responsible for the shortage of good books. They are responsible, however, for the selection of their editors. With encouraging exceptions, it has not been a matter of policy for publishers to employ on a full-time basis editors who have a real grasp of appreciation of science. One result is the considerable unimportance evident among children’s science books. Even the best series include many titles of more or less equal as well as outstanding efforts.

Another result is a certain lack of imagination in selecting subjects. If we cite only one example, rocketry and space platforms, and trips to the moon and Mars are undoubtedly excellent prospects and serve to demonstrate the implications of fundamental laws of physics. But we can have too much of a good thing, and this area definitely has a long way to go. A belated Reticence Award to the publishers does not include a book on space exploration, or the atom, or electronics or the annual list of children’s books.

We could also use more imagination in preparing illustrative materials. In many cases an artist is called in, given a manuscript he has never seen before, and asked to prepare suitable drawings. It may not be a hurry. He works with an author who feels that the really important part of the job, the writing, has already been completed and that illustrations are something secondary, like an index or book jacket. The artist is rarely involved in a book from the beginning, and rarely enjoys the status of a full-fledged collaborator; he functions as a kind of semimenial. It should therefore be no surprise that “new” illustrations are often slightly modified versions of what have been used over and over again. A book about research demands illustration with a fresh approach as well as fresh writing.

A final point. It is possible to devote to the subject matter and still completely to convey the spirit of research. The conventional approach to concentrate on the established...
This year, at the suggestion of its Scientific Staff Advisers, NATURAL HISTORY is devoting December's reviews to a discussion of 39 current science books for older children. A general introduction has been written by John Pfeiffer, himself an experienced science writer, while Drs. Walter Fairservis, Kenneth Franklin, John Imbrie, Jack McCormick, and Evelyn Shaw—all associated with THE AMERICAN MUSEUM—have reviewed books in their special fields. It is the Editors' hope that such comments, to be published every December, will be useful not only to gift-giving adults, but also to teachers and librarians as a latter-day Diogenes' lantern lighting the crowd of science publications.

Astronomy

In reviewing this selection of astronomical books for children, I was pleasantly surprised to see many that are adequate expositions, honestly produced. But the exceptions are sad. When children start school, they learn from their teachers that all knowledge is in books. Many things that children learn from books are entirely outside their own experience and beyond the possibility of personal confirmation. They must accept the book's authority wholly on faith. What a tremendous responsibility, then, for the writer and publisher to make absolutely certain that their work is correct and exemplary in every way!

Book designers and illustrators also must respect their audience. For example, I am inclined to judge a book by its cover: usually, if it is worth reading and keeping, it is worth binding well. But, all too often, this leads to error. More than one of the books in this list was a fine piece of writing put in a bad package. More than one was beautiful to behold, but the text was sloppy and inaccurate. Which will sell more? The beautiful ones, I fear, leaving the ill-set gems to languish on the shelf.

The history of astronomy is highly dramatic, but can be made dreadfully dull by the chronicler. Happily, The Kingdom of the Sun, by Isaac Asimov (Abelard-Schuman), is a refreshing, unpretentious, highly readable account of the development of man's knowledge and understanding of the nature of the solar system from early Babylonian observations to relativistic explanations of the subtleties of the motion of Mercury. Professor Asimov writes as if he were personally telling a very interesting story to you in your living room. Over three-score astronomers are revealed to be human beings, rather than mere names. Each one of their contributions is placed in the context of contemporary understanding, so that its impact and significance may be fully appreciated.

This entertaining narrative, alas, is poorly packaged. The jacket is unimaginative and uninviting of a second glance and the binding cheap. The skimmed production seems unfair to the hard work and skill of the author.

Terry Maloney, the author of The Sky Is Our Window (Sterling), is a Fellow of the Royal Astronomical Society and is described on the dust jacket as one of England's leading astronomers. His training is evident in this book, for he has treated a wide variety of subjects with skill and accuracy. Nothing is complex, for the author has confined himself to a light survey of astronomy. As he says, "This is not a book of formal instruction on astronomy. It is not intended as a textbook or even a guide to the heavens for the observer with a telescope. It is simply intended as a book to be read for pleasure." One's enjoyment is heightened by a profusion of photographs and some of the author's own paintings (several in color), although these are not as closely connected with the text as they should be.

Inevitably, opinions will differ on which subjects to cover in such a survey. This reviewer misses any discussion of modern ideas of stellar evolution as such, and their relation to our knowledge of the structure of the galaxy. There is the standard description of a comet, but no mention of the probable basic form of a comet, developed by research in the last decade. Indeed, almost the only gesture toward the inclusion of thoroughly up-to-date information is made with a few paragraphs on radio astronomy. In spite of these few differences of opinion, Maloney's book can be highly recommended to anyone, adult or interested high school student, who has an intelligent curiosity about astronomy and who wants to be introduced enjoyably to the space that man is setting out to explore.

Margaret Hyde's little book, Exploring Earth and Space (McGraw-Hill), leads a youngster on an expedition to all parts of the earth, inside and out. Earthquakes and volcanoes are explained with examples of actual occurrences. Antarctica, the oceans, and the atmosphere are discussed. Solar energy and the sun itself are treated, along with rockets and satellites and radio astronomy. If one reads this slowly, as a child might, he will not feel that too much is crammed into a small space. The pace is rapid but exciting. The illustrations convey more information than is usual in the case of line drawings, but the captions are a little too earnest. They would do well if applied to actual photographs, or made more generally.

A book of this size and scope can give a youngster an idea of the interconnections of many different sciences all working toward an understanding and harnessing of our planet and its environment. Mrs. Hyde exhibits an uncertain knowledge of solar features, but this is a relatively minor drawback. She appears to respect her readership and to have their interests in mind.

A Publisher's Note at the back of The Story of Planets, Space and Stars, by Gaylord Johnson (Harvey House), informs the reader that it is one of a series of books in the "Story of Science" Series, aimed at children in grades three through nine. The type is large; illustrations are plentiful; the volume is light, easy to handle and attractively bound. Because astronomy is filled with unusual words from the Greek and the Arabic (which have frequently been Latinized), one good feature of this book is an attempt to indicate the common
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pronunciation of most of these words.

Beyond this, there is little complimentary to be said. One chapter, entitled "How the solar system keeps going," logically begins with mention of Newton but immediately turns to the appearance of the sky as affected by the earth's rotation and its atmosphere. The explanation of "how" occupies nineteen lines, while the rest of the chapter is devoted to miscellaneous effects of gravity and descriptions of meteors and comets—the latter incorrect. The discussion of co-ordinates and time in another chapter is interesting but unnecessary for younger children, because it contains too much material incompletely explained. A mistake in proofreading that occurs here, "One degree (1/90 of a circle) ..." may contribute to confusion. In the discussion of the sun, the source of energy is incorrectly attributed to fission rather than to fusion: "The sun splits hydrogen atoms in a reaction chain." The process is also stated as taking place in the sun's atmosphere rather than at its center. Further confusion arises when "the hydrogen particles are now fused into atoms of non-explosive helium gas," for the entire process as described is illogical.

A "young beginners' book of astronomy," The Stars for Sam, by W. Maxwell Reed (Harcourt, Brace) was originally published in 1931, and has enjoyed longevity and a good reputation, at least among non-astronomers. It has now been revised and the editor states that the guiding purpose of the revision has been to bring the material up to date while retaining "the qualities that made The Stars for Sam so appealing to so many young people over the years."

Unfortunately, awareness of the "good reputation" of the original is only preparation for keen disappointment in the revised version. In general, the writing is uneven, and sometimes tautologizing. In a discussion of falling bodies may be found: "By an interesting and simple method the distance a rock will fall at the end of any number of seconds can be determined." This statement is followed by results, but there is no indication of the "interesting and simple method."

There are several examples of faulty logic: "If anyone lives on Jupiter, he must be as queer as any prehistoric fos-sil that has ever been discovered, then there is a dense atmosphere that is always full of yellow and red clouds." "All present evidence points to the fact that the Russians did hit the moon, although in reality it will be difficult to be absolutely certain since the recent ceased sending signals once it hit a wall."

With respect to the astronomy, as it is not well either. The discussion of the sun is vague and actually incorrect in many places. Several pages are used to discuss a theory of the origin of the solar system, which has been discredited for decades. A photograph showing stages of a lunar eclipse is misleadingly purporting to exhibit the phases of the moon. Three different periods for the moon's revolution are quoted—without any indication of which phenomenon goes with which period—and all of them is wrong.

The Editor's Note acknowledges the assistance of two competent men in astronomy. It is inconceivable that either one saw very much of the finished version of The Stars for Sam or that they did, their advice was taken. One of them, intimately associated with Harvard University for many years, would certainly have pointed out that Harlow Shapley has been retired and Director of the Harvard College Observatory for nearly a decade.

The revised edition of The Stars for Sam cannot be recommended.

KENNETH L. FRANK

Geology and Paleontology

There has recently been an unprecedented demand by young readers for good books on technical subjects. Looking at a dozen books in the relatively narrow field of geology and paleontology, it is refreshing to see the efforts of some authors and publishers in facing this demand with imagination. For the most part, however, the works are wide of the mark, poorly presented or inaccurate. Obviously, one must continue to be vigilant in choosing works while reading for young people, even this specialized sector of science.
Many of the books are evidently watered-down versions of college textbooks, and this, in effect, is their flaw. For in such a case, the author is forced to cover his topics too skimply and the result, through oversimplification, tends to be misleading or confusing. The more successful books in this selection are those that sacrifice breadth of coverage for depth in a limited area, and present the material with imagination.

From Bones to Bodies, by William Fox and Samuel Welles (Walcott), provides a general history and description of paleontology. Starting with the thesis, "A Rat is Like an Elephant," the authors cleverly and smoothly explain the purpose, methods, and achievements of paleontology. Their approach, while simple, is sound: evidence used in reconstructing past life is illustrated first in a general way, and then with photographs of work in three actual case histories. The result is distinguished: accurate, interesting, well organized, and smartly illustrated.

Another introduction to paleontology, Before and After Dinosaurs, by Lois and Louis Darling (Morrow), is addressed to rather younger readers. The book is superbly illustrated with original drawings so arranged that text and illustration support each other. By restricting their theme, the Darlings have been able to present a concise but informative book, although I feel the work would have been more interesting if technical detail, some of which is unnecessary, had been replaced by comments on the mechanisms of natural selection and evolution. Also, there is perhaps too much stress on peculiarities and "wonders," of which the book tends to become merely a compilation.

A junior treatment of historical geology in textbook style, with emphasis on fossils, is provided in The Story of Earth Science, by Dr. Horace G. Richards (Lippincott). Richards, a recognized authority, covers his topic with accuracy. The later chapters on minerals are brief, but well organized and useful for identification by junior collectors.

A sharp contrast is On the Face of the Earth, by Marion Gill MacNeill (Walcott), a shallow summary of the evolution of earth and the life on it. The author fails to qualify uncertain theo-ries and occasionally skirts hard fact with vague innuendo or worse: "... ocean tides, stronger and higher than we can imagine, swept over the rock surface of the earth—washing, beating and grinding the salt-bearing rock into soil...." Or, "Scientists believe, however, that some of the trilobites may have changed enough to survive—not as trilobites, but as lobsters and crabs...." The text as it stands fails to give a clear and accurate picture.

Turning now to the areas of general geology and geophysics, three books, happily on a higher level, should be noted. The first is Great Mysteries of the Earth, by Charles H. Hapgood (Putnam). This is a bold venture, presenting in simple language the arguments surrounding the major problems of earth science—for example, the permanency of ocean basins, the cause of glacial periods, and the origin of continents and mountains. It is generally well written, and I think will arouse curiosity to know more. But in translating the material into a readable volume for young people, Hapgood has risked giving some mistaken impressions, as when, discussing the "... mystery of mammoths,..." he has incantationally, as a nonprofessional, imposed "mystery" on a subject where none exists. Despite such excursions as this, Hapgood has produced a book that should both stimulate and entertain his readers.

The Earth for Sam, by W. Maxwell Reed, revised and edited by Paul F. Brandwein (Harcourt, Brace), is an updated version of a classic survey of the evolution of our planet and the life it contains. It covers a tremendous amount of ground, and is, therefore, limited in the depth with which any single topic can be covered. Thus, it runs the risk of confusing the reader—as, for instance, in the first chapter, where several theories of the earth's development are skinned over. There are other faults, as well. The geysyncline concept—one of the most important in geology—is covered in one sentence. Again, the author mentions natural selection, but fails to identify or elaborate upon this phenomenon. Although part of the book follows the various geologic eras chronologically, the Cambrian and Ordovician periods of the Paleozoic, and the Paleo-
DNA

A complex molecule is deemed the master substance of life

By John Pfeiffer

Coiled like tiny springs in the nucleus of a fertilized human ovum are molecules of a remarkable compound known to biochemists as deoxyribonucleic acid or, more conveniently, as DNA. Half of this DNA has come from the sperm and half from the ovum itself. The sum of the two halves is exceedingly small, about two ten-trillionths of an ounce. But his minuscule total is enough to start a process in which a single cell, barely visible to the naked eye, will develop into a mature human, a highly organized community that contains some seven thousand billion cells.

DNA represents the master substance of life and growth. It is hereditary material, the stuff out of which genes are made. Studying its structure and how it works has become a major objective of present-day research in the life sciences. In fact, biology is currently in the midst of a breakthrough as significant and exciting as the recent advances in physics that led to the release of nuclear energy—and one important reason for this is science's new insight into the nature of these complex molecules.

The more we learn about the DNA molecule, the better we shall understand the subtlest reactions of living matter. It is the basic unit, the "atom," of biology. For one thing, this nucleic acid has the notable property of being able to reproduce. The cells in our bodies contain—in their genes—faithful copies of the DNA molecules in the ovum that was each of us at the time of conception. In other words, the DNA we inherited from our parents has duplicated itself many billions of times and it will continue to do so in our children and theirs for endless generations.

Reproduction is an enormously complex process, even at the molecular level, and DNA is an enormously complex substance. The discovery of its basic structure, one of the key advances of modern biology, came during the winter of 1953 at Cambridge University, England. The setting was hardly glamorous—not a shining laboratory but an unimpressive office in a sort of barracks, a space just large enough to hold two desks and a bookcase. Francis Crick and James Watson, a physical chemist and a biologist, found themselves engaged in a curious scientific game.

The game was a kind of jigsaw puzzle in three dimensions. The pieces of the puzzle were metal sheets, about the size of ordinary playing cards, but cut into different shapes representing six different substances. First was the sugar deoxyribose (the D in DNA); second was a phosphate group; and finally came four nitrogen-containing compounds known as "bases." Previous studies had shown that the DNA molecule is made up entirely of these six "building blocks," although it includes many of each type. Other evidence had hinted that the over-all shape of the molecule might be some sort of intricate coil.

Crick and Watson started fastening their metal sheets together in various ways, using rotatable joints to serve as analogies of chemical bonds. They spent more than two weeks getting nowhere before they finally hit upon a new way of putting the metal parts together to form a structure that checked with the known evidence. Then, in three days and nights of work, they assembled a model that resembled a piece of abstract modern sculpture—a double helix, two interconnected molecular strands twisted into a spiral-staircase structure.

Each strand in the model has as its foundation a long chain of alternate sugar and phosphate units. Attached to this chain at regular spacings, and sticking out as side groups, are sequences of four nitrogenous bases: adenine (A), guanine (G), cytosine (C), and thymine (T). Thus, one strand might be assembled as shown on the following page. The diagrams there represent only short sections of the chain, for each strand in a DNA molecule has thousands of these base side groups.

Now, each such DNA strand has a similar structure, and each is attached to another strand by its side groups. In other words, the nitrogenous bases not only pair off with one another, but pair according to a definite rule that Crick and Watson deduced while building their model. Adenine can combine only with thymine, and guanine only with cytosine. So two attached strands look something like a ladder or a zipper (below, in same drawing on following page). If one thinks of the two lined strands twisting like a ribbon (right, in the illustration), one has a schematic representation of the DNA molecule.

Investigators have been quick to note the biological implications of this model. Among other things, it offers possible mechanisms for the self-duplicating capacity of DNA. Imagine a solution containing the six essential DNA building blocks, including ample quantities of the four bases, plus a "parent" molecule of DNA. The two strands of the parent molecule have separated by some sort of unraveling
process. Now this solution, like most solutions, is a site of frenzied activity. Particles of the four bases are moving at high speeds in all directions. They collide with one another and with the unraveled DNA strands and, as a rule, they bounce apart after colliding. A free adenine particle, for example, bounces off an adenine or guanine or cytosine group attached to a DNA strand; but if it collides with an attached thymine group, there may be a neat fit and it may stick in place.

A sufficient number of appropriate collisions will thus produce two new DNA strands, formed on and fastened to each strand of the original molecule. In short, each of the original strands is complementary to the other and effectively serves as a template or mold that determines the other structure. The result is reproduced at the molecular level; two DNA molecules exist where only one existed before. Furthermore, because there are billions and billions of collisions in the solution every second, reproduction may occur swiftly. Art Kornberg of Stanford University prepared special solutions in which DNA “breeding” actually takes place (last year he won a Nobel Prize for his work in this field).

The Crick–Watson model is of outstanding significance for another reason. Since DNA is the main hereditary material—the physical basis of genes—differences in its makeup determine the differences among species. These differences are extremely subtle. In fact, the similarities are far more obvious than the dissimilarities.

DNA exists throughout the w
range of living things. It comes in "packets," molecules of about 15,000 "base-pairs" each. At the lowest end of the scale of life, DNA is found in many viruses—for instance, in certain tadpole-shaped viruses so tiny that more than five billion of them would fit comfortably into a sphere no bigger across than the period at the end of this sentence. DNA is also found in bacteria, and in all higher organisms from amoeba to man. It is generally constructed according to the same pattern, a double helix of paired strands, made of the same half-dozen building blocks. Moreover, the foundation chains of alternate sugar and phosphate groups are always identically the same in basic structure.

The subtle essential differences that characterize different species involve the base-pairs connecting the chains, the "rungs" of the DNA ladder. Broadly speaking, the higher we move up the evolutionary scale, the greater the number of base-pairs—that is, the longer the ladder. There may be packets containing some half-million base-pairs in the molecules of virus DNA, ten million in bacterial DNA, and perhaps ten billion or more in mammalian DNA. This is what we would expect, assuming that a more advanced species needs more DNA to transmit its hereditary traits to future generations, and this rule appears to hold in general.

But a word of warning is in order. Part of the excitement and challenge of biological research is its exquisite complexity; living things frequently fail to obey our most "logical" rules. To cite a stubborn fact, it apparently takes more DNA to form a lungfish than to form a man, and this striking exception to an orderly increase of complexity has yet to be explained.

Suppose that we had complete information (which we emphatically do not); that we knew the exact and complete sequence of base-pairs in the DNA molecules of every species on earth. Suppose, further, that the molecule packets of each species were attached and then untwisted to form a single continuous strip. In that case, we would have about two million such strips, because the earth houses an estimated two million species.

Now, according to current concepts, each one of these strips would be unique, in that its base-pairs would be arranged in a different order from those of every other species. In theory, we could study the strips one by one and "read off" their base-pairs as though we were reading information from a vast collection of ticker tapes. No two strips would read in exactly the same way and each would represent a distinct species. Thus a sequence starting "A-T, G-C, T-A, C-G, A-T . . ." might represent a jellyfish, "G-C, A-T, C-G, G-C, T-A . . ." might

Getting down to finer detail, a complete reading of base-pair sequences— theoretically—would make it possible not only to distinguish strains within each species but also individuals within strains. This is another way of saying that, excepting identical twins, no two individuals have exactly the same order of base-pairs and every individual represents a unique combination of inherited traits. This is another way of saying that, excepting identical twins, no two individuals have exactly the same order of base-pairs and every individual represents a unique combination of inherited traits.

The differences between all living things, in this conception, may be traced to the four bases in their DNA molecules: the language of heredity may be written with an alphabet of only four letters.

The amazingly precise organization of hereditary material reflects the job it has to do. DNA contains the plan or blueprint for the construction of living cells and systems of living cells. Its specifications are expressed in a code of base-pairs that includes all the information needed to synthesize that all-important class of biological compounds, the proteins. The contraction of each muscle, the action of growth-promoting hormones, the flash of electrical signals along nerve fibers, digestion and the regulation of body temperature, even thought itself—in these and all other functions, the proteins play a fundamental role.

The cycles of life would be impossible if it were not for enzymes—substances that speed the rates of biochemical reactions without themselves undergoing changes in the process. And all of the six hundred to seven hundred known enzymes are proteins. So are the thousands of different antibodies, each designed to combat the effects of a different infective agent. Yet, for all their variety, proteins—like DNA—are composed of a relatively small number of building blocks, some twenty organic units known as amino acids. Here, again, DNA has a vital and complex part to play.

RNA "factories" are shown in analogy here. Each sphere is a ribosome, afloat in cell's cytoplasm. Coded slots on sphere's surface are attached RNA molecules, the "workers" that receive and align carrier molecules drifting by.
of protein—uses its needle-like "tail" to inject "working dies" into cytoplasm of victim's cells, thus multiplying self.

Carrier molecules lock into RNA "die"—see equator of closest sphere, below—thus aligning the amino acid units they carry. Amino acids instantly link, forming a protein that breaks away to drift off through the fluid cytoplasm.
granules play a central role in our story. Known as "ribosomes," they contain eighty per cent of all RNA.

Let us take an imaginary look at the protein assembly line. Think of a single ribosome, magnified so many million times that it appears as a sphere about the size of a grapefruit. We may picture an RNA molecule, fastened securely to the surface of this sphere and containing—by way of mechanical analogy—a succession of "notches" or indentations. The working die, so to speak, is now in place.

Now, the solution in which the ribosome is constantly bathed includes large numbers of special "carrier" molecules. There are twenty different types of these molecules, and each type has attached itself to a different one of the twenty amino acid units that, in combination, make up all proteins. Each carrier type is also designed to fit into a particular notch of the RNA working die. For simplicity, our illustrations (pp. 12-13) show only four types of molecules and notches.

In the solution, the carrier molecules are moving at high speeds. They collide with one another and with the RNA working die: usually, they bounce off. But when the right molecules collide in just the right way with the right notches, they fit into place as snugly as a key in a lock and stay put. Eventually—and, in cellular terms, "eventually" may be a fraction of a second—we have the situation illustrated on the preceding pages.

What has been accomplished? As the "keys" fit their "locks," a series of amino acids, attached to their individual carrier molecules, have been put into a particular alignment. Lined up in this order, the amino acids then link to one another and separate from their carrier molecules as a completely assembled protein.

It should be emphasized that this is both a highly simplified and a highly mechanistic analogy for what is believed to be happening in protein synthesis. Proteins contain anywhere from fifty to more than ten thousand amino acids, and actual RNA working dies are correspondingly long. Furthermore, research is continuing at such a pace that our ideas about what happens will certainly be modified in the light of increased knowledge. But these schematic diagrams indicate the general picture of protein synthesis as we know it today.

The picture is a dynamic one. Every one of the thousands of proteins in the body has its specific working die, a length of RNA that occupies a key position in the amino-acid assembly line. Every second, protein molecules are being manufactured by the billion in the legions of ribosomes of tissue cells. These new molecules appear at just the right rate to replace old, broken-down molecules that have served their purposes. Life is a delicate balance between synthesis and demobilization. Survival depends ultimately on the structure and function of the self-duplicating master substance in the cell nucleus—DNA molecules passed on from parents to offspring, generation after generation.

Research on the structure and the function of DNA and RNA has created a new, rapidly expanding area of biochemical genetics. It has brought a new understanding of mutation and the possibility of new treatments for hereditary diseases. But it has done a great deal more than that. The implications of current studies are so far-reaching that they concern not only the mechanisms of heredity but every major field of biology.

To cite one example, consider what happens when a virus enters the system. Certain defense cells go into action and produce antibodies that are designed to neutralize the effects of the virus. The significant point is that a unique antibody is produced for each invader. According to one estimate, the average person may be exposed to some ten thousand different kinds of infective agents during a lifetime—and in consequence manufactures some ten thousand different kinds of antibodies.

As we have already mentioned, antibodies are proteins. This means that the vast store of RNA working dies in the tissues includes a supply of special antibody dies ready for emergency use. It also means that our genetic reserves are enormous, because each working die is shaped according to the precise specifications of its DNA "master die" in the nuclei of antibody-producing cells. So an intimate connection exists between one's resistance to infection and one's own hereditary material.

The connection goes far deeper. Viruses are hereditary material on the loose; mobile genes, themselves DNA or RNA molecules enclosed in protein shells. A struggle is going on in the body of a patient suffering from polio, smallpox, influenza, or any other viral disease. The invading virus may take over the genetic apparatus of an infected cell, so that the cell no longer manufactures its own proteins. Instead, it manufactures hundreds or thousands of new viruses, and infection may spread swiftly. This is a war to the death, a war of competing hereditary materials. The importance of understanding such processes becomes ever clearer in the light of recent work suggesting that viruses may be involved in some forms of human cancer.

In an entirely different area, nucleic acids may have something to do with the highest workings of the mind. We hold enough information in our brains to fill hundreds of thousands of volumes, and investigators are speculating about the possibility that our records of times past may be stored in the form of appropriately patterned protein molecules. If so, DNA—RNA research and brain biochemistry may bring a dramatic increase in our knowledge of memory and learning.

Finally, biologists now believe that the development of animate from inanimate matter may have involved DNA-like molecules. Perhaps such self-duplicating molecules, taking the shape in primeval waters some three billion years ago, were the biochemical ancestors of all modern organisms. Perhaps these naked genes mutated, developed protective shells to become like viruses, and gradually gave rise to cells—so that the great mainstream of evolution was under way. Ideas like these, and the accumulating body of solid evidence behind them, are signs that we are on the verge of breaching through along the entire front of biology. Basic research on this hereditary material is providing the biologists today with fresh insights into the fundamental nature of life itself.

Electron micrograph, right, shows number of RNA molecules, taken from the sperm cells of the salmon. Photo made by M.I.T. Professor Cecil H. is seen here at x200,000 enlargement.
In the summer of 1957, a group from the Institute for Films and Pictures in Science and Education in Munich, worked in the forests of Westphalia near Dülmen to observe and photograph the lives of black, green, and great spotted woodpeckers in their nesting holes. We were anxious to locate nesting trees in which we could cut observation ports and thus record the details of these birds' parental care on film.

At last, we found a black woodpecker's hole high in a fine, hundred-year-old tree in a beech forest. The pair of woodpeckers there, we knew from observation, were in the second day of incubating their eggs. With three days to go before the eggs would hatch, we started to build a blind—twenty-two feet in the air—and cut our observation port into the tree trunk. It was not until the day after the young black woodpeckers had been hatched that our labor of cutting in the nesting cavity was completed. Now, the observation glass had to be fitted to our hole without delay. The parent woodpeckers were so worked up by our presence that they flew boldly up to us as if they were going to attack. After forty minutes, the blind blacked out.

Now that the blind was finished I could not resist the temptation to climb up into it and find out what could be seen. It took some time before my eyes became accustomed to the darkness and the twilight and I could see the four sleeping youngsters. Then I heard a woodpecker's claws strike the tree. I hardly dared breathe when the big woodpecker poked his head into the nest for the first time. The bird's powerful beak, brightly rimmed, piercing eyes, and fiery nape-patch were visible only a moment. Then he withdrew frightened. This happened twice more. Several anxious minutes went by.

Only later was I told that the woodpecker had flown to a tree nearby, and from there had inspected his nest tree from every angle. Ten minutes later, I again heard him climbing up the tree trunk to the entrance hole. Then he gave his jackdaw-like call. The barriers were down.

The bird clambered about his den nest with his head down. Upon entering the nest, he had regurgitated some food into his beak and he now began to rouse the nestlings, who had heard neither his calls nor the noise.
Beak flipping upward, a black woodpecker hursts wood chips from entrance of a nesting hole under construction.

Birds stop working every four to eight minutes to throw accumulated shavings from hole, which will be their home.
his entry. The day-old young woodpeckers huddled together in a pyramid to keep warm and did not respond to the gentle touch of his chisel-like beak on their backs, necks, and wings. I saw that the parent bird had first locate swellings at the sides of the youngsters’ beaks. At his first touch on these swellings, the nestlings stretched out their necks and opened their beaks wide for food.

I noticed that the nestlings had several special markings, which enabled the parents’ task of finding their hungry beaks and feeding them during these first few days. Their beaks were tipped with white and the ends of their tongues were brightly colored, as I could see when they opened them to accept beaks to be fed. These markings appear when the youngs’ eyes open.

Our male woodpecker now rotated each youngster in turn and, to my amazement, his beak disappeared most entirely down each bird’s sky throat as he fed it. He had brought enough food that he fed each of his young three times over, and still had some left over. The nestlings had enough, however, and did not request further to the proffered food, some swallowed it again.

Feeding lasted three minutes. During this time the parent bird had hung head down. He stayed in this position some time longer while he cleaned the nest. He tapped each nestling’s hindquarters with his beak to stimulate excretion. Then he stroked the young and covered them with his soft breast feathers to keep them warm. He had to keep his head and neck stretched upwards and put his head with their fearfully sharp claws, sideways. Most of the time while he was warming his brood, he kept his beak closed but no noise escaped his attention. As soon as he heard the call of a thrush or some other small bird that was wide awake and climbed up to the entrance hole to see that all was well, he returned. Every now and then, he tapped each youngsters with his beak to see whether it needed to excrete again and then resumed his vigil.

After eighty minutes I heard a hen woodpecker making her call.
Head down in its nesting hole, a male woodpecker braces claws against hole's sides as it feeds brood by thrusting beak far down youngsters' throats. Narrow, urn-shaped nest permits the woodpecker to enter and climb down head first.
After the fifteenth day, the young birds were so big and strong that they often jostled their parents. The nestlings found their stay on the nest floor irksome. They wanted to try their beaks and tongues on the sides of the entry hole. After eighteen days, they began climbing about their nesting hole. When they were twenty days old, they were fed at the entrance to their nest.

From the time the young hatchlings until they were twenty days old, the parent birds took turns bringing food eight to twelve times a day. They fed the young every ninety minutes on the average. The first foraging flight was usually made shortly before 6:00 A.M., two hours after sunrise. The young were fed for the last time at about 5:00 P.M.

Feeding accelerated when the fledglings were twenty days old. They were almost grown, and their food intake had increased. On the twenty-fifth day, the parent birds slackened noticeably in feeding the brood. The next day, the parents sat for hours on a branch in front of their hole and uttered the loud “klee-ae” cry surprisingly often. That afternoon, we observed only one feeding. The fledglings became so hungry that they craned far out from the entrance hole, clamoring for food. With excited cries, the parents tried to coax the youngsters out. When twenty-seven days old, the fledglings dared the leap to the ground.

None of them returned. In all my observations, I have never found a pair of young woodpeckers return to the original nest once they have left it. They will spend the first several nights in the open and then seek out a suitable new dwelling hole for themselves.
Beak and tail of young woodpecker do not attain their full length until several months after bird has left the nest. Woodpecker's brain resists shocks of hammering because bones connecting beak and cranium are flexibly joined.
A Turtle of Taste

Birds, beasts, and gastronomes relish the diamondback terrapin

By George K. Reid

To the Gourmet, no reptile has ever attained the fame and esteem once held by the diamondback terrapin. From the Gay Nineties to the Roaring Twenties, diamondbacks were consumed with gusto, and at prices that stagger the imagination. As late as 1921, terrapins were reportedly selling for ninety dollars a dozen. But by the late twenties the catch began to decline and the dish’s popularity to diminish. What apparently was a dietary fad passed. Despite the grandeur that was the terrapin’s, and although United States government agencies had entered into a program of terrapin propagation and culture, little is known of the northern diamondback’s life history in its natural state. For example, we are not sure where the young go and what they do immediately after hatching: it is thought that hatchlings hibernate at bottoms of estuaries or ponds until their second year. Because few young diamondbacks have been caught in the wild, knowledge of their natural growth rate is scant. Nor is there much knowledge about seasonal foods and feeding habits. We say tacitly that these turtles live in salt and brackish water for, to date, there have been no scientific reports of diamondbacks in fresh water. Although the U.S. Fish and Wildlife Service has studied propagating and rearing terrapins at its Beaufort, North Carolina, station, mixing of northern and southern diamondbacks in rearing pens reduces the value of studies there in terms of natural terrapin behavior and life history.

The northern diamondback terrapin (Malaclemys terrapin terrapin) belongs to the same family (Emydidae) of marsh and fresh-water turtles as the common box turtles (Terrapene), map turtles (Graptemys), painted turtles (Chrysemys), and a widespread group of turtles of the genus Pseudemys. Brightly colored young of the last two groups are often sold as pets in novelty stores.

The reptilian order Chelonia is made up of a varied and exciting array of scaled, egg-laying animals whose body temperature is generally that of the immediate environment.
CRYPTODIRAN TURTLES—SELECTIVE "FAMILY TREE"

FAMILY

FAMILY TRIONYCHIDAE
- Soft-shelled turtles
  - Amyda

FAMILY DERMATEMYDIDAE
- Central American river turtle
  - Dermatemys
  - Malaclemys
  - Graptemys
  - Map turtles
  - Chrysemys
  - Pseudemys
  - Cooters
  - Chicken turtle
  - Deirochelys
  - Asiatic pond turtles
  - Terrapene
  - Tropical terrapins
  - Geoemyda
  - Clemmys
  - Box turtles
  - Pond turtles
  - Land tortoises
  - Gopherus
  - Snapping turtles
  - Leatherback turtle
  - Macrolemys
  - Dermochelys
  - Caretta

FAMILY CHELYRIDAE
- Land turtles
- Macrolemys
- Gopherus
- Leatherback turtle
- Sea turtles

FAMILY DERMOCHELYDIDAE
- Sea turtles
- Caretta

FAMILY CHELONIIDA
- Sea turtles
- Caretta

SUBORDER

CRIPTODIRA
- Cryptodira

EXTINCT SUBORDER

AMPHICHELYDIA
- Extinct Suborder

SUBORDER

PLEURODIRA
- Pleurodira

TRIASSIC
- Triassic

JURASSIC
- Jurassic

CRETACEOUS
- Cretaceous

PALEOCENE
- Paleocene

OLIGOCENE
- Oligocene

MIocene
- Miocene

Pliocene
- Pliocene

PLEISTOCENE
- Pleistocene

RECENT
- Recent

CENOZOIC
- Cenozoic

MESOZOIC
- Mesozoic
Distinguishing feature of diamondback terrapin is its way of bending its neck in a vertical plane when retracting head within shell. Diamondbacks belong to a turtle family whose members are found throughout the world except Australia.

Living turtles are divided into two suborders, the Pleurodira and the Cryptodira. The former live only in the Southern Hemisphere today, and are known as “side-neck” turtles because they bend the neck laterally when withdrawing head into shell.

Members of the Emydidae, like other cryptodirans, bend the neck vertically in retracting the head. The emydids are different from other related families (see chart) in essentially lacking a roof over the head’s temporal region, and in having three-jointed middle digits. The plastron, or lower shell, is made up of twelve bony shields with a bony connection to the upper shell, or carapace. The skin on the upper surface of the head is not broken into furrowed patterns. The front feet have five claws and the rear have three or four, usually with some webbing between claws. This family of turtles, the largest, is widely distributed over the earth—in fact, Australia is the only continent where no member of the group is found.

Diamondback terrapins (*Malaclemys terrapin*) are found only in North America, and six subspecies occur in coastal marshes and brackish waters from New England along the Atlantic coast to Florida, and westward through coastal areas of the Gulf states and Mexico. These subspecies, or races, occupy certain geographical limits, and within their ranges are generally differentiated by form and structure. However, at extremes of ranges, where distributions overlap, subspecies apparently interbreed and their characteristics blend. This phenomenon, referred to as “intergrading,” results in individuals not referable to either subspecies involved, since intergrades are usually intermediate between two subspecies. Between zones of overlap, animals may be recognized by their characteristics and may be named accordingly.

Northern diamondback terrapins (*Malaclemys terrapin terrapin*), the subspecies with which we are concerned here, are found from Cape Cod southward to the Cape Hatteras area. In the southern portion of its range,
the northern diamondback intergrades with its southern counterpart, *Malaclemys terrapin centrata*. Differences between them are slight, the best distinguishing characteristic being the shell’s shape. That of the northern diamondback is rather wedge-shaped and narrowed toward the front, while the shell sides of the southern subspecies are nearly parallel. The southern diamondback ranges to the southern tip of Florida, where it intergrades with the mangrove terrapin (*Malaclemys terrapin rhizophorarum*), the latter being recognizable by bulbous keels on the carapace’s central plates and by the absence of light-colored centers on carapace plates. Adjoining the mangrove terrapin and ranging from the lower Gulf coast of Florida to near Pensacola, the Florida diamondback is quickly recognized by bright yellow or orange centers in each plate of the carapace.

The Mississippi terrapin (*Malaclemys terrapin pileata*) inhabits the

Gulf coast from eastern Louisiana to western Florida. This subspecies has a very knobby keel on the carapace and is evenly brown or black in color, including the top of the head. In eastern Louisiana, the Mississippi terrapin intergrades with the Texas diamondback (*Malaclemys terrapin littoralis*), the latter ranging southward along the coast of Mexico. This last subspecies is uniformly dark-colored on the carapace, but the top of the head is usually white.

Habits of the northern terrapin in its environment are fairly characteristic of all terrapins. It inhabits salt creeks and estuaries, and even open seas. Although terrapins are primarily aquatic, they have been known to make long treks on land. Females, in particular, may travel over dry ground to find a nesting site. Copulation occurs in the water before the female begins her nesting mission. Indeed, there is evidence that one copulation may supply enough fertilized eggs to last the female for as long as four years. As is the case with many animals, there is a great size disparity between sexes of the diamondback. Females may grow to no more than ten inches in length, while males never become much longer than eight and a half inches or possibly six inches at most.

These turtles are omnivorous feeders, and eat crustaceans and mollusks and scavenge on nearly anything palatable. They may also eat seaweed and plants. Captive diamondbacks are fed raw fish. When cold weather prevails, diamondbacks hibernate in mud at the bottom of watercourses. They may leave their hibernacula during harsher parts of the winter.

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Female diamondback deposits eggs in nest she has dug with hind feet. After eggs are laid, female fills in nest with mud before moving back and forth to smooth edge.
During the summer of 1953, I was studying the social organization and movements of the periwinkle (Lito-
rina) in marshes of the York River in Virginia. One June morning, as I started toward the study area, I saw a
female diamondback poised on the edge of her newly dug nest, depositing eggs. Here was a chance to watch
an event seldom seen among "wild" terrapins but that had been observed often among captive animals. I re-
turned to my car for a camera, then approached the terrapin cautiously. She obliged briefly while I photo-
graphed her, but then began to move away toward a nearby stream. At-
ttempts to persuade her to finish her task failed, so I examined the nest.

The nest site was near Yorktown, where diamondbacks had lived for many thousands of years before the settling of the historic site of
Cornwallis' surrender. The nest had been dug in sand and shell material that had been used for filling a marsh
area for highway and park construction. It was about sixty feet from a tidal creek that joined the nearby
York River. The hole in which the eggs were being laid was roughly tri-
angular, about four inches across and six or seven inches deep. Seven eggs
had been laid; they were elongate and ovoid, slightly more than an inch
long and less than an inch thick.

The eggs were removed from the nest, placed in a basket containing some of the surrounding sand, and
taken to my home. There, the sand was kept moist and the basket was placed in the kitchen under the
watchful though somewhat skeptical gaze of my wife.

On a Sunday, sixty-nine days from the time the eggs were laid, I returned
home from a trip to the marsh and

Hatchlings emerge from buried eggs to face uncertain fate. Eggs and the
soft-bodied young are often destroyed by various small mammals and crows.

my wife announced that a terrapin hatchling had fallen from the table
onto her foot. A search of the sand revealed that the other eggs were also
in the process of hatching.

Diamondback hatchlings are quite brightly marked on both upper and
lower shell surfaces. The markings become duller with age. When a
baby terrapin leaves the egg, its carapace is about an inch and a quarter in
length and three-quarters of an inch wide. It probably takes seven years
for the diamondback terrapins to grow to the stage of sexual maturity.

Although the once abundant northern diamondback terrapins declined in numbers, there are indications that the
population is now increasing. Various states protect the reptiles, limiting the taking of diamondbacks to certain seasons, and restricting
sizes that may be caught for market.
To behold the animal world through the looking glass of Romanesque sculpture is to be transported to a twelfth-century realm of strange paradoxes and entrancing marvels. Certainly medieval art deals primarily with Christian themes, presenting religious narrative, dogma, and the like through human figures. Special areas of the architectural framework of every church in the Romanesque period had become established carriers of sculptural imagery whose purpose was didactic—setting forth scripture, history, doctrine, and ethics before the worshipers. The principal parts thus employed included the great space under the entrance arch (the "tympanum"); the post (the trumeau), which divided the portal at the center while supporting the tympanum; the interior and exterior capitals, and those of the cloister.

In Romanesque art, animals achieved their highest degree of sculptural prominence that they were to have in all the medieval period, sharing the favored locations in the church or almost equal terms with the figured representations, human and divine. Herein lies one paradox for, while the sense of the figured subject is fairly explicit, that of the animal carvings conceals its mystery from us more often than not. Scholarly opinion ranges from those who profess to find symbolic meaning in all the animal imageries to those who find most of them to be products of arbitrary invention. Neither extreme has been satisfactorily demonstrated and the search for the truth is still actively pursued.

One would think that the monumental trumeau—conspicuous as it must be at the center of the main portal, and compositionally bound...
OF FACT
FANCY

to the tympanum and jamb sculptures—would yield the key to the reading of its animal carvings. But this has not yet happened. The most famous of all, the trumeau of the abbey church at Souillac, left, presents an amazing tangle of such indecipherable beasts. Hybrid, winged quadrupeds with bird or beast heads, arranged in crossed pairs above each other, weave in and out of a framing trellis, twisting backwards, biting and clawing a series of animal victims, suspended helplessly on the middle axis of the shaft. It seems hardly credible that the sculptor would have been given complete freedom to invent, at will, the subject to be displayed on so large a scale at the church entrance.

In the virtually complete absence of external evidence for any interpretation at all, we must isolate whatever may be discovered of the essential ideas contained within the work itself. The theme is plainly that of violent struggle between two different animal kinds. There are the monstrous beasts and there are their victims. The former are chaotically entangled grotesques for which no names can be found. The latter are visibly differentiated from each other and their aggressors, and are depicted as recognizable animals based on a natural order in creation. The progression begins with a frog-like reptilian at the bottom (not visible here), continuing with a wild animal (of unknown species), a canine, a bird, and finally, a man. Is there, in this drama, an epic of the struggle between the creatures of the orderly world and the inchoate forces of brute darkness and evil, or is it, instead, a sort of a warning or threat held up to man, as the ruler of the animals?

Bestiary creatures decorate one face of octagonal pier in church at Souvigny. In descending order are seen hippocamp, griffin, unicorn, elephant, siren.
Siren, above, together with centaur and harpy, was carried into medieval art from classical antiquity. This figure is on a capital from La Daurade, Toulouse.

If no other monuments afford us helpful light on such questions, they do yield further animal epics of tantalizing brilliance. Among these, the trumeau of the church at Moissac (see cover) stands supreme, with its succession of paired lions and lionesses chiastically punctuating the shaft as if in some bizarre heraldry. It might seem an easy matter to apply to the Moissac trumeau one of the many known meanings of lions in the Middle Ages. Among the real and nonexistent beasts described in the bestiaries,

Cloister passage of the church of Saint-Pierre, at Moissac, displays capitals of three types—those devoted to religious subjects, to animals, and to foliage.
illustrated in the manuscripts, and carried into monumental sculpture, the lion stands first. He is identified with Christ, “the Spiritual Lion of Judah,” and is interpreted to symbolize the Resurrection. But in other contexts the lion may symbolize evil over which Christ is triumphant. The style of the Moissac lions must be termed abstract, despite their recognizable derivation from nature. And here, from the point of view of style, is another Romanesque paradox—the actual becomes abstract while the nonexistent

Gargoyles, such as these at Limoges, are carved water spouts of the Middle Ages, although the term has been incorrectly used to describe chimeras on Notre-Dame.
may become real. For all their overpowering sense of reality, the conventionalized modes of Romanesque stylization transform the contours, hair, flesh, and sinew of the lions away from natural appearance toward abstraction. Their force and vitality come from the fact that the sculptor, through line, shape, and pattern, has been able to distill the most essential qualities of surface, volume, and action of the lion, rather than attempting to duplicate its more obvious naturalistic appearance.

Thus, too, the unreal monsters of the Souillac trumeau partake of the same quality of reality, despite their hybrid components. In this instance, flesh, feathers, horns, scales and bone, which would have been conspicuously disparate and incongruous in an illusionistic style, have become all of one stuff—stylized and abstracted to the same degree throughout. In place of an implausible bogey, the sculptor’s creature assumes an awful, if bizarre, visual reality.

The weight of evidence against finding symbolic and other calculated meanings in these representations is based mainly on the text of a letter written by a competent witness during the first quarter of the twelfth century, just after these sculptures were carved. This was St. Bernard of Clairvaux, criticizing extravagant display and decoration in churches that he had just visited. He referred specifically to the sculptured capitals in the cloisters: “But in the cloister, under the eyes of the Brethren who read there, what profit is there in those ridiculous monsters, in that marvellous and deformed comeliness, that comely deformity? To what purpose are those unclean lions, those fierce lions, those monstrous centaurs, those half-men, those striped tigers, those fighting knights, those hunters winding their horns? Many bodies are seen under one head, or again, many heads to a single body. Here is a four-footed beast with a serpent’s tail; there a fish with a beast’s head. Here again the forepart of a horse trails half a goat behind it, or a horned beast bears the hinder quarters of a horse. In short, so many and so marvellous are the varieties of divers shapes on every hand, that we are more tempted to read in the marble than in our books, and to spend the whole day in wondering at these things rather than in meditating the law of God. For God’s sake, if men are not ashamed at these follies, why at least do they not shrink from the expense?” [written circa A.D. 1125.]

For this study of animal iconography, the editors are indebted to the guidance and co-operation given by Dr. Harry Bober, Associate Professor at the Institute of Fine Arts, New York University. Dr. Bober is a distinguished medievalist whose work is internationally recognized. Hans Guggenheim, who executed the cover, also spent many weeks in France photographing the Romanesque animals that illustrate this special Natural History article.

Between the lines of St. Bernard’s tirade one may read a sensitive and profound sympathy for these very sculptures and their kinds and forms could not be more succinctly characterized than in this denunciation. Their rejection, so far as symbolic possibilities are concerned, would appear to be categoric and comprehensive. Still, we need not resort to the view that these stone beasts are nothing but “follies.” St. Bernard’s position could not have been a common one or it would not have required such painstaking vehemence. No doubt there existed a vast and unforgettable lore of animal symbolism, not only in the bestiaries—which continued to be copied and illustrated to the end of the Middle Ages—but also in scriptural allusions and metaphors, especially in the Psalms, and in the terrifyingly vivid creatures of the Apocalypse.

If the hybrid sirens and centaurs of classical mythology were most systematically preserved in the bestiaries, they were also carried in the living tradition of folklore, where they retained the bewitching taint of paganism with its reprehensible connotations. The fishtailed siren was then, as it remains today, the universal symbol of man’s entrapment through sensuous delusion. Indeed, in the cardinal medieval antithesis between good and evil, deformed reptilian creatures are to be discovered everywhere in contexts that leave no room for doubt as to their sinister meaning. The type may be shown in the guise of a particular virtue, contrasted with its relevant vice. This is epitomized in the sculptures of the archangel Michael defeating the demonic dragon (pp. 30-31, top), taken to signify both the struggle between the forces of good and evil and the ultimate triumph of the heavenly hosts over the fallen angels and Satan.

The lion and ram, zodiacal beasts also relating Christ as the King and the Lamb, are from cast of marbel piece in church of Saint-Sernin, Toulou
Hell Mouth's gaping jaws await damned souls prodded forward by weapon-wielding demons at left. Like many beasts of the period, the monster is a hybrid and unidentifiable. Detail is from tympanum of west portal, church of Sainte-Foy at Conques.
Snake-entwined Prince of Darkness rules Hell, surrounded by damned and beastlike demons. At left, pride tumbles as knight falls from horse, and lovers are roped together. At right, miser's moneybag hangs from his neck. This is also on church at Conques.

Fanciful creatures adorn lintels of abbey church at Beaulieu. In top panel is lion-bodied, eagle-headed, winged griffin. In lower panel is seven-headed apocalyptic beast representing antichrist (or Rome). To its right is human-headed dragon.
The angel, symbolical of Matthew, the winged lion of Mark, the winged ox of Luke, and the eagle of John, surround Christ in Majesty on cathedral of Chartres.
Lamb, a detail of carvings over main portal of Cahors, probably has a religious symbolism, but is also a realistic study of an economically important animal.

Considering what has been said about the peculiar capacity of Romanesque abstraction for giving convincing visual shape to the fantastic, it may be expected that the real heyday of monstrous animal sculptures comes to a close with the dawning of Gothic art—in the second half of the thirteenth century and thereafter to the end of the Middle Ages. The Gothic sculptor, with the things of the actual world for his models, could find little place for the strange beasts born of Romanesque invention. But these beasts never disappeared entirely: we find them as a contrasting marginal counterpoint to the main scenes of illuminated manuscripts, in the famous drôleries of Gothic miniatures, and in the periphery of architectural sculpture. Thus, as a bizarre foil to the smiling angels and saints of the portal sculptures, the glowing demons are made to mask the waterspouts and are silhouetted against the sky as the familiar, spectral gargoyles. Of these, indeed, it may be most truly said that they are whimsical and decipherable "follies"—drôleries in stone.

Curiously enough, it is in an area of science that one special class of imagined animals becomes fixed, namely, in the constellations of the zodiac. Among the twelve signs in that imaginary belt of the heavens, seven were named for beasts, natural or mythical. The tradition by which man comprehended groups of stars by superimposing such imaginary figures is common to all the major historical cultures since the days of ancient Babylonia. While the animal symbols assumed definite, fixed forms in the illustrations of medieval books, they often took remarkably unrecognizable shapes when they emerged in Romanesque sculpture. But the permutations of single signs are of less interest, in this context, than is the use to which the cycles were put in the planning of sculptural programs. In the majestic tympanum of La Madeleine in Vézelay, the main subject—which presents Christ giving the mission to his apostles—is framed by a series of medallions that include the zodiacal signs alternating with little scenes of the activities of the months. The signs therewith provide the symbolic orientation for the central dogma, setting Christ in the heavens that embrace the widest dimensions of cosmic creation. Again, one of the faces of the octagonal pier at Souvigny shows the twelve signs. Taken together with another face, depicting the activities of the months, and one showing the animals of the bestiary, the pier may be said to comprise a symbolic compendium of natural history; the heavens (zodiac), earthly time and the seasons (occupations of the months), and the earth's animals (the bestiary).

Unique among Romanesque sculptures of zodiacal animals is an isolated marble relief slab, now in the Toulouse museum but originally part of the city's church of Saint-Sernin. It shows two seated women, each with one foot shod and the other inexplicably bare (p. 33). Each holds an animal on her lap—one a lion and the other a ram. The mystery would be complete were it not for an inscription: SIGNUM LEONIS, SIGNUM ARIETIS, HOC FUIT FACTUM T(OLOSAE) TEMPORE IULII CAESARIS. These are, then, surely the zodiacal lion and ram, and refer to an event said to have happened in the time of Caesar. The allusion derives from dim local legend that tells of two women who, in

Dolphin is crypticographic representation of Christ as ichthys, the fish—a symbol with many interpretations. This Coptic sculpture is now displayed in the Louvre.
In early Christianity, animal symbols were widely used, the fish being especially favored among those that stood for Christ. Its adoption was partly based on the pagan belief that dolphins actually saved shipwrecked sailors. The Christ fish emblem is generally identifiable as a dolphin (p. 37), and its reference is to salvation. More than that, when it was noticed that the first letters of the Greek for “Jesus Christ, of God, the Son, Saviour” formed an acrostic of the word for fish, “ichthys,” the symbol became identified with the very person of Christ. Nevertheless, the idea at the core of this animal symbolism was salvation, reiterated in other subjects, including Jonah, Daniel, and Christ as the Good Shepherd.

If we return now to the twelfth century and our subject of Romanesque art, which brings the first large-scale sculptural embellishment of the churches, we are struck by its terrible gravity. It has been said that the Christianity of this period was “a religion of threats.” Indeed, in one church after another, it is the Last Judgment that confronts the faithful as they approach the church’s main portal with its enormous tympanum. True enough, the Last Judgment reliefs usually divide the space equally between the happy blessed who have been saved and the unfortunate wretches consigned to Hell. But, if the tranquility of virtue is ordinarily apt to pale against the colorful drama of vice, this is more than ever so in Romanesque sculpture. Hell enjoyed the attentions of spirited sculptural inventions and, no doubt, afforded

One of a sequence of nonnative but realistic beasts, this bear adorns portal of church at Carennac. Collar indicates sculptor may have used tame bear as model.

Eagle capital crowned with stalking lion, above, is at Saint-Gilles-du-Gard. Animals, below, at Saint-Pierre, Aulnay, are clearly labeled: “These are elephants.”
one of the main attractions in the tympanum. In the Last Judgment at Sainte-Foy, in Conques, the activities in Hell have evoked marvelous monstrosities and tortures (pp. 34-35). There is no mistaking the calculated intention of this mournful work, for an inscription on the lintel warns: "Oh sinners... change your ways or know that a severe judgment is in store for you."

Another tympanum of the Last Judgment, in the abbey church of Beaulieu, shows a Hell in which monstrous beasts carry off sinners to torment them for eternity. In the detail reproduced here (p. 35), we find a griffin, a seven-headed beast of the Apocalypse, and parts of other beasts extending the length of the lintels. Only Romanesque style could lend such forms real force and terror, for the line is fine that separates fantasy from the ridiculous.

A second theme that found favor among the abbots who planned the church sculptures was the Majesty of Christ, showing Him in an almond-shaped aura, surrounded by the four symbols of the Evangelists. Only Matthew's symbol—an angel—employs the human figure. Mark's symbol is a winged lion, Luke's a winged ox, John's an eagle. These composites rank among the rare instances in which hybrid beasts belong to the category of positive symbolism, their textual origin stemming from the Biblical visions of Ezekiel and St. John. And if the winged ox and lion stir memories of Mesopotamian art, it is possible that Ezekiel's vision might have been colored by his familiarity with later Assyrian sculptures.

The fauna of art—painted and carved creatures of man's own creation—have often been examined for their scientific testimony as recorded observations of animals in nature and as a measure of man's empirical knowledge of zoology. Clearly, it might seem, here was logical and sound method. Its usefulness, more-

Chained apes and a camel, exotics rarely seen in France, may have been based on travelers' reports. These are on the central portal of the facade of Saint-Gilles-du-Gard.
Hunting scenes decorate church facade at Cahors.
Artist has managed to capture a sense of panic and speed as a stag, left, is pursued by giant hound.

over, could be readily demonstrated in many areas, whether in Paleolithic cave paintings or in the Renaissance drawings of Pisanello.

STRICTLY speaking, much of medieval art—and especially of Romanesque art—would be found wanting if viewed solely from this approach. Here and there we do find single animals that reveal direct and interested concern with the original, such as a bear at Carennac (p. 38), whose collar suggests that the sculptor had somewhere seen a trained bear. The splendid eagles that adorn cloister capitals and façades in Provence, however, have their ancestry in Roman sculptured remains that were still visible in the area, rather than in any studies of the species in nature. Trained apes could be seen in traveling animal shows, but such exotic fauna as elephants must have been copied from other works of art, or from pictures in the illustrated bestiaries. The sculptor of the camel on the socle of Saint-Gilles is altogether exceptional in that his relief is far superior in accuracy to those we know from manuscripts. One can only guess how he might have seen a camel or come by a reasonably accurate drawing of one.

In the main, however, one must not expect scientific naturalism in seeking to understand Romanesque animal sculptures. In its stead, we must try to recover, from the depths of primeval memory, fantasies of untrammeled childhood, its fables, dreams, and nightmares.

Also at Cahors, a mounted hunter, accompanied by his footman with bow and spear, follows a dog of modern, pointer-like appearance in pursuit of their quarry.

Aesopic figures top tympanum of Saint-Ursin, in Bourj. At center, men with dogs hunt boars and stags. At bottom are shown the activities for each month of the ye.
Brush stockade encloses Karamojong permanent settlement, seen from a nearby hillside. The interior of the settlement is divided into individual compounds, each of which belongs to a married woman. Composing the compound are houses for men, women and work.

Men, Women and Work

A man is known by

By RADA DYSON-HUDSON

In the northeastern corner of Uganda, where it borders on the Sudan and Kenya, live the Karamojong, one of a score of African tribes classed by language as Nilo-Hamitic. Karamojong tribesmen are closely related to, and speak the same language as, many of their neighbors—the Dodoth, Nyakwai, and Jie tribe nearby in Uganda, the Toposa in the Sudan, the Turkana in Kenya, and the...

Fighting sticks whistle through the air as young herdboys stage a mock battle.
sleeping and storage, as well as granaries. Cattle corrals and pens for small stock are within stockade, normally on the north side. Most women and many children remain in the settlement all year; men are often in outlying cattle camps.

In A Pastoral Society

the cattle he keeps

Nyangatom who live in a no-man’s-land between Kenya, the Sudan, and Ethiopia. The environment shared by these peoples is harsh—desert or semidesert. The rainfall is often localized and is always unpredictable. Although Karamojong-speaking tribes are pastoral at heart, regarding cattle as their most valuable possessions, those who live in areas of relatively more favorable rainfall supplement

MILKING CATTLE is a typical activity in the Karamojong’s pastoral existence,
their pastoral economy by agriculture. The Karamojong themselves live in such an area of higher rainfall. The annual average is about twenty-five inches over most of the plains and thirty-five inches or more on higher ground and near the base of the mountains that constitute the tribal area. Women practice agriculture, and much of their diet comes from agricultural products. The first love of all Karamojong, however, is cattle.

In southern Uganda, through the year, banana trees remain green and one corn crop succeeds another. There are seasonal differences during the year—some months are hotter, some wetter—but the general aspect of the countryside never really changes. Karamojong country changes each year—from burned red desert to lush green grassland to burned red desert again. During the dry season—late September to March—the sun bakes the countryside and burns the grasses; trees shed their leaves and look bleak and dead. Cattle and people grow thin as food becomes scarce. In the rainy season—April to early September—grass sprouts from the red earth, trees are once more clothed in leaves, fields are planted and grain grows and matures. Cattle become fat and sleek, and food is plentiful again.

This pattern is considered "typical." Actually, the rainfall in Karamojong country is extremely variable. Some years, ample rain may fall every month. Then the country will remain green all year. Other years, the rainy season brings only meager showers. Then water sinks but a few inches into the ground, grass scarcely grows, crops fail, red dust covers the country, and cattle and people die of starvation.

To the geographer, Karamojong country is a plateau—3,700 to 4,500 feet above sea level and two degrees north of the Equator. To the Karamojong herder, the country is rather a gently undulating plain strewn with many small hills and scattered rock piles, and ringed by four great mountains, remnants of long-dead volcanoes. From these mountains flow semipermanent springs. These, together with permanent swamps on the western edge of Karamojong tribal land, are the main sources of water for cattle during the dry season. But the most reliable sources of clear water are the central, sandy portions of major rivers. These rivers start as steep, rocky tributaries in the east, turn into broad, meandering, sandy streams in central Karamojong country, and become seasonal swamps in the west. After the torrential downpour of a local rainstorm, rivers come down in a great flood; the water level may rise six or seven feet in less than an hour. Riverbanks are undercut by the flood's immense power; trees are swept away, and sometimes cattle and people are drowned by rushing waters. The flow subsides rapidly. Within two or three days, river beds are dry again. But in the central, sandy portions, water has been stored underground.

Women come daily to fill earthen pots from wells dug in the sand. Just after the rains, the wells may be only a few inches deep, but the water level drops as the dry season
on the heads of the women back to their permanent settlements.

All permanent settlements are in a relatively small area in central Kara-
mojong country. Most are within carrying distance of a well in a sand
river and within walking distance of a rich alluvial terrace near a river-
bank, which yields excellent crops. Settlements are stockaded for protec-
tion against wild animals and human enemies and divided internally into
corridors for stock and compounds for people. Every married woman (ex-
cept a newly married bride) has such a compound, where she lives with her
children, prepares food, eats, sleeps, and entertains friends. It is her pri-
ivate domain. Each compound has a small gate where a visitor must pause
and ask permission to enter. Entering without asking is very ill-mannered.
Within the compound are one or two sleeping houses, a storage house for
domestic utensils, one or more grain storage baskets, an open fireplace,
and an open-sided shelter for protection from the intense sunshine. Even a
husband is really a guest in his wife's compound, and has no specific place
of his own there. The men's place is on the other side of the settlement—
the aperit, a sleeping place near the corrals. Older boys and young men
often eat there rather than in their mothers' or wives' compounds and
they sleep there to guard the stock from thieves and predators at night.

During the rainy season, settlement life begins long before dawn. The
first activity of the day is the women's—to churn the previous evening's
milk. Before first light, children are awakened by their mothers. Shivering
and hugging their thin bodies for warmth, they go to the cattle corral, each
child carrying a wooden tub. As a cow wakens and raises her tail to re-
lieve herself, whoever spies the movement shouts and runs across the cor-
ral to catch the urine in a tub. It is used to curdle milk, clean out milk
gourds and churns, and wash and warm the cold hands of the waiting
children. As the tubs are filled and the sky lightens, older girls and younger
wives come to the corral to begin milking—a task that must be finished
before the settlement's clouds of flies become active at dawn. A calf is al-
lowed to suckle briefly, then is tethered near its mother to the corral
fence or is held by a small child while an older girl milks the cow. The calf
may then suckle again. At full daylight, the cattle are driven from the vil-
lage to graze and calves are separated from their mothers until evening.

Cold sorghum porridge left over
from the previous evening may be
finished before the people set out
on their daily jobs, but many start the
day with nothing to eat. Men and
boys tend herds of cattle, the goats,
and sheep. Women and girls cultivate

Pushing goat into a stock pen, right,
is last task of day for 8-year-old lad.
Young wife stirs porridge in cattle camp shelter. Younger brides and nubile girls follow their husbands or friends to camps in dry season, but live apart.

Spear tip is tool for a man braiding a leather collar for favorite ox. Later, holding same spear, man was killed in cattle raid against neighboring tribe.

Walls of sleeping house are built of sticks tied with bark strips. Although fields and attend to domestic tasks—grinding grain, fetching water, and collecting firewood.

During a period of heavy work, a woman and her daughters may take a cooking pot to the field and prepare porridge at midday. The herdboys will snatch quick meals, milking the goats directly into the palms of their hands, picking wild fruit, digging edible roots, and robbing bees’ nests of honey. But the evening meal is the main meal for everyone in the settlement. It usually consists of sorghum porridge, mixed with sour milk if cattle are staying in the settlement, or with boiled herbs, fruit, fat, or dried vegetables at times of the year when the cattle are far away.

By dark, everyone has returned to the settlement. The cattle have been milked again, the evening meal has been eaten, and the settlement gates are blocked for the night with large thorny branches. For a short time, people visit between compounds to
woman, left, has two co-wives living in village, she prefers neighbor's aid.

gossip and perhaps to share a pot of sorghum beer and to sing. Then fires
are built in the sleeping houses and at the corral guards' post, untanned
cowskins are unfolded on the ground, and all settle down for the night. The
stick walls of the houses, although solid enough for shelter and to keep
smoke inside the houses, do not block the many sounds of the night. One
hears the occasional wailing of a child, the continuous, guttural coughing
of goats, the restless stamping of cattle, and hyenas howling outside
the settlement. Whoever wakes up pokes the fire, adds a log, and goes
to sleep again—until, before dawn, daily activities begin again. Interruptions
in this general routine come only when public or domestic ceremonies
are held in the village.

The days are not without change, however, for there is a yearly cycle of
activities in the settlements. October and November are transition months.
The rains have ended in September;
Sorghum is spread on cowhide in sun to keep down weevil infestation. Regular sunning can preserve grain from one harvest to next. In background, at left, is sleeping hut of woman; directly behind her is a woven basket for grain.

Grain has ripened, and the grass has dried and turned yellow. The women gather tall grasses for thatch and thresh the harvested sorghum. Skilled men weave supple branches into storage baskets for grain and replace those that have collapsed since the last harvest. As grazing becomes sparse near permanent settlements, cattle herds gradually move out toward dry season grazing areas—some only a few miles away from the settlements, others as far as seventy-five miles away from the Karamojong villages.

December, January, and February are the hottest months of the year. The men are away with the cattle, moving over dry season grazing grounds in search of grass and water. Small children go with them, particularly if the previous harvest was small and grain is in short supply; they can live on the cattle's milk. Those who can walk; the youngest are carried on the shoulders of older brothers and fathers. A few men remain in the settlements to protect the older women and nursing children who are then...
Strong adult males carry hindquarters of sacrificed ox across ceremonial ground. "Sacred" hindquarters are to be laid before assembled elders, who will pray for blessings on land, stock, and people, then feast on sacrificial meat.

throughout the dry season. The women work in a desultory fashion. They finish threshing; they sprout, ferment, and grind sorghum to prepare beer flour; they rebuild their compounds and houses that have been ravaged by termites.

In February, women begin clearing thorn trees from land to be used for fields, and building fences round cleared ground with the cut branches. Husbands return to the settlements for a few days to aid their wives in this work, often walking fifty miles or more, staying several nights, and returning again to their herds. This work of clearing and fencing is the only agricultural activity in which married men regularly help their wives. If there is a bumper crop, men may assist with the harvest, but only a man with very few cattle helps his wife cultivate her fields. Among

Dr. Dyson-Hudson, now lecturing at the University of Khartoum, and her husband, Neville, spent nearly three years with the Karamojong. They took the photos illustrating this article.

Precious water is dipped from sandy hole as cattle drink from wooden tub. Waterholes are carefully tended, since they are vital to villagers and herds.
Seated near fire, men and boys in a cattle camp talk at evening. Tree still standing near cleared sleeping area is convenient prop for the men's spears.
AERIAL PHOTO shows abandoned site of stock camp, left, and camp shared by three herds, which occupy separate corrals, subdivisions of big stockade.

The Karamojong there is rigid division of labor. The men look after stock, and animals are theirs to allocate or dispose of. Women raise crops, and grain is their private property, to keep, to share, or to trade as they wish.

Only after the season’s first good rainfall does agricultural work begin in earnest. This may be any time from late February to early May. While the ground is moist and soft, women hoe the fields and plant their seed, interplanting sorghum with cucumbers and marrows. Drought often follows a rainy spell and seeds germinate only to die. But the women re-sow at the next rainstorm and succeeding ones until mid-June.

In June, work in the fields shifts gradually from planting to weeding. June and July are crucial months, for by August the harvest size will be known. From late July to mid-August is a busy time for the children. They must be in the fields before dawn to scare away small weaver birds, finches, and doves that come in dense flocks to eat the still soft, but maturing, grain. This is the coldest time of year; in early morning, smoke rises from fires on platforms built amid the tall grain. The children drive away birds by flinging mud pellets that have been stuck to the end of long supple sticks, and shouting “kurri—kurri—kurri.” At midday the birds are less active, and the guards can rest; but in the evening the children are busy again, waving their arms and shouting until they are hoarse. Only at sunset may they return home to the warmth of the cooking fire and the comfort of the evening meal.

As the grain hardens, birds become less of a menace. Now that the crop is assured, women begin to repair and build storage houses for the coming harvest. Hills and riversides echo with their songs as they cut heavy, forked uprights, trim flexible poles, and strip bark for fiber with which to bind the poles together. Grass, carefully hoarded from the past autumn, is used to thatch the shelters. In August and September comes the harvest. Occasionally, all seeds sown between March and June mature, and a bumper crop is reaped. That is a year of great rejoicing—feasting, ceremonies, and dances mark the harvest time. Usually, however, only some crops reach maturity—barely enough to feed each woman and her family until the next year. Sometimes each rainy spell has been followed by a three- or four-week drought, and no crops ripen. Then the people face hunger in coming months.

Animals enable the Karamojong to survive such periods of crop failure. People in areas of total crop failure drive their goats to trade with more fortunate neighbors. Sometimes, although crops fail, rains have been sufficient to maintain some grasses, and cattle continue to yield milk. Or, if the cattle starve, people subsist on the meat of the animals that die. In time of famine, a man will slaughter a goat, or very rarely an ox, to feed his family. Thus, by exploiting crops and herds, the Karamojong survive environmental vicissitudes that might else prove fatal.
If their permanent settlements only were observed, the impression might be that the Karamojong are agriculturalists who also keep animals to supplement their diet. The true pastoral nature of Karamojong life is fully revealed, however, by a look at the cattle camps—infested by tall, naked, free-striding men who live as herders.

Almost without exception, every Karamojong man owns cattle—anywhere from five to five thousand head. Guarding cattle is his way of life; the animals provide both the means by which he can marry (every close relative of his bride must receive at least one animal during the wedding ceremony) and the means by which he feeds himself and his family. Optimum size for a Karamojong herd seems to be from one hundred to two hundred head of cattle. A man with less than this will join with a rich relative or friend; if he has very few cattle, he exchanges his labor for food. A man with hundreds of cattle will split his herd into smaller units, each in charge of a grown son or other close relative. Often, two men from the same settlement, each with his own herd, will share herding responsibilities as a form of insurance. One man will take a part of both herds to one area of the country; the other will herd the rest elsewhere. In a land where many cattle may be wiped out by thirst, starvation, and epidemics, or may be stolen by enemy tribes, a wise Karamojong never keeps all his stock together in one large herd.

Shifts in grazing land the Karamojong make in their semiarid country are opportunistic, and therefore complex. Several forces influence cattle movements. One is the herd leader's tendency to go each year to an area he knows well. Another is his desire to be near his settlement so he can keep in touch with his family and supply his dependents with milk. A third is his desire to go where grazing and watering conditions are best at a given time. Circumstances underlying the decision of each herd leader dif-
water at a particular place deteriorate, the camp is abandoned, at the herd leader's discretion, and the herds move to places where conditions are better. The men then make another camp. First they build a stockade to protect the livestock. Then separate corrals are made for the different herds, and finally they build shelters for themselves. The camp site may be occupied from a few weeks to several months. People who are herding in the same area often build together—for protection and for company—but each herd has its separate corral, and the decision to move is based entirely on the judgment of individual leaders. After a few weeks, some abandon a camp and seek better grazing elsewhere; others decide to stay longer.

Life in cattle camps is austere, often intensely uncomfortable, and sometimes highly dangerous. During the rainy season and early in the dry season, only men live in them. Although nights are cold, the men sleep naked in the open, near the corrals, where they can hear every noise and sense every mood of the cattle. Each man has a cowhide to sleep on; between every two men is a small fire. If it rains, each man wraps his cowhide around him for protection. Only ashamed should a shortage of brothers force her to help with the herd as she grows older. Livestock are concern of males, not pursuit for a growing girl.

As the conditions of grazing and storms are capricious. Rain may repeatedly drench one area during the dry season, leaving the rest of the plains dry. Or showers may fall first in one part of the country, then in another. It is by means of temporary cattle camps that herds are able to exploit such rapidly changing conditions.

Each cattle camp is essentially a cluster of corrals, surrounded by a strong fence and perhaps containing a few rough shelters for the herdsman. As the conditions of grazing and Herdboy's dog shares boy's food and work, is fed herbs "to make it fierce."
in a downpour will the men flee to their crude shelters of sticks and straw. When the storm ends, they return to their places near the cattle. As the dry season progresses and agricultural work in settlements is finished, young wives and girl friends visit their men. Each woman brings a pot of beer to insure her welcome. If a girl is invited to stay, she may build a small house and remain in camp until it is time to return to the settlement to clear her field. If she is not made welcome, she will stay a few nights only and then return home.

The visiting women bring their own grain, which they cook, adding to it whatever milk is given them by the herdboys, and they eat apart from the men—who now subsist mainly on blood and milk. Women build their shelters to one side of the camp, not near the men's fires. At night, a man may visit his wife briefly—but he will return to his sleeping skin to be near his cattle and guard them through the night.

When no women are available to carry it, there may be no water in camp or, at most, a few tiny gourds of drinking water. All utensils are washed in cow urine; so, long before first light, herdboys must be at the corral ready to collect it. Next comes milking. Wooden tubs, each shared by two or three boys, are lined up near the corral entrance. Each cow is milked into a long, graceful milking vessel of wood; then her milk is poured into the appropriate tub—milk from a particular cow going to a particular group of young boys for their early morning meal.

When the sun is well up, the restless stamping of the cattle, as they grow more anxious to start grazing, becomes intense. The gates are opened, and the herds leave camp, followed by goats, frisking and bleating as they scamper toward freedom. The boys call their dogs and set out to watch the herds. Younger boys—six to eight years old—watch calves. Eight- to ten-year-olds guard goats, while boys of ten years and more guard cattle throughout the day.

During the day, the camp is deserted. Small children, five and six years old, take charge of kids and lambs. These are confined in a small thorn enclosure near the camp. Grown men sometimes help with the herding. During the dry season, when water is scarce, they supervise the watering, making sure that each animal receives enough, but that none lingers at the water hole and drinks more than its share. If enemies are reported nearby (despite efforts by the British Administration, cattle-raiding between Karamojong and their eastern neighbors is a frequent occurrence), the herd leader accompanies the boys, carrying two spears and, in addition, a tough shield made from hide.

But often the men are not with the herds. They may be sitting in the shade of a tree near camp, carving stools and wooden bowls, gossiping with neighbors, or simply sleeping. However, even when they seem to be relaxed, the Karamojong are in fact very much occupied with cattle matters. While engaged in apparently aimless gossip with other men, they are learning about grazing conditions elsewhere, getting reports of cattle disease, or receiving news about enemy raids. Routine matters are left to children, but the men are ever alert—ready to supervise and guard their beloved stock from any threat.

As the sun nears the horizon, the noises of returning cattle grow. Each boy returns with his herd. Sometimes the boys also bring a tiny gourd of drinking water or a piece of dry wood for the night fires. When the cattle are safely directed to their corrals, the boys select an ox for bleeding. A braided leather noose is tightened around its neck and a blocked arrow is shot into the distended jugular vein. Blood pours out and is collected in a wooden tub. The amount of blood is carefully gauged; when the animal has been bled enough, the thong is released and bleeding stops. Shaking his head, the ox rejoins the herd. A small boy briskly stirs the blood to remove clots; it is then divided among the wooden tubs laid out for the evening meal. The mixture is the evening meal for men and boys.

Gradually, the camp settles down for the night. Should two bulls start fighting during the night, however, the owners are immediately up to pair them. Should the dogs bark in alarm, the men spring up and seize their spears—propped against a convenient tree in camp. They rush out, shouting, ready to face animal or enemy raiders. After each disturbance, the camp settles down—until just before dawn when the children must go to the corrals again to begin a new day's work.

Attendance on the needs of the cattle continues from day to day for the Karamojong, through all seasons. It is not, like agriculture, subject to periods of rest or changes of activity. He may herd close to his settlement in the wet season and far from it in the dry season, but the
Blood spurts into wooden tub from which it is doled to herdsmen and boys. It is drunk "straight" or combined with milk. When enough blood has been drawn, thong on neck of ox is released, bleeding stops, and the animal ambles off.
activities of the herder remain changeless during the whole of his life.

For the Karamojong cattle represent status as well as wealth, objects of affection as well as attention. Men sing poems to and about cattle, as well as milk them. They decorate their favorite beasts with collars and bells, as well as bleed them for food. A man marries with cattle, secures rights in his children through cattle, supports his dependents by means of cattle and, when he dies, is laid in a cow-hide and buried beneath the dung of the cattle corral.

Nowhere can this close personal attachment and identification between a man and his cattle be seen more clearly than in the Karamojong custom of “name oxen.” Every Karamojong boy is given a calf by his father: it is the first animal he owns. He shares with the calf the blood and milk he receives as his own food; he weaves for it a collar from wild sisal string, and makes a bell for it from the shell of a tortoise. He gives it names according to the colors and marking of its hide, and makes poems about it to sing while he is herding. He trains its horns into a decorative shape as they grow, hammering them with a stone and tying them into position with thongs made of leather.

The ox and his master grow together, and are closely identified. As the boy becomes a man, his name of respect is “father of” his ox—“father of the black striped ox”; “father of the ox that is patterned like an ostrich.” This joining of man and ox is more than a matter of names. If his beloved ox dies, the man will grieve, and friends will travel miles to console him.

Living in an uncertain environment, with few technological resources to protect them from caprices of nature, the Karamojong often suffer. When crops fail, men and women complain bitterly that there is hunger in the land. But when misfortune affects the cattle herds, neither men nor women openly complain: they mourn silently, as over the death of a relative. Among the Karamojong, a man without cattle is a poor man and, since he has no voice in public affairs, insignificant. Worse, he is, so far as the Karamojong are concerned, a man without purpose, without interest: it will be said of him that “He lives for nothing, he grows old in vain.”
are no women available to bring water to them, men may not have any in camp.
While playing the lead in the Broadway musical "Greeneville," the distinguished American actor Mr. Anthony Perkins phoned us from New York. We learned that he had used telescopes since boyhood, has a 4-inch refractor, and had practically memorized our booklet. He asked some questions and in June delivered of a quartz-mirror Questar. When asked how he liked it, he said, "Your booklet does not do it justice," We asked if we could quote him in this space. "Indeed yes," he replied, "but change that to read 'no catalogue could do it justice.'"

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When you finally get tired of lifting and carrying your telescope in and out of doors, tired of setting it up and taking it down in chilly darkness

When you've had enough of heavy loads, of quivering tubes and images, enough of drives that falter and slow-motions that fall short

When you finally realize that it has become too much trouble to use your telescope any more because it only gives you an aching back and a pain in the neck — when you've had your fill of the whole unhandy contrivance — send for the Questar booklet!

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Questar, as illustrated, still costs only $995 postpaid, in handmade velvet-lined English leather case. Terms are available. May we send you the booklet?
SKY REPORTER
Clusters of a hundred thousand stars
BY SIMONE DARO GOSSENER

ONLY LARGE TELESCOPES, assisted by modern photography, are capable of revealing the true appearance of those formidable stellar aggregates known as globular clusters.

To the naked eye, these objects look like ordinary stars, while a small telescope shows them as fuzzy dots, rather similar to a tailless comet. The French astronomer Messier, an ardent comet hunter, included them in his Catalogue of Nebulae and Clusters merely because he wanted to avoid pausing to wonder whether they might be comets after all.

Before the improvement of photographic processes, astronomers had no alternative but to sketch celestial objects as they saw them through their telescopes. A severe drawback of this technique is that the observer tends to interpret what he sees and may incorporate some alien features into his sketches. Witness (top, right) the drawing of a globular cluster executed by Louis Trouvelot—a noted specialist in such matters—and published in the Harvard Observatory Annals of 1874. This cluster is found in the constellation of Hercules. It is the ninety-second entry in Messier’s catalogue and, for this reason, is commonly designated as M92. The S-shaped feature in the center is wholly spurious, probably inspired by the spiral arms that are present in other celestial objects (galaxies). By contrast, a modern photograph of M92 would look almost exactly like that of M3 reproduced here, another globular cluster, in the constellation Canes Venatici (center, right).

Known globular clusters in our Milky Way galaxy number barely over a hundred. Since few have been discovered in this century, it is reasonable to assume that their total number is not much greater. About two hundred are recognized in the great galaxy in Andromeda, an almost identical twin of the Milky Way. No doubt they exist also in more remote galaxies, but cannot be observed because of their greater distance.

The one hundred-odd clusters in our galaxy form a system concentric to the Milky Way, but the volume they occupy is nearly spherical whereas the Milky Way is disk-shaped. The radius of this sphere is roughly 65,000 light-years, or more than twice the distance of the sun to the system’s center. Accordingly, many more clusters are seen in the direction of the Milky Way nucleus than in the opposite half of the sky (since about three-fourths of the system’s diameter lies in the former direction). As a matter of fact, this lopsided distribution gave the first hint that the sun is not located at the center of the Milky Way.

Individual clusters contain a minimum of 50,000 to 100,000 stars, the majority of which fill a roughly spherical space not more than thirty light-years across, with the remainder thinning out to perhaps fifty light-years from the center. Such heavy concentration suggests that distances between adjacent stars may be comparable to those between planets in the solar system. This, in turn, implies heavy gravitational effects, which can be counteracted only by fast rotation of the cluster as a whole (otherwise, the strong attraction between stars would cause the system to collapse toward its center). There is every reason to believe that the slight flattening evident in most globular clusters is caused precisely by this rotation.

These clusters are so far away that only their brighter stars can be distinguished. It is hardly surprising, therefore, that all cluster stars appear to be giants. If any ordinary stars, like the sun, are present, they are too faint to be seen. Since there is no theoretical reason to exclude such stars from these aggregations, it is quite possible that the total population of a cluster far exceeds present estimates, perhaps even by a factor of ten.

The presence of a majority of red giant stars and the total lack of interstellar gas within the cluster are interpreted as signs of old age, in accordance with current theories on the evolution of star systems. There is an uncanny resemblance between globular clusters and small elliptical galaxies — also believed to be very old. Both in brightness and in the types of stars that they contain, the two are nearly identical. Even the smallest elliptical galaxies are much larger, however, and the apparent similarity of these two classes of objects may be fortuitous. On the other hand, if there is a link between the two, no satisfactory explanation has yet been devised to account for this puzzling relationship.
THE SKY IN DECEMBER

From the almanac:

<table>
<thead>
<tr>
<th>Phases</th>
<th>Dates</th>
<th>Times</th>
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<tbody>
<tr>
<td>Full Moon</td>
<td>December 2</td>
<td>11:25 P.M., EST</td>
</tr>
<tr>
<td>Last Quarter</td>
<td>December 11</td>
<td>4:39 A.M., EST</td>
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<tr>
<td>New Moon</td>
<td>December 18</td>
<td>5:47 A.M., EST</td>
</tr>
<tr>
<td>First Quarter</td>
<td>December 24</td>
<td>9:30 P.M., EST</td>
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The sun will reach the winter solstice December 21, at 3:27 P.M., Eastern Standard Time.

For the visual observer:

Mercury, in the morning sky (—0.5 magnitude), will rise an hour and a half before the sun on December 1, and forty-five minutes before the sun on December 15. Except for the first few days of this month, its proximity to the sun will interfere with observation.

Venus (—3.7 magnitude) will be conspicuous in the evening sky. Low in the southwest at dusk, it will set at approximately 7:15 P.M., local time, on December 1, at 7:45 P.M. on December 15, and at 8:15 P.M. on December 31.

Mars, in Gemini, will be at its brightest for the year (—1.3 magnitude) at the end of December. On Christmas Day it will be at a distance of 56 million miles from the earth, its closest approach since 1958 (see below). South of Castor and Pollux, it will rise at 7:00 P.M., local time on December 1, at 5:45 P.M. on December 15, and just before sunset on December 31. It will pass nearly overhead at 2:30 A.M. on December 1, at 1:30 A.M. on December 15, and midnight on December 31, and still be high at dawn.

Jupiter, in Sagittarius (—1.4 magnitude), is approaching its superior conjunction with the sun and will be visible only in the early part of December, setting at about 6:30 P.M., local time, on December 1, and at 5:45 P.M. on December 15. A clear view of the southwesterly horizon will be required for observation. By the end of the year, the planet will set with the sun and will be lost in its glare.

Saturn, in Sagittarius (—0.3 magnitude), will be found to the east of Jupiter. Like Jupiter, it will be too close to the sun for easy observation at year’s end. It will set at 7:15 P.M., local time, on December 1, at 6:30 P.M. on December 15, and at 5:30 P.M. on December 31.

Two meteor showers may be expected in December: the Geminids on December 13, with a maximum rate of 50 meteors per hour, and the Ursids on December 22, with a maximum rate of 15 per hour (for a single observer).

Close approach of Mars:

Once every two years and fifty days, approximately, the planet Mars reaches a point where it is closest to the earth. However, the orbits of Mars and the earth are not exactly circular, and their distance at close approach varies appreciably (between 34.6 and 62.9 million miles). In this light, Mars’ approach in 1960 is not a particularly favorable one for astronomers. The shortest distance between the two planets is near its minimum value every fifteen or seventeen years. It was during such a close approach, in 1877, that the two satellites of Mars were discovered by Asaph Hall at the U.S. Naval Observatory. In the present century, these minima have occurred in 1900, 1924, 1939 and 1956; the next one will not be until 1971. Nonetheless, Mars—high and bright in the night sky—will be the spectacular object for amateur observers this winter.

The former Astronomy Editor for Nature Magazine, Mrs. Gossner, continues in that role for Natural History.
MAGNITUDE SCALE

- 0.1 and brighter
- 0.0 to +0.9
- +1.0 to +1.9
- +2.0 to +2.9
- +3.0 to +3.9
- +4.0 and fainter

TIMETABLE
December 1  11:00 P.M.
December 15  10:00 P.M.
December 31  9:00 P.M.
(Local Standard Time)
Botany and Ecology

The modern "tweenager," as children 12-16 years old may be called, is too frequently in an educational dilemma. He may be interested in several aspects of science, but finds he either cannot take all the courses he would like or that the courses do not meet his needs. To some degree, a solution for this dilemma is available in today's variety of books on almost every subject, written from almost every point of view. The seven books selected here represent only a scattering of points along the spectrum of approaches to science in current books. Generally, these selections are of higher quality. Some, however, are typical of the many books--often of extremely attractive format--that are marred by inaccuracy, incompleteness, and lack of purpose.

One is a book of the survey type. Since every science is made up of a number of areas of specialization, some are well known while others are almost unpublicized. The survey approach discusses all or a number of these areas for a given science. Margaret O. Hyde's Plants Today and Tomorrow (Whitney House) is one of the best of these. Mrs. Hyde's book properly depicts botany as a modern, dynamic, experimental science. Botanists are shown to be searching for clues to new food sources, testing the effects of radiation on plant growth and physiology, seeking new antibiotics and drugs, investigating the causes and cures of plant diseases, isolating hormones and developing growth regulators, determining environmental controls over plant growth and methods of manipulating these factors for human benefit, and even experimenting on plants in artificial atmospheres to simulate conditions in spacecrafts and on other planets. Leading plant scientists are introduced by name and their researches are clearly described in a succinct style. This book should be read by every young man or woman interested in biology, as well as by any adult who wishes to learn more about the activities of modern botanists.

The historical approach to a science is typified by Plants That Changed the World, by Bertha S. Dodge (Little, Brown). The book considers only that phase of botany known as plant exploration, telling the story of the location, exportation, cultivation, and exploitation of several well-known plants. Although the text is authoritative, it is so burdened with details of popularity and anecdotes that one tends to lose interest even in the accounts of such important products as rubber, breadfruit, cacao, and quinine. The final chapter, "A Look Ahead," attempts to indicate the opportunities for future plant exploitation but it lacks enthusiasm and presents little challenge to the student.

How to Grow House Plants, by Mildred K. E. Selman, is an example of the "applied" approach to the discussion of science. While the principal aim of this book is to provide information on the indoor culture of plants, it is also an excellent introduction to basic plant biology: not only are the "cookbook" methods of plant care given, but the reasons for each recommendation are clearly presented.

Turning now to ecology, John H. Laby's Nature and Man (Roy), typifies the scatter-gun approach. The author jumps into his subject with very little advanced preparation. As he continues his jumping, he keeps the reader abreast of the text by defining words and explaining concepts as they arise. Hiller's book also exemplifies the narrative-first-person method of writing, for the author is widely traveled and sketches every chance to develop his theme by relating it to some incident from his own journeys. Although the book includes some interesting tales of African adventure, it contains numerous errors: "The elephant is the biggest animal on earth," or "some curious obiter dicta: "Originals there were no...mammals of any kind in Australia," and some very unusual discussions of ecology. Indeed, it is a hit-or-miss in its presentation of ecological principles as to be more damaging than constructive.

THE BOBCAT of North America by Stanley P. Young
A complete study of the Bobcat, spiced with anecdotes from the author's rich experience. Presents a wealth of information from U.S. Fish and Wildlife Service files. Illustrated. $7.50.

PRAIRIE DUCKS
A Wildlife Society Literary Award winner. By Dr. Lyle K. Soila, of the famed Delta Waterfowl Research Station. 47 plates, 60 line drawings. $4.12.

THE DUCKS, GEese and SWANS of NORTH AMERICA
by F. H. Kartright

CANVASBACK ON A PRAIRIE MARSH
H. Albert Hochbaum takes you with him on an excursion into the duck country. Well illustrated. $4.50.

HAWKS, OWLS AND WILDLIFE
An exhaustive study dispelling many of the myths and half-truths surrounding these magnificent birds and showing them in their true role in the world of nature. By Frank and John Craighead. 468 pages, 68 plates, tables. $7.50.

THE STACKPOLE COMPANY
62
Another ecology book, Ted S. Petit’s *The Web of Nature* (Garden City), illustrates the developmental approach to a subject. This is the arrangement used in most textbooks: one is first exposed to a number of basic facts that are necessary to the understanding of the more complex matters in the main text. Petit’s book is an introduction to community ecology. Accordingly, it begins by presenting a highly selective assortment of facts regarding plant-animal communities, embedded in a lavish display of full-color illustrations. The greater portion of the book is a superficial survey of the principal natural communities of North America—tundra, forest, grassland, and desert. Unfortunately, the book contains a number of ambiguous and indefinite statements and many oversimplifications.

Henry B. Kane’s *The Tale of a Meadow* (Knopf) draws the reader into a day-by-day investigation of the activities of animals and plants in a small New England meadow. Mr. Kane tells his story through the eyes of a young boy. It is a convincing text, enhanced by a number of spectacular photos taken by the author. The reader participates in every experience, from the observations of a chipmunk scampering through an old stone fence row to the investigation of the depth of a snake’s concentration. Although the book contains a great amount of information on botany, zoology, geology, and ecology, the reader never feels that he is being “taught”—he is always “discovering” information. One ends up feeling that it would indeed be wonderful to observe a meadow or forest of one’s own in the same way that the boy in Kane’s excellent book has observed his.

Another approach to science is through the study of a current problem. Conservation is often publicized by this technique—which all too frequently involves a tear-filled, scaremonger treatment. However, Ivah Green’s *Wildlife in Danger* (Coward-McCann) stands at the opposite end of the rank. It fails either to excite one about the danger to wildlife, or to incite one to action to thwart such danger. *Wildlife in Danger* discusses nineteen birds, eight land mammals, and two marine mammals. The appearance of each is given, together with data on its habitat, habits, range, food, reasons for reduction of its numbers, estimate of its present populations, areas in which it is protected, laws for its protection, and methods employed to assist the recovery of some species. Most of the chapters do not offer any constructive suggestions for action in order to preserve or assist the species that is alleged to be in peril—in the discussion of the flamingo, for instance, the most positive position taken is “These beautiful birds need our protection.” The book is further marred by various erroneous reports—of birds in the twenty-nine species listed as “in danger” are already extinct—spinless statements, and a general lack of purpose.

Jack McCormick

**Zoology**

It is surprising to see, among the numbers of young people’s zoology books that are published each year, how few strike a proper balance and achieve some kind of consistency in their merits. We find that the pictures in one book are enchanting, but that the text is impossible to follow—or vice versa. We find some authors assuming that, because the reader is young, he must be written down to, and so on. What we hope for—whether to review or to read—is a book whose author selects his subject carefully, avoids the common error of including too much, organizes and presents his material clearly, and assumes that his reader is intelligent. Of the baker’s dozen of books reviewed below, only three fulfill these requirements.

Four books on animal habits and behavior are available for various ages. The youngest readers will find a few examples of behavior in George Mason’s *Animal Habits* (Morrow) under such categories as instinct, intelligence, nest-building, affection and grief, and several others. Unfortunately, the choice of activities that Mason describes is influenced by his own observations rather than by their significance, so that the book is merely anecdotal. We are told about a cat that opens a latch door, for example, and a crow that steals jewelry. These actions—which Mason explains as due to trial-and-error learning in the cat and to the crow’s attraction to bright objects—are certainly insufficient to illustrate things as complex as animal intelligence. It appears that the author is afraid to overwhelm his reader with substance and, therefore, offers gloss. Many students of animal behavior will also regret that the book opens with a chapter on instinct: to “explain” certain behavior as inborn may tend to preclude further investigation of that behavior. However, Mason should be commended on one point—he stresses that there is no need to ascribe human characteristics to animals.
HER GRANDMOTHER PEDDLES SOUP

Jong Sook lives with her grandmother in a tent. The grandmother peddles soup. She earns enough for one meal a day for herself and Jong Sook. Jong Sook dreams of school but her grandmother cannot afford the small school fees.

Jong Sook's parents fled to South Korea in 1950 seeking freedom from Communist rule in the North. They lived as refugees. After the cease fire, her father worked as a fisherman. In 1957 he was lost at sea. One month later her mother died in childbirth. A child like Jong Sook needs your friendship!

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Do-it-yourself proof of the difference between cone and rod vision is shown in The World of Feeling. Close one eye,

In another book by the same author, The Bear Family (Morrow), he leaves the general survey approach for a more specific subject: the habits of black, brown, grizzly, and polar bears. This book mixes technical information and anecdotes in a somewhat contradictory blend. A reader seriously interested in the bears' way of life will find the anecdotes bothersome and the technical information inadequate, while the reader interested in stories of Mason's experiences with bears will probably be bored by the technicalities.

Strange Travelers, by Sigmund Lavine (Little, Brown), surveys animal migrations, briefly describing periodic, sporadic and accidental movements over land, sea, and air among a great variety of creatures, from prehistoric camels to whales. Although the book is well written, informative and accurate, I wish that the author had covered fewer animals and described each in greater depth. As it is, he skips over most of the interesting problems posed by migrations: bow groups assemble, the physiological changes within the animal, and the like. I also object to the word "strange" in the title. These happenings are not strange or peculiar: they are part of normal behavior among a vast array of living forms with many different adaptations for survival. Interesting, yes; freakish, no: I think it is codding the reader in a most unfortunate way to suggest that they are.

For the 12-16 age group, I highly recommend J. D. Carty's The World of Feeling (Roy). This book, which compares the sensory systems in man and animals, is in fact one of the finest studies available on sensory functions. Carty has selected the main features of each system and, while he does not pause unduly over the more complex details, his information is everywhere abreast of the finest and most recent research. It is also stimulating in that he goes beyond the old concept of five sense organs, discussing the other senses of the body—those of heat, pressure, cold and balance—and the specialties peculiar to certain animals, such as the sensitivity to water currents in fish. All this is done in a style that both assumes the reader to be intelligent and treats him as an adult—in which spirit a short list of pertinent books for more advanced reading is also included. One only regrets that the illustrations are not crisper and done in greater detail; some are difficult to follow unless the reader has a background in physiology.

With the ever-increasing interest in oceanography, the reissue of W. Maxwell Reed's book, The Sea for Sun (Harcourt, Brace), is a timely action. Revised by Paul Brandwein, a scientist active in bringing modern biology to high school students, the first half of the book is devoted to oceanography—tides, waves, currents, water temperature, changes, and depths, all sprinkled with historical accounts of exploration and great shipwrecks. The second half discusses marine biology, from minute bacteria and algae to the great whales. These latter chapters were written by Willfrid Brown, who unfortunately suffers from an anthropomorphic tendency when describing many animals. But if the reader can overlook this failing, he will find a vast amount of information about sea life, necessarily brief and often superficial, but serving to stimulate further reading. The photographs, collected from many sources, are beautiful—in fact, superb—and an excellent index makes this book most useful as a reference.

Science on the Shores and Banks, by Elizabeth Cooper (Harcourt, Brace) has a different aim—that of instruction in the finding and collecting of living forms. Naturally, in a book of this sort considerable emphasis is placed on equipment, and there are suggestions...
on how to adapt ordinary household articles for collecting. But habits and life histories are also discussed, so that the young collector will learn more about the biology of animals and plants than would be readily apparent from his own observations. My major criticism of this book concerns its organization: it would have been far better had Mrs. Cooper divided the book into two parts, one concerned with fresh water, and the other with marine forms. As it is, the reader does not know the book's scope at the outset or, once he realizes this, where to look for treatment of a specific subject. Since the book is so poorly organized, it will never serve as a field guide and will stay in the library, to be read only between collecting trips.

For those who prefer collecting on land, Percy Morris has offered a companion volume to his other books on frogs, toads, salamanders, and snakes by publishing The Boy's Book of Turtles and Lizards (Ronald). The animals are neatly catalogued in groups, which are introduced by discussions of general anatomy and evolutionary history. As to individual forms, Morris covers identifying features, range, distribution, size, habitat, source of food, and, wherever known, something of the breeding habits. He assumes that his reader already knows how to collect specimens but gives information on their care once they have been captured. Minor errors, as when the pelvic girdle is mentioned where the pectoral girdle is meant, do not detract from this excellent book. The photographs are very good.

Younger and older amateur entomologists will enjoy two books about insects. Dragonflies and Damselflies, by Mary Phillips, and Grasshoppers and Crickets, by Dorothy C. Hogner (both Crowell). The latter book, intended for young children, is delightful—clearly written, informative, factual, and charmingly illustrated. It discusses the anatomy of grasshoppers and crickets and their way of life and it tells how to find and keep them. Some of the anatomical descriptions, in which technical terms are employed freely, should serve as models for many who write children's books. Mrs. Hogner does not feel it necessary to draw poor analogies nor to be humanistic in her exposition. Where analogies are drawn, as in a comparison of chitin with bone, they are presented in such a way as to inform, not mislead. Nor does Mrs. Hogner lack imagination: she sends readers children, for example, of the Chinese custom of keeping crickets as pets, and she may start a rage for cricket-keeping among the younger set.

For the older child with a serious interest in entomology, Dragonflies and Damselflies is a well-written, informative book. There is much technical information on the biology, life history,
habitat, and methods of collecting and preserving these magnificent, iridescent insects. The back pages contain a good listing of other books on insects, and the index makes this volume valuable as a reference source.

The next four books cannot be recommended, but they should be mentioned because they are more representative of the overall level of juvenile science books than the comparatively laudatory efforts discussed above. They are representative not only in being bad, but also, on the whole, in the particular faults they embody.

Peter Farb’s problem, in The Story of Butterflies and Other Insects (Harvey House), is an overwhelming variety of material. Any author, if he is to bring order into this chaotic welter, must show some ability to select. But Mr. Farb does not. He is far too ambitious, with the paradoxical result that instead of presenting everything, as he had intended, he gives only a scrap heap of bits and pieces. Further, the style is written “down” in a misguided attempt to simplify things. The illustrations are poor and the colors of the butterflies incorrect.

Helen Cruikshank’s Wonders of the Reptile World (Dodd, Mead), on the other hand, suffers not from an excess of purpose but from its lack. Her aim appears to have been to combine the fossil history of reptiles with the biology of living reptiles. Actually, both are badly treated, because the author has not been able to decide how to proceed. She will state a fact and never develop it. She will concentrate on highly specialized, rather than typical aspects. Her book is full of platitudes and weak statements such as this one: “Most turtles have a keen sense of smell. No doubt this helps them find food.” Enough.

Another book in the publishers’ same “wonder” series, Wonders at Your Feet, by Margaret Cosgrove (Dodd, Mead), falls into a common error we have already noted—anthropomorphism. This book is saccharine, humanistic, and rife with emoting insects. It is also so erratic as to be impossible to follow, springing from one topic to another in as little time as it takes an insect to beat its wings.

Perhaps the best of these bad books, although still very scrappy one, is C.L. Ripper’s Ground Birds (Morrow), which discusses the habits of the woodcock, road runner, ovenbird, owl, bobwhite, whippoorwill and snowy-bunting. This embraces, as one can see, a wide range of habits, and the reader wonders what rationale lies behind the selection. His doubts are fortified when, on opening the book, he finds drawings of an albatross and heron and reads that, while these are typical birds, they are not ground birds and are used only to introduce ground birds! The work is obviously organized round the drawings (done by the author), and the text consists of the author’s own field observations. Alas, there is a good deal more to zoology than that!

In sum, of the books reviewed, three are considered to be very good: The World of Feeling, The Sea for Sail, Grasshoppers and Crickets. This is not all too few, but at least these three demonstrate that it is possible to write clearly about very complex subjects and be interesting and as well.

Evelyn Sia

Anthropology

Any new book in the field of anthropology should take advantage of new knowledge—that is, it should use the wealth of information that has come only in the last twenty years, whether the researchers be ethnologists, archeologists, historical anthropologists, or whatever. Further, since anthropology is a science, such a book’s facts should be accurate. Finally, both the writing and the illustrations should be worthy of the minds to which they are directed. It would seem unnecessary for any reviewer to stress the fundamental principles, were it not for the foolishness to which so many children’s books in America have descended.

The benighted science of archaeology makes a four-part case for our dodos. Ever since Schliemann sought Troy, whole armies of professional hack historians have received substantial remuneration for describing the labors of the archaeologist. How many times, on their pages, has Arthur Evans “panted” over tombs, Howard Carter “gasped with awe” at Tutankhamen, Stephens and Catlin with wood “sweated” at Uxmal, and po...
De Perthes “begged for understanding!” It is all a horrendous spectacle.

The first two of these form part of a desperate series called the "All About Books" (Random House). Supposedly aimed at the 10–14 age group, they are described in _The New York Times_ "Book Review" as "written by authorities [sic] in each field...lively and informal in style, but not superficial...won an enthusiastic audience among fact-hungry young people..."

Nothing could be further from the truth regarding the two examples before me, _All About Archaeology_, by Anne Terry White, a housewife turned author, simply tells abbreviated adventures to the rhythm of a metronome. It contains little on the subject as a science and would give one the impression that nothing of interest has happened in the field in the last twenty years. Its companion volume, _All About Prehistoric Cave Men_, is the work of Sam and Beryl Epstein, a team that has composed over fifty books for "young readers." Here is a book "All About" prehistoric man that does not mention the Java man or South Africa, and discusses Peking man without mentioning Franz Weidenrich, the great student of the subject. One illustration shows a group of Neanderthals stabling at a large wooly mammoth in an Ice Age setting; animals and trees are appropriate to the climate, but the Neanderthals stand about half-naked, as if they were too stupid to dress for the weather. The Neanderthals would turn in their Stone Age graves if they could see this book.

_Secrets in the Dust_ (Dodd, Mead), a more pretentious effort, is written by a man described as "...a New Yorker with a great variety of interests." Raymond Holden tells his adventure stories with more detail than do some others, but they are the same tales. The "painting, gaping, avestruck, sweating" heroes of decades ago all still rush breathlessly to their Nemesis. Holden’s book is subtitled "The Story of Archeology," leaving us to infer from its gaps that the story of archeology excludes the "father of archeology," Sir Flinders Petrie (he was not one to "pant") or the present dean of archeologists, Sir Mortimer Wheeler (hardly one to be "aestruck"). The Dead Sea scrolls, the "Solar Boat" of Khufu, the decipherments of Michael Ventris, and the discoveries at Nippur, Jericho, and in the Negev—all within recent years—are given no place.

The best of the lot, _Man in the Making_ (Putnam), is written by another educated housewife, according to the jacket blurb—Estelle Friedman. More carefully researched than the others, it nevertheless betrays a naiveté that makes it a weak reed for a child to lean on. The re-creation of past life from skeletons is exemplified by those attempts at reconstruction from odd pieces of bone carried on years ago by Cuvier and by Sir Arthur Keith, as though prehistorians continually work with such jigsaw puzzles. Then there are such statements as "If a tool for scraping animal skins is discovered, the archeologist can be fairly sure that the clothing must have been made of animal skin stitched together." As one who has worked on just such problems, I should like to ask what stitching has to do with scraping. So it goes—there is some good material here, but it is buried in the ash of misstatement and error. The illustrations, by the way, are terrifying.

All details of inaccuracy and superficiality aside, the essential point is that these books are mediocre creations of amateur "scientists" who barely touch upon what is an immense and, for that matter, a practical subject. The vast perspective of man’s story on earth, his physical evolution, the dynamics of his cultural beginnings, the character of his ancient societies, the achievements of his developing mind, and the continuous experiment, failure, and success that characterize his actions in nature are meaningful topics, which archeology— as a science—examines.

If these authors had chosen to look, they would have found that library shelves are stocked with hundreds of monographs and thousands of articles describing archeological findings throughout the world. They might have learned of such techniques as seriation, Carbon 14 dating, pollen analysis, aerial photography, qualitative analysis, serology of prehistoric skeletons, obsidian dating, skin diving, and dozens of others that are at the service of archeologists. Modern archeology is no more pedantic than the primitive archeology our authors so love to describe. It is just more complex, more meaningful, and less amenable to television-style writing.
A series of magazines and books put out by American Heritage Publishing Company has sold like hot cakes almost since its inception. The formula is to use plenty of original illustrative material, combined with short, but not too elementary, texts, ostentatious bindings—and presto! Whatever the text, no one can ignore fine reproductions of original paintings, drawings, and photographs. Inspired by their success, the publishers have swept into the children's field as the American Heritage Junior Library. An example before us is entitled Indians of the Plains, but it could better be called Blood on the Plains, for a more gory book has yet to be written.

This is, in its way, a most curious venture: it purports to inform young minds about some American Indians, and yet its bias is overwhelmingly hostile to them. This is most evident in the illustration, which relies largely on the work of the white artists of the nineteenth century, but it affects the text as well, "Tomahawks and scalping knives," for instance, are given ten pages and a wealth of bloody detail, while "tribal law" is dismissed in a page. And yet the first half of the book pretends to treat of the Indians in themselves. When, in the second half, we turn to "the coming of the white man," the text merely recounts epic after sanguinary epic—the Minnesota Massacres, Custer's Last Stand, and the rest. There has been nothing like it since the Columbian Exposition of 1893.

The reader soon wonders if there were any human beings among these savages. Did they have different societies and contrasting cultures? (The book passes very lightly over the sedentary tribes.) Did they ever live in harmony with man and nature? (After all, most peoples do, or at least have done so.) Did they enjoy being Indians? But, then, if it answered such questions perhaps the book would sell.

Perhaps I may draw a final example from my own experience. I had to examine a textbook for high schools—"...the last word in the right book for American children..." said the publisher, backed by a dozen or so educational experts and their house organs. Thumbing through its colorful pages, I came to Greece. Here were nine pages, given over to the wars of Alexander; as for Socrates, he rated one sentence, and Aristotle none at all! What responsibility this represents! What a splendid foundation for America's creative leadership! It seems unfortunately clear that it is not the child that must grow up, but the publisher.

WALTER A. FAIRBIRK, JR.

The following books for older children, written by members of the staff of THE AMERICAN MUSEUM, have been published during the past year:

Franklyn M. Branley, The Moon (Crowell) -- Guide to Outer Space (Home Library Press)
Edwin H. Colbert, Dinosaurs (Home Library Press)
Brian H. Mason, Treasures Underground (Home Library Press)
John A. Moore, The Wonder of Life (Home Library Press)

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