NATURAL HISTORY

THE MAGAZINE OF THE
AMERICAN MUSEUM OF NATURAL HISTORY

VOLUME LVI

1947

TEN ISSUES A YEAR

Published by

THE AMERICAN MUSEUM OF NATURAL HISTORY
NEW YORK, N. Y.

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Search for Early Man · Flamingos · In Gorilla-land

Bubble-Bathing Bugs · Winter · 20 Million Centuries

L E T T E R S

SIRS:

South and southwest of Kiluea Volcano is the Kan Desert, a region of ash fields and fantastic lava formations, where I have often watched "wind devils," miniature whirlwinds, romp across the countryside. They range from a few to thirty feet or more in height and spin with considerable velocity.

In one section a steady, though not strong, current of air plays through some large earthquake cracks. When the wind devils arrive at the edge of a crack and meet this current, which flows in the opposite direction from theirs, they veer away or are destroyed.

It seems to take very little to deflect a wind devil, and since it is a small replica of a tornado or hurricane and subject to the same laws, couldn't a full-size hurricane be deflected by a counter blast of air, as from a man-made explosion? The wind devils rebound at the same angle at which they approach, like a ball bouncing from a wall, so I should think the angle of deflection could be easily controlled.

Since such explosions could be made over regions uninhabited by man, the explosion itself would do little harm in comparison with the storm itself.

Perhaps you could tell me whether this idea would be practical, or whether any other attempts have been made to destroy or direct the devastating whirlwinds that plague certain parts of the world each year?

MRS. HELEN S. BALDWIN.

Hilo, Hawaii

The following answer is offered by Harry Wexler, Chief of the Special Scientific Services Division, U. S. Weather Bureau:

A special study of the effect of explosions on weather was made at the time of World War I. The study led to the conclusion that these man-made explosions had no effect whatsoever in causing or altering weather patterns.

The explosions of atomic bombs in New Mexico, Japan, and Bikini demonstrated that man has discovered a source of energy that surpasses by far any other form at his disposal. However, the amount of energy released in the explosion of an atomic bomb is still practically negligible in comparison with the energy generated in a storm of hurricane intensity. To understand this more easily, one only has to compare the duration and extent of each phenomenon. The greater part of the physical energy of an atomic

Continued on page 4

Hubert A. Lowman photo

▲ GIANTS IN WHITE: lonely survivors of a race that flourished a hundred million years ago but was almost driven out of existence during the Ice Age. One of these trees can live for 5000 years if not destroyed by fire, axe, or other misfortune. A winter scene in Sequoia National Park, California

NATURAL HISTORY

The Magazine of the American Museum of Natural History

FREDERICK TRUBEE DAVISON, President ALBERT E. PARR, Director

VOLUME LVI—No. 1 JANUARY, 1947

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THE COVER THIS MONTH

Many plants have assumed weird shapes in response to environment. In desert-dwelling forms, evaporation must be reduced, and, consequently, cacti may be barrel-shaped or columnar, or they may have paddle-like branches as in the prickly pear. The body of the Hedgehog Cactus, whose flower is illustrated here in a photograpl by Tad Nichols of Tucson, Arizona, is spherical and about a foot high, suggesting a rolled-up hedgehog with spines sticking out in all directions. The spines on cactus may be plentiful enough to retard evaporation from fleshy structures, but whether straight, curved like fishhooks, or barbed like porcupine quills, they provide adequate armor against hungry animals. The name, *Echinocereus mojavensis*, says that this plant is a "hedgehog cereus," known originally from the Mojave Desert. A relative, the night blooming cereus, is a conspicuous house plant. Most cacti blossom in the daytime, and the brilliant waxlike flowers—yellow, white, flaming red, or pale violet—contrast with the deep blue of the desert sky. With the exception of the leafy cactus (*Pereskia*), all are native to the Western Hemisphere, though they have spread to Australia and North Africa to the woe of farmers.

H. K. SVENSON.

PUBLICATION OFFICE: American Museum of Natural History, Seventy-ninth St. at Central Park West, New York 24, N. Y.

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Magazine subscriptions, Membership applications, and Advertising inquiries should be sent to Charles J. O'Connor.

NATURAL HISTORY is published monthly (except July and August) at New York 24, N. Y. by the American Museum of Natural History, Seventy-ninth Street and Central Park West. Subscription price $4.00 a year, single copies fifty cents. Subscriptions to Canada, Newfoundland, and all foreign countries $4.50. Entered as second class matter March 9, 1936, at the Post Office at New York, under the Act of August 24, 1912. Manuscripts and illustrations submitted to the Editorial Office will be handled with care, but the publisher cannot assume responsibility for their safety.

The American Museum is open to the public every day in the year without charge

bomb explosion (discounting radioactivity) is expended in a matter of minutes and is confined to an area of a few square miles. A hurricane, on the other hand, maintains itself for several days and usually over an area of at least 40,000 square miles.

It has been estimated that to counteract the energy driving a hurricane having a radius of 450 miles, it would be necessary to release energy equivalent to 400,000 tons of TNT or 20 atom bombs per second over the entire area covered by the hurricane. Assuming that the expense of producing and releasing this tremendous amount of energy would not be too great, and that it would be possible to get the explosives close enough to the storm, there still remains the problem of directing the explosions. It would be absolutely necessary for the explosions to be directed downward from above the top of the hurricane in order to oppose the violent upward velocities in the storm. Any upward blast would only tend to intensify the hurricane greatly. Just how to direct the explosion downward would be a difficult problem.

The physical processes involved in artificially controlling the weather are so complex and so exposed to disastrous by-products inseparable from the beneficial results, that extensive investigation and careful tests are necessary before large-scale action can be attempted. The Weather Bureau is much interested in controlling weather and, in co-operation with other agencies, is continuing the study of methods of control that appear to have some practical value.

SIRS:

. . . I am a comparatively new subscriber to your wonderful magazine, and I sincerely enjoy every article. I read it from cover to cover and am saving each one and filing them, because they will never grow old and will make a wonderful reference. My only regret is that I didn't subscribe sooner.

MRS. KENNETH J. WILEY.
Cedar Rapids, Iowa

° ° °

From an Annual Member:

". . . Words cannot express our joy from the wonderful lectures on Thursday nights. We greatly appreciate your courtesy in allowing us to bring our friends as guests so that we can interest them in becoming members also . . ."

° ° °

SIRS:

Like many others, I was always thrilled by the many strange peoples I saw while in the Pacific. The accompanying photograph shows a native of Talesia, New Britain, wearing full dance regalia, with two boars' tusks on his chest. Several hundred natives were participating in the ceremony at the time the picture was taken, in January. 1944.

E. E. HUCKSTEP.
Alton, Mo.

° ° °

SIRS:

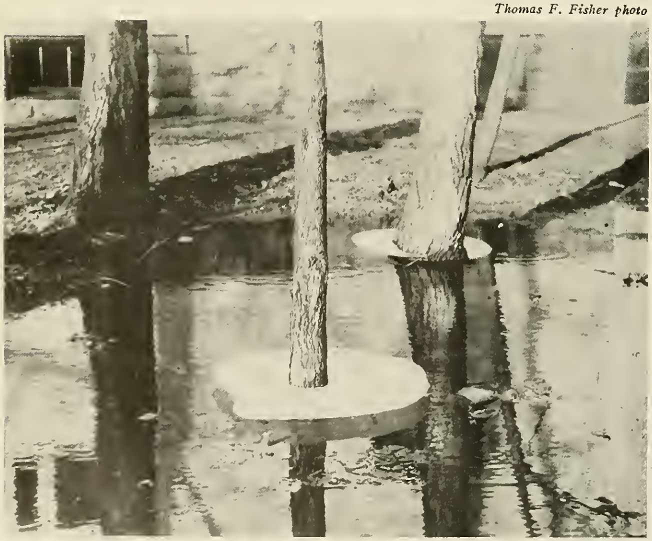
I call your attention to the accompanying photograph of an interesting "ice collar" which formed around a small tree standing in a small temporary pond near my home.

The ice ring, or collar, is about two feet in diameter and about one-eighth inch thick near the edge. It was about four inches above the water level at the time I took the picture.

THOMAS F. FISHER.
Schenectady, N. Y.

▼ ICE COLLARS

Thomas F. Fisher photo



E. E. Huckstep photo

▲ NATIVE of Talesia, New Britain

° ° °

SIRS:

A number of people were gathered recently at an evening party, and many fish stories were told. The one I mentioned was the "cuddling" of fish, the method by which it is said to be possible to place the hand in the water on the shady side of a brook and have a trout cuddle in the hand. No one believed what I said, and I want to prove

Continued on page 46

NOTICE—Readers are encouraged to submit their own photographs of natural history subjects. Those selected for publication on these pages will be paid for at $2.00 each, with full credit to the photographer. Return postage must be included.

YOUR NEW BOOKS

AUDUBON BIRD GUIDE • WORLD OF NUMBERS
THOREAU • GARDEN LILIES • MICHIGAN MAMMALS

AUDUBON BIRD GUIDE
(Eastern Land Birds)
- - - - - - by Richard H. Pough
with illustrations in color of every species by Don Eckelberry

Doubleday and Co., Inc., $3.00,
312 pages

AMONG the multiplicity of handbooks on birds, it is rare to find one that really presents new ideas in charm and practicality. The *Audubon Bird Guide*, however, surely does so both through the text of Mr. Pough and the illustrations of Mr. Eckleberry.

This volume is the first of pocket size that has solved the problem of including a colored portrait of every species within its scope and of covering the wide range of plumage dependent upon age, sex, and season. The goal has been attained with consummate success, not only because of the high aim but also because Mr. Eckleberry is fundamentally a painter, a qualification by no means true of some of the draftsmen who have illustrated books on American birds.

The author's text is remarkably concise, yet no less comprehensive. The "descriptive" technique has been abandoned in favor of the modern "diagnostic" method. The reader can learn as much from the five short paragraphs on relationship, habits, voice, nest, and range as from many a more verbose life history. I regret only that egg dimensions have been recorded in the antiquated hundredths of an inch. With all American school children learning the essentials of the metric system, millimeters would have been preferable.

Mr. Pough's introductory matter is no less practical than the rest of the book, presenting swiftly and soundly the modern conceptions of classification, behavior, distribution, ecology, conservation, and methods of bird study. The end-paper maps, which correlate the familiar North American life zones with the newer conception of biomes, are a useful addition to popular bird books.

This guide is restricted to "eastern land birds," although a surprising number of "western" forms have been pulled into it by recent field work. It is earnestly to be hoped that the author and illustrator will proceed with their collaboration in a similar work to cover North American waterfowl, shore and marsh birds, and hawks.

R. C. M.

IN THE FORESTS OF THE NIGHT
- - - - - - - - - by James Riddell

A. S. Barnes & Co., $3.00,
229 pages, 97 plates

HOW two young Englishmen went photographing animals in Kenya and among the Kivu volcanoes of the Belgian Congo is interestingly told by one of them. The other, by whom, according to the author, the book "should have been written," unfortunately perished during World War II, the outbreak of which brought the adventure to an end.

The book is partly written in support of the more than 90 photographs. Although a few of them, including the leopard (page 11) and the cheetah (page 175) are excellent, quite a number are poor, even when due allowance is made for the many difficulties that accompany flashlight photography of animals in the wild. Part of the trouble, I suspect, was caused by the humidity of the climate acting upon unexposed film in the cameras, and part to deterioration of the film after exposure and before development.

The two explorers and their African helpers worked with a battery of 20 Leica cameras and synchronizers, together with thousands of flash bulbs. These they distributed hither and yon in the forest, with trip wires of black thread cunningly set across game trails to cause unsuspecting creatures to take their own photographs.

Even though the writer emphasizes his non-scientific status, he should still hold himself responsible for the accuracy of his captions: The three-toed feet of the tree hyrax do not "prove him to be a relative of the rhino." There is an interesting account and photograph (pages 117-118) of little animals "with the skin webbing between fore and hind legs stretched taut to form a square sail." As the author says, these animals "would come planing down in a long swooping glide to end with perfect timing, in a slight upward stall, on the trunk of another tree," and so on, again. Now, there is not the slightest doubt that these little animals were African flying squirrels of the family Anomaluridae, but the author names them "flying foxes."

"Meanderthal" (page 134, *sic*), as applied to the wandering mountain gorilla, is either a feeble pun or a misprint. You can take your choice. And though zoologists will not carp at Mr. Riddell as violently as he presupposes for finding some of his gorillas up trees, they are likely to question his identification of the "lion" roaring on Mt. Mikeno at an altitude of 12,000 feet above sea level.

Amusing touches appear, such as the rule on a local golf course about picking your ball out of hippopotamus footprints without penalty. Fine descriptive passages include the congregation of elephants at dusk, the climb up to the beautiful site at Kabara saddle where Carl Akeley lies buried, and the struggle to conquer the upper slopes of the volcano Mikeno.

G. H. H. TATE.

GARDEN LILIES
- - by Alan and Esther Macneil

Oxford University Press, $3.50,
226 pages

BEFORE starting a small nursery in Vermont, the authors "had tried everything from truck farming to interior decorating," and they have brought forth, as they say, "a handbook for dirt gardeners who like to grow lilies and want information on how to grow them well." This book differs from the airy fantasies prevalent in gardening literature. The Macneils manage to touch on so many general problems of gardening, without pretense and without producing boredom, that the book is good reading. A sample of their ingenuity is the graphic presentation, on the inner covers, of flowering period combined with flower color and garden durability of various species.

Lilies are native to nearly all parts of the northern hemisphere, and one obtains quite a background from knowing geographical ranges, together with soil and climate requirements. From knowing how the lilies behave in Vermont, it is quite possible to forecast what they might do in other places. Many gardeners now accept the intellectual challenge of growing various species of a genus, rather than just a hodge-podge of garden plants. From this point of view it is hoped that this treatise, in which even scientific names are accurately spelled, will be a forerunner of many. The subjects covered are geographic sources, bases of selection and suggestions for garden placement, color variations, planting and propagation, exhibition lilies, pests and diseases, and a short history. The second half comprises a well-annotated list of lilies, in which various kinds of printer's type provide a solution for the problem of differentiating wild from horticultural varieties in the text. Well-contrasted photographs display the flowers, often nearly full size, and conventional types of bulbs are delineated. I have always felt rather vague about the classification of the Easter lily. Here it is, sure enough—*Lilium longiflorum*, from eastern Asia—and we learn, furthermore, that most of its forms are relatively hardy in our northern gardens.

H. K. Svenson.

The mammals of Michigan

- - - - - - - by William H. Burt

The University of Michigan Press, $3.50, 288 pages, 13 plates in color, 107 text figures, 67 maps

Among the several books now available on the mammals of single states, *The Mammals of Michigan* takes an outstanding place. It should appeal greatly not only to the residents of Michigan but also to all naturalists, amateur or professional. Michigan mammals, which include 64 full species and more numerous subspecies, may well stand as a type example of the continental fauna, with a blending of northern and of southeastern animals. Besides describing each Michigan mammal in an authoritative, interesting way, this book also includes excellent summaries of such broad subjects as adaptive radiation, home ranges, populations, the collecting of mammals, and classification of mammals of the world. It is an excellent work in every respect and one that anyone will be proud to own and fascinated to read. Its value is further enhanced by the physical attractiveness of the volume, which is well illustrated, well printed on good paper, and well bound. Dr. Burt, his illustrator R. P. Grossenheider, and the University of Michigan Press are to be warmly congratulated and thanked.

G. G. Simpson.

A river never sleeps

- - by Roderick L. Haig-Brown
Illustrated by Louis Darling

William Morrow and Company, $4.00, 352 pages, 12 full page illustrations

We have here numerous varied, simple adventures of a fly-fisherman. They are told so convincingly that one is confident they give a true picture. The streams and countryside of England, rivers and mountains of Northwestern America, and the personalities and habits of salmons, trouts, pikes, and other fresh-water fishes are discussed.

If a reader enjoys the out-of-doors whether as an angler or naturalist, he should find interest and pleasure in this book. The author's enthusiasm leaves one with the impression that fly-fishing is something very worth-while.

The book is conveniently divided into twelve chapters, named for the months of the year. Its stage is set in lands that lie east of oceans and therefore lack the seasonal contrasts we are accustomed to here. August deals mainly with salt-water fishing, added presumably for completeness. We may be prejudiced against this chapter because the killer whale and the blackfish are confused. Two kinds of trout would not have been!

To pick out one's favorite chapters is more difficult. Under January there is an introduction to western waters. Under December one finds a review of the milestones in English literature that have contributed to the art of fresh-water angling, together with something about knowing a river, which concludes—"A river is never quite silent; it can never, of its very nature, be quite still; it is never quite the same from one day to the next. It has its own life and its own beauty, and the creatures it nourishes are alive and beautiful also. Perhaps fishing is, for me, only an excuse to be near rivers. If so, I'm glad I thought of it."

J. T. N.

The world of numbers

- - - - - - - by Herbert McKay

Cambridge University Press, London; Macmillan Company, New York, $2.50, 198 pp.

Although there is little direct natural history in this book, there are many mathematical facts and figures that have a bearing on matters with which naturalists have to deal. Much of the text concerns the standards of measurement of natural phenomena such as the energy of the sun, the planetary motions, the mass of the earth, the brightness of the stars, and similar items. The methods and calculations used to derive these standards are interestingly explained, and corollary figures of wider interest are freely interspersed.

Thus we are told that about six million years would be needed for all the oceans of the earth to empty over Niagara, while the volume of Lake Superior, alone, would keep the Falls in operation for 124 years. The Amazon could supply the world's population with 800 gallons of water per day per person. The coast of England is eroding at the rate of a mile per 5000 years (giving an annual loss of 220 acres), while the coal consumption in that country is proceeding eight times as rapidly, calculated by the volume. At the same time, rain and river erosion is lowering the land level, with its present average elevation of 500 feet, at the rate of one inch in 250 years. At the rate of erosion in the Mississippi Valley (one-twentieth of a cubic mile of solid matter carried to the sea per year), the entire North American continent could be reduced to sea level in eleven million years.

The circumstances that produced the solar system are discussed, and the odds (800 million to one) are calculated against a recurrence of the phenomenon during the life of the sun. Some of the factors that permit life on the earth but not on the other planets are recounted. The author supports the interesting theory that if civilization had originated in the southern hemisphere, the human race would have developed a preponderant left-handedness through observing the apparent motion of the sun in a northern sky from right to left instead of the reverse.

There are enjoyable descriptions of other mathematical problems such as squaring the circle and the calculation of pi, the quantity $\sqrt{-1}$, various magical and symbolic numbers, favorite numbers of poets, and certain curious coincidences. Even the possibilities of nuclear energy have their place, although it required a postscript to the pertinent chapter to bring the subject into focus with developments more recent than the date of original composition of the text.

While the book will, naturally, appeal most strongly to readers with a mathematical turn of mind, there is a great deal in it to interest the general public who may discover unsuspected ways in which mathematics enters into human affairs. The author's genial style makes even the more complicated formulae as simple as their intrinsic nature permits, and the careful explanations of the processes make the account readable as well as informative.

JOHN T. ZIMMER.

THOREAU'S WALDEN
A Photographic Register
- - - - by Henry Bugbee Kane

Alfred A. Knopf, 169 pp., $4.00

HENRY B. KANE of the Massachusetts Insrtute of Technology, one of the most expert and sympathetic nature photographers, has included in this attractive volume more than 80 full-page photographs of his own portraying Walden Pond and vicinity. The end-paper map of the Walden Country in Concord and Lincoln, Massachusetts, made by Mr. Kane, shows many locations mentioned by Thoreau, with the latter's names. The places of which, or from which, photographs were taken, are identified by clearly printed but inconspicuous page numbers.

An appreciative introduction to the volume has been written by Brooks Atkinson of the *New York Times*, whose *Henry Thoreau, the Cosmic Yankee* proclaims him a devoted Thoreauvian.

Living in the town of Lincoln only about two miles from Walden Pond, Mr. Kane has found it convenient to keep this famous little body of water under close observation during all seasons of the year and in all kinds of weather. The excellence of his photographs depended much upon his waiting for just the right time of day for the best lighting and cloud effect, and upon his patience in choosing the season that would most effectively show the progress of plant and animal life through the year. That he has eminently succeeded in his project will be admitted by all naturalists and nature photographers.

Each photograph has an extensive and well-selected caption, a direct quotation from *Walden*. The frontispiece, which is a photograph of the entrance to the pine woods near Sandy Pond, has the following appropriate and revealing caption: "I went to the woods because I wished to live deliberately, to front only the essential facts of life, and see if I could not learn what it had to teach, and not, when I came to die, discover that I had not lived."

Mr. Kane, who is not only an artist-photographer but also a poet naturalist, has given us a handsome book of superb photographs beautifully reproduced, which enable us to visualize the objects of nature in which Thoreau saw himself reflected and interpreted.

CLYDE FISHER.

WALDEN OR LIFE IN THE WOODS
- - - - - - by Henry D. Thoreau Illustrated with 142 Photographs, an Introduction and Interpretive Comments by Edwin Way Teale

Dodd, Mead and Company, $5.00, 386 pp.

MR. TEALE quotes from one of John Burrough's essays on Thoreau the statement that "all our other nature writers seem tame and insipid beside Thoreau." This appraisal reminds me of a remark that Burroughs once made to me on a visit with him at Woodchuck Lodge. After discussing some surprising but unimportant shortcomings of the Concord naturalist, Burroughs said, "After all, I would rather be the author of *Walden* than of all the books I have ever written."

Nearly 50 different editions of Thoreau's masterpiece have been published in less than one hundred years. The edition under consideration differs from its forerunners in that it is more copiously illustrated than any that have preceded it. Mr. Teale, who made all the photographs, is an expert nature photographer, but it seems to this reviewer that the plates in the book do not quite do justice to his photographic artistry.

The editor, who is the same person as the photographer, has written a fine interpretive introduction to the book, as well as head-notes containing welcome information for each individual chapter.

The attractive illustrations include pictures of the various houses in which Thoreau lived, Thoreau's original map of Walden, and aerial map of the Walden region, drawing of Thoreau's hut by his sister, his quill pen and ink-stand, notebooks, spy-glass, and other implements. Also there are many beautiful photographs of trees, shrubs, flowers, and other plants of the vicinity which Thoreau saw and about which he wrote, and many fine studies of Walden Pond itself, particularly of Deep Cove, where his cabin was located. A century ago, in this cabin, Thoreau lived for two years, during which he kept up his wide travels in Concord and did much of his stimulating writing.

CLYDE FISHER.

SEARCH for Early Man

For half a century scientists have dug and delved in the far corners of the earth for pieces to complete the jig-saw puzzle of man's primitive ancestry. There is now evidence that our distant forefathers were giants

By G. H. R. von Koenigswald

Paleontologist of the Geological Survey, Bandung, Java

IN the last 150 years we have learned much about the history of our planet and the development of its plant and animal life. The oldest rocks of the earth show that at first there was no life. Then appeared lowly animals without backbones, the invertebrates. Next the fishes and amphibians came on the scene; then the reptiles, including the mighty dinosaurs, and last of all, the mammals. Some groups of animals disappeared, while others flourished. Some developed very slowly, others rapidly; but they all kept changing in an eternal process we call evolution.

Only after a vast number of observations and discoveries had revealed something of the history of animal life did people begin to realize that the human race, too, had had an ancient history.

Generally speaking, the preserved remains of prehistoric animals are by no means rare. You can find ancient shells by the million; the bones of dinosaurs and other reptiles are more precious. But when it comes to the remains of our own ancestors, we have to confess that they are among the greatest rarities. With the exception of Neanderthal Man, who is just one step away from us and who lived toward the end of the Ice Age only 100,000 years ago, we have had until recently only a few fragmentary bits.

Neanderthal Man was forced by the cold climate of the last glacial period to live in caves, and this has made it relatively easy to discover his dwelling places, workshops, and burials. But when it comes to the people who lived in the warm interglacial periods or in tropical regions where there were no marked climatic changes, we need a lot of patience, endurance, luck, and hard work. It is significant that none of the more important finds in this class have been made by accident. Schoetensack waited 20 years for the Heidelberg jaw, Berckhemer nearly as long for the Steinheim skull. When a human tooth and some other fossils came to light in a Peking drugstore in 1900, Davidson Black had to search the region around Peking most carefully in order to find Chou-kou-tien, the site of Peking Man. And all of our finds from Java, which form the subject of this article, are the result of a long and systematic search.

The discovery of early man in Java begins with an *idée fixe*. Eugene Dubois (1858-1940) had just finished his studies in the Netherlands in 1883 when he went to Indonesia, possessed with the idea that he could discover there the oldest remains of man. He was a young man and was very much impressed by Darwin's and Haeckel's ideas on evolution. Lydekker had discovered in the Siwalik fauna of India the upper jaw of an anthropoid ape, which he thought might be an ancient chimpanzee. As the same fauna was known also in Java, Dubois concluded that Java and Sumatra, whose tropical climate had not been influenced by the Ice Age, must be especially favorable places in which to search for the origins of man. He went to the Indies as a medical doctor in the service of the Royal Dutch Army and published his ideas in Batavia. He was lucky enough to arouse the interest of the authorities and, with the full support of the Government, was transferred to the Mining Bureau in Batavia to do paleontological research.

He went first to the vicinity of Padang in Sumatra and began, in "European fashion," to excavate in caves. This turned out to be very disappointing. It is commonly believed that caves in the tropics are inhabited by bats, snakes, ghosts, scorpions, evil spirits, and lizards, and it would seem that this belief is as old as mankind, for caves have nearly always been avoided

DR. VON KOENIGSWALD and *Pithecanthropus robustus,* a human type even older than the classical Java Ape-Man. In the reconstructed skull, the author is pointing to the "simian gap," a feature typical for the apes (gorilla, *lower left*) but absent in modern man (*upper left*) *AMNH photo*

von Koenigswald photo

▲ SCENE of the discovery of Dubois' *Pithecanthropus erectus,* at Trinil, Central Java. The skull was found in the opposite bank of the stream below the water level shown in this photograph, which was taken in the wet season

▼ A REPLICA of the original *Pithecanthropus erectus* skull found by Dubois in 1891 (*left*) compared with the more complete specimen, *Pithecanthropus* II, discovered by Dr. von Koenigswald in 1937

A.M.N.H. photo

▼ WHERE *Pithecanthropus* II was found, near Sangiran, Central Java. Dr. von Koenigswald is holding a portion of the skull

von Koenigswald photo

by man. The only interesting finds Dubois made there were some teeth of the orangutan, which is now extinct in Sumatra. This large ape is actually regarded as a kind of man by the Malayans, from whom we get the word "orangutan," meaning "forest man."

Upon receiving a human skull that had been found in Wadjak, near the southern coast of central Java, Dubois was inspired to go to that locality. There he found the remains of a second specimen. Wadjak Man is an extinct primitive type of modern man, perhaps related to the Australian aborigines. Whether he should be regarded as "fossil" is uncertain, for the age of the associated fauna that Dubois collected has never been determined. But from what we know from other localities in Java, these finds cannot be very old and probably should be regarded as only "prehistoric."

From Wadjak, Dubois moved north into the interior of central Java. Large fossil bones, belonging mostly to extinct elephants, had long been known to the natives, who believed they belonged to giants, *raksasas,* the guardians who watch every temple in Bali and ancient Java. Near Madiun, Dubois collected the first fossilized bones of larger mammals, including elephants, hippopotamuses and hyenas, and he also found a very small fragment of a human jaw. He concluded that these remains must be of Pleistocene Age, the geological period popularly known as the Ice Age.

Then, moving west, Dubois discovered a very rich site not far from Ngawi, near Trinil, on the banks of the Solo River. This site could only be worked at low water level during the dry season. It was here that Dubois, in October 1891, made his famous discovery—the top of a very low skull with a bony ridge above the eyes. He believed that it belonged to a fossil chimpanzee, the same chimpanzee that Lydekker had described from the Siwalik in India. But in August of the next year he found, only about 50 feet from this find, a complete human thigh bone. It was so human in the characteristics developed for man's erect posture that it could almost have belonged to a modern man. Dubois combined his two finds and in 1894 surprised the world with his famous publication, "*Pithecanthropus erectus,* a Human-like Transitional Form from Java."

The world was shocked. *Pithecus* means "ape;" *anthropus,* "man"—the "Erect-walking Ape-Man" from Java! Not without purpose had he chosen this name, which had been coined by Haeckel in 1868 for a hypothetical being which should link man with his anthropoid ancestors. Was Dubois' *Pithecanthropus* the "missing link?" No other fossils have ever been discussed by the public with so much vehemence. Man or ape? You can scarcely open a standard book on anthropology, zoology, paleontology, evolution, or prehistory without finding a picture of this celebrated fossil.

The reason for the many different and contradictory opinions is clear; the find (we mean the skull) is too incomplete. The most important part, the region behind the eyes on both sides, is missing, and interpretation of the fragment is indeed difficult.

Dubois tried to find more material that might solve the question, but without success. Nor did the German Selenka Expedition, which worked in Trinil in 1907-1908, find anything belonging to *Pithecanthropus.* However, they published a description of the animal remains from this geological horizon, which filled a great gap in our knowledge. It proved that this fauna, which Dubois had tried to make Pliocene (from one to seven million years old), could not be older than Pleistocene (a million years old at the most).

In 1929, news came from China that Davidson Black had succeeded in finding the skull of Peking Man. And Peking Man was really a man, not only from the anatomical point of view, but because he already knew the use of stone implements and fire. In describing the skull, Black found that it resembled the skull of *Pithecanthropus* in so many features as to indicate a close relationship between the two. So by analogy it became clear that our Java Ape-Man was a human being, in spite of his primitiveness.

Curiously enough, now that everyone else was convinced, Dubois changed his opinion completely. Basing his new ideas only on very theoretical speculations, he now regarded his *Pithecanthropus* as a gigantic gibbon, denying every relationship with Peking Man.

It seemed that the only way to convince Dubois would be to find a more complete *Pithecanthropus* skull in Java. An opportunity came when the Geological Survey of the Netherlands East Indies was established and began the systematic geological mapping of that region. In 1930 I went to Java to join the Survey as a paleontologist. Our headquarters were at Bandung, a beautiful town in the mountains of western Java. From the first moment, I hoped for a chance to solve the puzzle of *Pithecanthropus.*

We gradually collected enough specimens to learn that the animal life of Java had not been as uniform as Dubois had led us to believe, and that with the help of certain guide-fossils, it was possible to classify rock formations that were otherwise quite similar. A correlation with the formations in India could be worked out, and we could prove that Trinil was not

A.M.N.H. photo *von Koenigswald photo*

PITHECANTHROPUS III, found in 1938 not far from No. II and in same geological level. Sand and volcanic ash are still attached to the skull. (*Right*) Site of the discovery quite as old as Dubois had suggested. At least three horizons of Pleistocene Age were represented. We showed that Trinil was of middle Pleistocene Age, which means that *Pithecanthropus* lived about 300,000 years ago.

It was shortly after my arrival in Java in September, 1931, that my colleague, the late C. Ter Haar, discovered a high-level river terrace on the Solo River north of Ngawi, at Ngandong. He brought back quite a collection of fossil bones, and this encouraged the Survey to start excavations immediately. Among the first specimens sent to Bandung were, to our great surprise, fragments of two human skulls with low, receding foreheads. They were more primitive than modern man but more advanced than *Pithecanthropus,* and they represented a type which might be classified as neanderthaloid. From the geological point of view also, this so-called "Solo Man" was younger than Trinil Man.

During the excavations in Ngandong, which lasted until December, 1933, we found more than 25,000 bones, mostly belonging to elephants, rhinoceroses, hippopotamus, deer, and cattle. One of the most striking animals was a water buffalo whose horns spread more than two yards from tip to tip. Among this enormous collection were fragments of eleven human skulls and two shin bones. No other parts of man were discovered. As all the skulls had been broken and damaged in a very peculiar way, it is probable that they had been used by the ancient people as "skull bowls."

My first personal encounter with Early Man came on a hot day in June, 1937. A report had come that our workers in Ngandong had found what might be a human skull. They had left the find untouched and were waiting for assistance. So we went out – slim, always good-humored Ter Haar and I. We went by train to Ngwai and then set out on foot for the Solo River, followed by a whole caravan of coolies carrying our baggage on bamboo poles on their bare shoulders. It was about six miles to the site. We passed through the dense teakwood forest of the Kendeng Hills, and then, quite suddenly, we were standing on the bank of the Solo River. Our excavation was almost within the small hamlet of Ngandong, which consisted of only a few bamboo huts. Sixty feet or so above the river, spared from erosion, was a very limited remnant of a gravel deposit, only about one to three yards thick. From this came all our bones.

Our collectors had covered the precious find with sand for protection. We carefully began to remove the earth. Then, suddenly, there came to light the object we had expected but were thrilled to see –the upper part of a human skull! It lay upside down in the gravel, partly covered by a cemented crust of sand. I was so excited that I over-exposed all of my pictures! It was skull No. VI, the finest specimen in the whole series of Solo skulls.

For *Pithecanthropus* himself we had to wait longer. In 1936 my colleague Duyfjes, a very able

von Koenigswald photo *A.M.N.H. photo*

▲ Fragments of *Pithecanthropus robustus* (No. IV), with Dr. Weidenreich's restoration of the skull. Note thickness of skull compared with a modern skull (*lower right*)

◄ *PITHECANTHROPUS* IV was found where the man is squatting

A.M.N.H. photo

▲ **(*Left to right*): Lower jaws of modern man, *Meganthropus* (reconstructed by Professor Weidenreich), and gorilla**

➤ **Part of an enormous human lower jaw found in 1941: evidence of a giant human ancestor, known scientifically as *Meganthropus palaeojavanicus***

young geologist who died in a prison camp during the war, had one of our native collectors working near Modjokerto, west of Surabaja. Here this man discovered a small accumulation of fossil bones. Digging only about a yard deep, he found a curious human skull, very small and with very thin bones. It was the fossilized skull of a baby. A direct comparison with Dubois' find was impossible, but the skull came from a deeper level, known to be older than the layer where his was found. We called the baby *"Homo" modjokertensis* and suggested that it might belong to *Pithecanthropus*. We had, for the first time, proved the existence of human beings in the Lower Pleistocene of Java. But we could not convince Dubois, either by this find or by a fine fragment of a lower jaw (*Pithecanthropus* B), which closely resembled the lower jaw of Peking Man. This latter had been found by my collectors in 1936, but it only came to my attention in 1937 after my return from America.

This first trip to America had a special significance for me. When the Depression came, the budget of the Geological Survey was greatly reduced, leaving many of us out of a job. From 1935 to 1937, I could only continue my scientific work by means of grants. I had just been married, and we were having a very hard time. But I had Sangiran on my mind—the most promising site I had ever seen in Java. It had large natural outcroppings of black clay containing a rich Lower Pleistocene fauna (saber-toothed tigers and primitive cattle!) covered by tuffs and conglomerates yielding Trinil fossils. Every wet season, erosion brought thousands of bones, teeth, and jaws to the surface. Here, more than anywhere else, might we find a second *Pithecanthropus!* So, with very little money but assisted by good friends, we set out to collect material. We found the remains of many mammals not previously known to have lived in Java, but in the first years no *Pithecanthropus* came to light, with the exception of one broken and doubtful tooth.

From the outset of my work in Java, I had also begun to make a collection of the teeth of extinct mammals from China. These teeth are sold also outside of China—

von Koenigswald photo

even in New York—by the Chinese drugstores as "dragon-teeth," and they are considered a special and very powerful medicine. By visiting one drugstore after another in Java, it was fairly easy to collect teeth of rhinoceroses, *Hipparion* (a three-toed horse), a large giraffe, and other mammals of the Tertiary area. They are heavily mineralized, and often damaged on purpose to show the small calcite crystals in the pulp cavities.

Even fossil collecting in the Orient seemed to have been affected

◄ SATILLA, not only a nice Javanese girl, but also a clever collector of fossils

by the Depression, for from about 1932 on, second-rate dragon-teeth became more and more abundant in the drugstores of Java. They were not as completely fossilized and apparently were more recent than the earlier finds. No horses or giraffes were noted, but there was a different aggregation of animals, including bears, tapirs, giant pandas, and pigs. And in this material, which came from caves in Kwangi and Kwantung in southern China, we discovered a fossil orangutan.

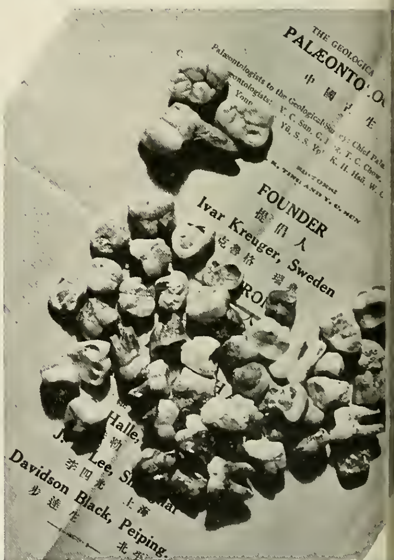
With the exception of a doubtful canine tooth from India, no fossil orang had ever been recognized. We were now able to prove, by our "drugstore fauna," that there had been more than one invasion of mammals into Java from Asia. An older Tertiary one had brought animals from India. A later one, from southern China, had brought the orangutan, gibbon, tapir, and bear to the present Malayan region.

The whole problem was so important for us that in 1935 I managed twice to go to Hongkong and Canton for material. There, in the wholesale drugstores, lay enormous numbers of dragon-teeth. Visiting these shops with my Chinese prescription and carefully looking over their stocks, I collected thousands of teeth, including about 1500 that could belong to fossil orangutans. The prices were high, and the druggists charged by weight. They could never understand why I preferred to have so many small teeth in place of one large, and probably more powerful, elephant tooth. Sometimes the prices were ridiculous, and I had to depart empty-handed. Once, in Hongkong, I saw a complete skull of a large saber-toothed tiger, surely a new species, but the price was "only" $5000. I left the shop and cried.

Among these isolated teeth from China there were three large molars

◄ UPPER AND LOWER MOLARS of *Gigantopithecus* (*right*) compared with modern man's (*left*)

▲ WHERE many fossil teeth were collected by Chinese and sold as "Dragon-teeth" to the drugstores



A.M.N.H. photos

▲ "DRAGON-TEETH" from Hongkong and Canton: three giant molars of *Gigantopithecus* and series of lower molars of extinct orangutan from China. Note on the paper the name of the "Match King," Ivar Kreuger, who financed Swedish paleontological expeditions to China and also paid for the publications

(I discovered a fourth one in 1939) that belong to the largest higher primate ever found, much larger than any gorilla. I described them as a new species, *Gigantopithecus blacki,* meaning "the gigantic ape of Black," named after Davidson Black, the discoverer of Peking Man. From the beginning, some of the characteristics of these teeth, known only in human teeth, puzzled me. It was not until many years later that new finds in Java helped us to interpret them.

But let us turn back to Java. Our search for human ancestors was very seriously limited by lack of funds. Then I received an invitation to attend the Symposium on Early Man, at the Academy of Natural Sciences of Philadelphia in 1937. We went there, taking with us casts, slides, and samples. And then came help. The late Dr. John C. Merriam, President of the Carnegie Institute of Washington, became interested, and I left the United States with a Carnegie grant as to Research Associate. I returned to Java via China, paying a visit to Peking to collect more dragon-teeth.

Now we could reorganize our search for *Pithecanthropus!* I had two Indonesian chief collectors, for whose help and loyalty I am greatly indebted, and under them there were hundreds of natives to aid in the search. Every fragment of a fossil that they found was brought. We paid premiums for important finds and stimulated interest by means of festivals with *gamelang* and *rongengs*—native orchestra and dancing girls. We paid good collectors in advance and sent sick children to hospitals. Most of the material obtained was worthless and had to be thrown away, but we had to encourage collectors. We had to buy everything because if a man found three pig teeth, he would not look for more until these were bought. So we had to spend quite a lot of money for nothing (some people certainly regarded me as a fool), but it seemed the only way to get results.

And results came! Only a few months after my return to Java, my men sent me a fragment that was unmistakably part of an ancient human skull. I went directly out to the collecting fields. There, on the banks of a small river, nearly dry at that season, lay the fragments of a skull, washed out of the sandstones and conglomerates that contained the Trinil fauna. With a whole bunch of excited natives, we crept up the hillside, collecting every bone fragment we could discover. I had promised the sum of ten cents for every fragment belonging to that human skull. But I had underestimated the "big-business" ability of my brown collectors. The result was terrible! Behind my back they broke the larger fragments into pieces in order to increase the number of sales!

von Koenigswald photo

▲ **Looking for our ancestors: collecting fossils in the Trinil formation near Sangiran, Central Java. Fine elephants' teeth have been found at this particular site**

We collected about 40 fragments, of which 30 belonged to the skull. They were very thick, averaging about one centimeter (.39 inch), and could easily be fitted together. They formed a fine, nearly complete *Pithecanthropus* skullcap. Now, at last, we had him!

It would be difficult to find, without careful selection, two modern skulls that resembled each other as much in detail as did the Trinil find and this new skull—except that the latter is more complete. This time, the important side parts were preserved on both sides, and now we could prove beyond doubt that *Pithecanthropus* belonged to the human family.

I immediately informed Professor Dubois, who was living in Haarlem. His attitude was very disappointing. He published the photograph of my find, which I had sent him only for personal information, and he tried to prove by misleading measurements that the new skull—which belonged, as he had to admit, to a human being—was more or less a fake. According to him, my find belonged to a young representative of Solo Man, while his *Pithecanthropus* had to remain an ape. He made any collaboration between us impossible and refused to acknowledge that a single one of the new finds belonged to *Pithecanthropus.* During the German occupation of the Netherlands, only a few weeks before his death, he still published a very confused article, the last of a whole series on this subject.

Davidson Black had suggested a relationship between Peking Man and *Pithecanthropus.* To study this problem further, I was invited by his successor, Professor Franz

Continued on page 46

WINTER *through the* CAMERA'S EYE

Random views show the work of King Frost in scenic Sierra settings

By JOSEF MUENCH

◄ A LACY PLANT stretches upward toward Upper Yosemite Falls, which leaps from its granite ledge to pound the snow of the valley floor

▲ FROST HAS FRINGED these blossoms of the cow parsnip in Yosemite National Park, turning them into fairy decorations to offset the majesty of Half Dome

▼ SNOWY BANKS do not halt this eager stream but only accent its rhythmic glistening course

▼ WHITE BANNERS of snow-dust are swept from the summit of Half Dome, while below, the Merced River flows at leisure between its swollen banks

▲A LONELY MONARCH standing guard beneath a wintry moon. Beyond, sleep the ridges and peaks of the High Sierra. When the snows curl up about the trunk, only those adventurous enough to chance skis or snowshoes visit this spot atop Sentinel Dome, in Yosemite Park

▼THICK as a feather bed, the blanket of snow gives these roofs interesting lines of light and shadow. The unbroken mantle bears mute testimony to the fact that this chalet in Sequoia Park is not now open for business

Twenty Million Cent

If you have difficulty grasping the enormous periods of geological history, just suppose that the world was born on January 1, 1900. Then unshackle your imagination and take a dizzy ride down the corridors of time

By James C. Beardsley
Drawings by Museum Illustrators Corps

"HOW long is a hundred thousand years?" my young nephew asked me recently. After several attempts to answer his question, I retired from the discussion, leaving him with the dissatisfied impression that a thousand centuries was considerably longer than his current school term and was approximately equal to the difference between his age and mine.

The question had been inspired by a magazine reference to a point in geological history. Nor could I blame my nephew for his inability to comprehend such a span of time. Only with arithmetic is it possible to contemplate the period of 100,000 years.

Similarly, when science tells us that the Age of Reptiles ended about 60 *million* years ago or that *Pithecanthropus erectus* knuckled his path through the primeval forest 3,000 centuries past, it is rather difficult to fit such vast lapses of time into our own rather vague idea of the prehistoric records of our earth.

If, however, we reduce the complete chronological record of the sphere into a convenient scale and superimpose this small record onto our own lifetime, we can get a much more conceivable picture of the proportionate periods of time into which the history of the earth is divided.

JANUARY 1, 1944
The Dinosaurs ruled with muscle and claw

JANUARY 1, 1939
Lowly creatures of the sea, armored against sharklike fishes

JANUARY 1, 1900
The earth a lifeless, flaming planet

For example, let us assume, at noon on this first day of January, 1947, that our earth began its existence as an independent planet 47 years ago on approximately the first day of January, 1900.

From that date, January 1, 1900, until the spring of 1934, we can find no trace of any form of life on this planet. For hundreds of millions of years our earth had glowed incandescent, erupted, and spewed lava and ashes high into the heavens as it traveled through space, until fin-

ies

JUNE 1, 1946
The Himalayas rose; so did the ancestors of the monkeys

ally the steam clouds condensed and the crust of the earth cooled. Eventually, after these countless millions of years, came a day when a human being *could* have stepped upon the earth and lived. Rain fell. We can detect its traces on rocks dating from that time. The rocks and coarse soil, however, were devoid of vegetation. Our sphere was completely lifeless and barren.

Then in the primeval ooze of some shallow sea, there was an infinitesimal movement. Life had come into being. And early in 1934, it left records in the rocks that modern man has been able to recognize as evidence of life. Within the next two or three years, by our reduced scale, this spark of life fanned itself and spread by diversified lines until the sun-warmed seas were teeming with the ancestors of our starfishes, clams, crabs, snails, and similar types of sea life. Various sea plants learned to grow, furnishing food for their hungry cousins. Sometime in 1937, the earliest known fishes made their appearance. Life ebbed and flowed with the tide along the alluvial shore.

Although life prospered in the sea, it became apparent in the next few years that this marine existence had its dangers. The land was rising, the seas were drying into marshes and the marshes into arid flats. In order to survive, numerous creatures of the sea were forced to learn to live and breathe part of the time on land. Even certain types of sea plants had accustomed themselves to a comparatively dry existence and had spread themselves throughout the swamps.

In 1938, therefore, the shores of the seas, as well as the seas themselves, became inhabited. World geography at that time was considerably different from what it is today. Great bodies of water extended where now our Appalachian and Rocky Mountains rear toward the sky. North America, Europe, and Africa were joined in one mass of land. The Mississippi Valley was a great inland ocean. The climate throughout the world was apparently appreciably warmer than it is today.

Many of the fish that had learned to live most of their lives on land—the amphibians—were now able to get their feet under their bodies and use them more as feet than as fins. By June 1, 1941, they had abandoned sea life entirely. These new creatures we call "reptiles." They are the distant descendents of the first "amoeba" life, the "grandchildren" of the fishes, and the "children" of the amphibians. These creatures and their cousins, and their uncles and aunts, lived more or less happily by preying upon one another, even as some of their survivers still do today.

By the spring of 1941 many changes had come. Great upheavals and surgings of the earth raised the Appalachian Mountains higher than the Swiss Alps of today. The earth's climate became colder, and even the equatorial mountains had their ice caps. Many of the reptiles and amphibians perished under these colder conditions. Only the most hardy among them survived.

April 1, 1942, ushered in the Mesozoic Age, the Age of the Middle Life or the Age of Reptiles. The weather had commenced to warm again, and within the year certain surviving reptiles evolved into dinosaurs and were growing larger. These dinosaurs expanded with the benign climatic conditions until in 1944 they ruled the world with a tyranny of muscle, claw, and fang. Some of the reptiles, for safety, had taken to the air and were soaring on wings developed during

eons of jumping from one tree to another. The first bird probably appeared late in 1943, but he was still quite reptilian.

Also in 1942, a new generation came into existence—the mammals. The mammals were the children of the reptiles, forced, perhaps, by the colder conditions to adopt a fur coat and to develop warm blood in their bodies in order to survive. The Rocky Mountains had been thrust up to their great height a few months before, cutting off an inland sea, the remnant of which we now call Great Salt Lake.

The dinosaurs, because of the climatic change or for some unknown reason, died off rapidly and by the first of August, 1945, were completely extinct. Thus commenced the Cenozoic Age, or Age of Recent Life. The warm-blooded mammals were predominant in this period (as they still are), moving freely from land to land because Europe, North America, and Asia were joined at this time. These animals increased rapidly until they covered the globe. Some were herbivorous and grazed on the plains. Some were carnivorous and ate their neighbors. Some lived in holes, caves, or in trees and ate what they could get.

About seven months ago there was a gradual but tremendous land upheaval in Asia which resulted in the Himalayan mountain range. This upheaval was accompanied by very cold weather. Most of the animals in this area escaped to southern climes, but a few were cut off by the newly raised mountains. The tree-dwelling members of these entrapped animals were, according to some recognized authorities, our remote forefathers—forced by the requisites of survival to exercise ingenuity and a certain intelligence when faced with their newer, harsher environment.

Again there came a change in the land masses of the world, so that Europe, Asia, and North America were no longer connected by land bridges as they had been from time to time. The climate became colder and drier. In North America, the Colorado River trickled through a small gully which has since become the Grand Canyon. The Appalachian Mountains had long since worn down, the erosion from them having formed the Catskill Mountains. The continental limits of the world assumed approximately the appearance we know today.

Eight days ago came the first of the four great glacial epochs. The Great Lakes were gouged out by icy tongues, and the ice cap extended as far south as St. Louis.

Most forms of life were driven south. It was now that the Heidelberg Man and the Piltdown Man, relatives (but not ancestors) of our present race, flourished and sought to survive, not alone through brute strength, but guided by a flickering intelligence.

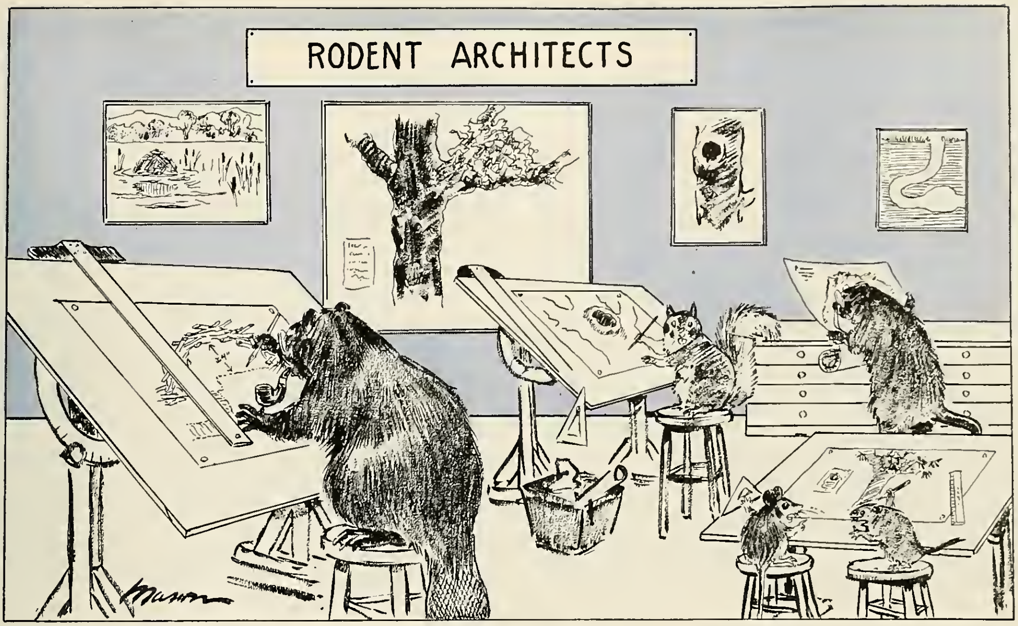
But it was not until *this very morning*, January 1, 1947, at 3:45 that the Cro-Magnon Men—the first

of our certain ancestors—made their appearance. They amalgamated with or drove away their cousins, the Neanderthal Men, who had been living in Europe for a few days. By 7:53, forty minutes after the last glacial advance, the Cro-Magnons had learned to use the bow and arrow.

The first civilization flourished farther south, in Egypt, about 11:00 this morning. Rome, to the north, was at its height just *24 minutes* ago or at 11:36 A.M. today. Columbus sailed the ocean about five and a half minutes ago, and our own Civil War came to a close within the last 61 seconds.

The famous time capsule buried in New York a few seconds ago is scheduled to be dug up at two minutes after one this afternoon, at which time it will have completed its 5,000 years of rest.

Now it is 12:00 noon. What fantasy can we expect from tomorrow? If the completely stupid dinosaurs were able to reign supreme for, by our scale, over two and one-half years, perhaps humanity can expect to be dominant for at least that period, aided as we are by science, intelligence, and greater adaptability. If, therefore, we have several years of grace and have used less than eight hours of these several years in reaching the level of attainment we have already reached—what absolutely inconceivable marvels await us within the week, to say nothing of next year! Interplanetary travel this afternoon is almost a certainty. Unbelievable human longevity, well-nigh impregnable health, and colossal intellect are, perhaps, all mere hours away. Small wonder that we cannot conceive of what may be days, months, or years in the future. The Past forces the Present to compound the question, and upon Human Posterity falls the burden of answering.



By John Eric Hill

Drawing by
G. Frederick Mason

IN these days when there is a greater need for new homes than ever before in our history, we might wish that our housing problems could be solved as easily as those of many gnawing mammals, or rodents.

The largest rodent house is the beaver lodge, which looks like an untidy pile of peeled sticks and mud. One beaver lodge measured some 36 feet in diameter and was nearly seven feet high, but the usual size is ten or twelve feet across. Inside is a rounded nest chamber, two to six feet in diameter, gnawed out by the industrious owners. A big lodge may have two or three such chambers, like a multiple dwelling. These apartments commonly have separate entrances, but they may be laid out more sociably, opening into a common passage.

Some beavers, however, do not build lodges. Instead they live in burrows that they dig in the banks of rivers or lakes, more or less like those constructed by the ancestors of our modern beavers. Although the bank den begins below the water level, it rises to an expanded living room well above this. It extends almost to the surface of the ground, and a small hole is usually made for ventilation. After heavy rains this hole may be too large for safety because the passing of a heavy animal overhead may cause the roof to cave in. If that happens, the hard-working rodents bring sticks and mud to repair the breach.

When the water of a beaver pond is gradually raised by a dam, a home that began as a burrow soon becomes flooded. The beavers, however, continue to pile material over their dwelling and extend their living room upward into this heap. The nest chamber often consists of two levels, one just above the water, the other a foot or more higher. In the upper chamber there may be a bed of shredded bark or grass, but some beavers seem to care little for comfort and sleep on a litter of chips and small sticks.

There are two or more entrance passages to the den, and these almost always open under water. And in warm weather, at least, there are several passages in the outer wall of the lodge which allow the inmates to observe through protective wooden bars any enemies that might come near the lodge. With the approach of cold weather, the beavers plaster mud over every crevice, except at the top where space is left for ventilation. The irregularly projecting sticks catch snow and build up an extra coating that helps to insulate the house.

In contrast to the "moated castle" of the beaver, delicate hanging nests are built by some tree-living mice. Thus the golden mouse of the southeastern states builds a small, rounded nest far out on the branch of a cypress or in a dense growth of green thorn or brier. It is about the size of a baseball and is often woven of Spanish moss and finely shredded bark, like the nest of a small bird.

People today who would like to buy a home sometimes get the impression that houses are made of money, for they cost so much. An account was recently published about a squirrel's house that was actually made of money. A squirrel gnawed into a box in which an Arizona couple kept their savings and took out \$500. With the shredded five and ten dollar bills, the animal lined its winter nest. For its size, this was surely one of the most expensive homes on record!

THE *Flamingos* OF ANDROS

It was worth the 1800-mile trip to view the "hundred jets of flame swoop low against the water and vanish . . ." It was worth the hazards and discomforts of Andros Island to sight the brilliantly spectacular flamingos, whose destiny is shadowed with the threat of extinction

By DUANE FEATHERSTONHAUGH

NIGHT was falling as our dinghy grounded in a lonely salt swash in the Bahamas. Hastily we unloaded our 600 pounds of supplies. A full quarter-mile of knee-deep water separated us from the desolate cay where we planned to establish temporary camp.

Suddenly a honking sound filled the air. We looked up to see a hundred jets of flame swoop low against the water and vanish behind a bank of mangrove.

"Flamingos!" we cried in unison. "We've found them."

The first sight of the beautiful birds in their native haunts justified the 1,800-mile trip from New York City to Nassau and the two-day "cockle-shell" voyage from the quaint Bahaman capital to desolate lower Andros Island.

During the last forty years there had not been a single recorded trip to this spot for serious bird study. Dr. Paul A. Zahl, biologist and old-time tropical explorer, and I had long wanted to study and

▼ PART of a large breeding colony of flamingos. Telephoto equipment was necessary to secure views as intimate as this one

▲ **When the men approached,** the birds rose like a vermilion cloud and soared away, honking loudly

photograph flamingos at their nesting colonies if they could be located. Information about Andros, largest but least known of the Bahamas, was scarce but encouraging. Accounts by C. J. Maynard, who visited the flamingo colonies in 1884, and by Dr. Frank M. Chapman, who made trips there in 1902 and 1905, indicated flocks of 10,000 to 30,000 birds.

There were unverified reports that many of the birds had been frightened from the island during the war by low-flying military planes, but it seemed improbable that the huge flocks had vanished. Besides, we rationalized, there were many other forms of bird life on the island, if we failed in our main objective.

At Nassau, Hackett Roole, a broad-featured, jet-black Negro, looked at our equipment for fully ten minutes before he agreed to transport us to Mars Bay, a three-house settlement some 30 to 40 miles from the nearest reported flamingo nesting colonies.

We looked at his small sailboat for almost as long, debating whether we should trust irreplaceable camera equipment in such a small craft for the 130-mile trip over open ocean.

Our photographic equipment included a Leica, with three lenses, a 2¼ by 2¼ Zeiss Super Ikonta B, and a 3¼ by 4¼ Speed Graphic for general black and white photography and synchronized photoflash use.

Camping equipment was standard for the tropics, but instead of a tent we used a 10- by 16-foot Nylon tarpaulin, which was rainproof and sturdy. It weighed but eight pounds and folded into a package that could be placed in an overcoat pocket. With the exception of canned meat, we carried only dehydrated food.

Uncomfortable Camp Site

Camping on Andros proved a major problem. There were few trees to which to tie tent ropes, the ground consisted solely of razor-sharp honeycomb coral, and the only water available was what could be scooped from rock holes where the rain water had accumulated. It was brown and tasted brackish, and was filled with mosquito wrigglers, tadpoles, and large land crabs.

We wouldn't admit it to each other, but we were apprehensive when our native boatman left. We asked him to return for us in three weeks. Meantime we would be out of contact with civilization in one of the least explored sections in this part of the world.

Nature is hostile on Andros. Sharks and skates inhabit the bights that divide what is termed "an island" into thousands of small cays. For six months of the year there is no rain. From August through October there is constant danger of hurricanes.

An underwater shelf, part of the Great Bahama Bank, surrounds Andros. It extends from eight to twelve miles offshore and prevents large boats from docking at the few native settlements.

The island is inhabited by approximately 6,000 natives, almost all of them direct descendants of Negroes imported by the English from St. Andro Island off the coast of Africa in 1787. Unlike other West Indian Negroes, they have not intermarried with whites to any extent and retain the jet-black skin and broad features of the native African type.

The population is centered in a few settlements along the northeast coast. Otherwise, the 100-mile long island is uninhabited.

We knew the flamingo nesting period was during late May and early June. We also knew, however, that they sometimes—as when disturbed—change the nesting area each year. But it would be easy, we thought, to trace the birds to their colonies by watching where they landed.

The next morning we awoke to the same honking we had heard the previous day and stuck our heads from the tent in time to see a flock of a hundred or more birds flying toward the south. They appeared to land beside a cay about a mile away. Several other flocks, all flying in the same direction, passed over during the morning as we shifted our camp to a permanent location on a ridge a short distance away.

A flamingo in flight is one of the most glorious of nature's spectacles. The long legs and the equally long neck are carried in a straight line. Sunlight gives a flamelike appearance to the vermilion feathers on the underside of the bird. The jet black feathers of the wing tips heighten the illusion of a flickering flame.

The word "flamingo," incidentally, does not mean flamelike. Its derivation, according to Webster, is from the Italian *fiameng*, meaning splendid.

Naturalists differ on the exact classification of the flamingo. Julian Huxley says it is "so completely intermediate between the Anseres (ducks and geese) on one side and the storks and herons on the other that it can be ranged with neither." Hans Friedrich Gadow places the flamingo as a suborder of storks (Ciconiiformes), immediately followed by ducks and geese.

I observed the roseate flamingo daily for more than five weeks. It has many of the characteristics of the duck and goose family. The broad lamellated bill resembles that of a duck, except for its great size and the fact that it is bent sharply downward. The flamingo also has webbed feet.

▲ YOUNG GREAT BLUE HERON, still in the downy stage

The call of the flamingo could be mistaken for that of a wild goose. The flight pattern also is similar. Large flocks fly in a V-formation, small ones in single file.

The Search

Locating the nesting colonies was a difficult job.

We were up before sunrise the second morning. A large flock passed over our camp a short time later. We started after them. For more than two hours we waded through the swash. Razor-sharp coral and clutching marl alternated to make footing miserable.

The misery was lessened by the sight of six or seven small flocks of flamingos. We photographed several of them in flight and observed a characteristic which we realized at once would make it difficult to follow the birds to their nesting colonies. The birds would swoop down from a considerable height, fly low over the water, wheel behind a mangrove bank, and then climb again and continue their flight. To an observer a mile or so away it would appear that the original descent to the water was a landing.

We learned during our first day in the field that the flamingo is an extremely nervous, wary bird. A flock will wheel away from a man at a distance of more than a quarter of a mile, honking loudly as though to warn other flocks in the vicinity.

They are slow to detect a still object. We found that if we stood absolutely motionless at the first sight of a flock, the birds often would fly only a few feet above our heads.

The extreme nervousness of the flamingo is in marked contrast to the behavior of the many other

birds on Andros. In photographing herons, plovers, ospreys, gulls, and others, we could approach within a few feet of the birds. Most of them, doubtless, had never seen human beings before and were entirely fearless. But the closest we ever approached to a wading flamingo was about one hundred feet. Telephoto equipment and the use of mangrove blinds were necessary to secure close-up pictures.

For two weeks we followed the birds daily. We found several old nesting grounds and had ample opportunity to observe the birds wading and feeding. But we could not locate an inhabited nesting colony.

Disappointed, we took time out to photograph other bird life in the salt swashes.

I have never visited an area so rich in bird life. Half a dozen varieties of hummingbirds played about our camp each day. We located the nest and young of the yellow-crowned night heron and studied from less than twenty feet Great Blue, Little Blue, Little Green, and Louisiana Herons caring for their young.

A Rare Shot

Once I was able to photograph the Wilson's plover from a distance of less than ten feet, which was a remarkably close approach to this nervous little fellow.

In the meantime we had ample opportunity to photograph flamingos in flight and to observe more of their habits and characteristics. It was apparent that there were not more than 400 to 500 of the birds in the vicinity of our camp, although some of the old nesting colonies we saw contained as many as 2,000 to 3,000 nests.

This seemed to confirm the previously unverified reports that the birds were either leaving the island for other breeding grounds or were facing extinction.

The possibility that the roseate flamingo might become extinct presented an urgent problem. More factors seemed to favor its extinction than its survival, and any information that would lead to more adequate protection was strongly needed.

The bird's high degree of specialization jeopardizes its survival. It eats only a small, spiral-shelled mollusk, and it is slaughtered by natives in search of food. The stealing of eggs by natives and the inundation of nesting colonies by spring tides, as well as the bird's nervous disposition add to the precariousness of its position. Bahaman laws protecting the flamingos are ineffective, because no warden or other enforcement official is stationed on Andros.

On the other hand, there are still ample numbers of the birds on Andros and other West Indian Islands to insure their survival if prompt action is taken.

Two steps are of the utmost importance. Existing laws against the taking of the birds and their eggs must be carefully enforced. And all visits to colonies during nesting periods, excepting possibly those of accredited naturalists seeking information, must be prohibited. This is necessary because we found that every time the flock took to the air a dozen or more eggs were knocked from their nests and destroyed.

▼ THE RUBBER BOAT served as shelter from the sudden tropical storms and as a blind from which to study the remarkably rich bird life

◂ AUTHOR (*left*) and Dr. Paul A. Zahl (*right*) in their base camp, 130 miles by open boat from Nassau. Their tent was a Nylon tarpaulin that could be carried in an overcoat pocket

▸ A CLOSE-UP of three yellow-crowned night herons. Unlike the flamingos, the herons were tame and would permit approach to within a few feet

▾ THE EARTH where the flamingos were nesting was dotted with hundreds of knobs, on each of which was an egg. High spring tides destroy many eggs, and inadequate conservation measures leave the birds in a dangerous position

We left Grassy Creek, where we had established our camp, disappointed but satisfied we had done the best job possible. And we had the memories of those glorious flamelike flights.

At the foot of the bight we found a small cruiser of the Anglo-Bahaman Petroleum Company. The engineers aboard her invited us to spend the night. They explained they were surveying the area with the idea of drilling for oil.

A native boat drew alongside the next morning. We were about to push on toward civilization but listened with unbelief when the Negro said:

"Boss Mon. I'm Robbie Ferguson. I know where filly-mingos. Many, many."

We looked at each other, hoping that Ferguson was not just another would-be guide who, having heard there were two visitors looking for flamingos, was making up the story for the money involved.

"How many?"

"Many, many, many," he answered. The natives sometimes have vague ideas of numbers or distances and express them in such comparative terms as "Many," and "Many, many," and "Far," and "Far, far."

There was something about his manner that led us to trust him.

"We'll go," I said. "How far?"

"Far," he answered.

We knew that meant about a day's journey.

Robbie was a turtle fisherman, and his boat was an old lifeboat of a British liner. He had built a deck over it and rigged up a sail. Still, it was much larger and sturdier than most of the native craft.

The hold smelled like a magnification of a combination of all the worst smells I had ever experienced.

We left the mouth of Grassy Creek at 6 A.M. and headed south. Mile after mile slipped away. Overhead we saw an occasional man-of-war bird. A few curious sharks looked the boat over and edged aside to let us pass. We took advantage of the shallow water to dive from the boat and collect sponges, conch shells, and sand dollars. There were numerous examples of coral forms.

By midafternoon I was a bit worried. We were entirely out of food and pipe tobacco and had only coconut milk to drink. Still, the thought of the flamingos kept us from turning back. Finally we left the last point of land on Andros. The next land would be the northern coast of Cuba, about 150 miles to the south.

Then Robbie steered east and in a few minutes we saw a small group of cays, which we identified by our chart as Water Cays. We reached them half an hour later and sailed to a larger cay a short distance north.

"Filly-mingo in there," Robbie said. He indicated a large mangrove swamp.

Eagerly we plunged into the swash. In less than fifteen minutes we could hear the honking of a large colony of flamingos. Soon birds began to fly out of the mangrove ahead. A white ibis stalked in the water not six feet from us at one point, a perfect photographic opportunity. So intent was our interest in the "firebirds" that we didn't stop.

Suddenly we came to a break in the mangrove. There was a clear bight, possibly three hundred yards across. On the far side was the most beautiful sight I have ever seen.

At least 1,000 blood-red birds waded in the shallow water, scooping up Cerithium with their deep, broad bills. Behind them the earth was dotted with hundreds of knobs. On top of each was an egg.

A few females were sitting on their eggs. Most of them were feeding at the moment but remained closer to their nests and eggs than the males.

The birds obviously had not seen us, and for a few moments we remained hidden in the mangrove, entranced by a spectacle that few persons have ever seen.

Then we began to wade across the bight.

The birds saw us instantly. They commenced a disturbed chattering, and the females moved back toward their nests and eggs. The males remained in the water, watching us suspiciously.

Sexes Similar

The only obvious distinction between the males and females was this difference in their behavior as we approached. In color they were the same, and the size of the cock and hen appeared about the same. We paused from time to time to photograph the flock.

Halfway across, the males suddenly rose into the air, wheeled sharply over us, and vanished somewhere in the mangrove-banked horizon.

The glint of sunlight on the vermilion birds as they banked overhead, not more than 40 or 50 feet away, gave the impression of a red cloud rising suddenly from your feet and then soaring away.

The females remained with their eggs.

Slowly, we approached.

The females began to show apprehension when we were about a hundred feet away. They walked about rapidly and honked loudly.

A single bird, more nervous than the rest, broke into flight. The rest followed.

The second red wave vanished. We were left in the desolate silence of the salt swash with hundreds of nests and eggs.

Two turkey vultures reached the colony before we did. They began to eat the eggs that had been broken as the flock departed. The vultures paid no attention to us until we were within a few feet of them. Then they sullenly left the broken eggs with the blood-red yolks and flew a short distance to one of the degenerated palms that spot Andros.

Approximately half of the nests had been inundated by tides, and the eggs were floating in the water. We collected these spoiled eggs, reluctant to take any of the good ones.

We photographed nests and eggs and then withdrew across the bight. In about fifteen minutes one or two flamingos flew overhead and honked. A minute or two later the entire flock returned. It was as though they had been waiting for the signal of the lookout birds.

The flock went about eating and feeding as though we had never come.

We spent the night on the deck of Robbie's boat.

In the morning we returned for additional photographs. Again the males fled when we were at some distance. Again the females waited until we were within a hundred or so feet before they flew.

We hurried through our studies and photographic work and left, anxious not to contribute to the extinction of these brilliantly beautiful birds.

There is still much to be learned from a study of the bird life of Andros, and we hope to make another trip there to concentrate on other birds. The few human beings and the absence of all mammals, except bats, mean there are few natural enemies. If the flamingos can be given the protection they deserve, they should survive. There is no reason why such protection cannot be enforced, but things like this don't just happen without somebody doing something about it.

Bubble-Bathing Bugs

One of the country's leading insect photographers describes at close range the life story of the familiar but little understood froghopper

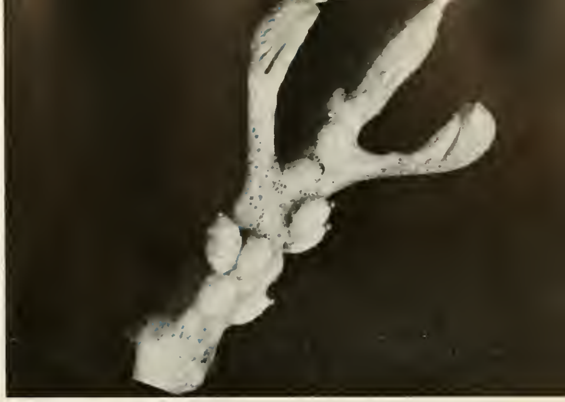
By George Elwood Jenks and Kay McKay

HOLLYWOOD is not the only place where bubble-bathing is popular. In the fields and woods—perhaps right in your own garden—there are tiny insects that eat, drink, and live their lives in a constant succession of bubble baths.

You have probably seen their sparkling little houses many times, but have you any idea of the fascinating life of the tiny tenants—the queer little froghoppers?

In order to secure the various scenes for this bug biography, hundreds of the insects were reared in the photographer's home laboratory. A curled leaf of the wild walnut provided . . .

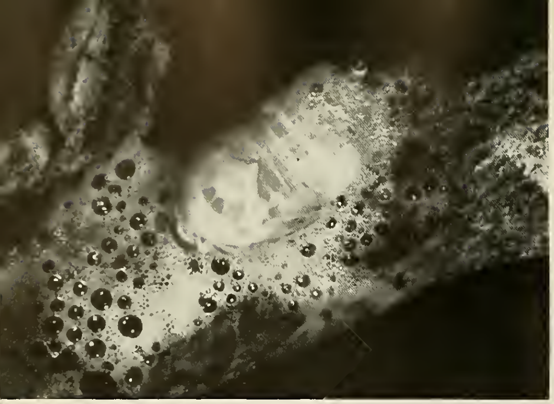
1 ▲ . . . an ornate tub for our introductory bubble-bath scene, in which the tiny "star" splashed contentedly. We even . . .



2 ▲ . . . arranged a bathing pool party. Buckets of "suds" were produced, and a "good time was had by all"

3 ▲ You have probably seen the froth left by froghoppers on grass and weeds. It is made out of excess sap taken from the plant by the insect for nourishment

4 ▲ Until recently, it was thought that this little bug actually *blew* the bubbles or simply used her "nozzle" like an egg-beater to churn the liquid sap into a froth



5 ▲ Now we know that she presses the bubbles out from a channel beneath her body by moving her abdomen up and down

6 ▲ Like a child at a soda fountain, she drinks and drinks. Soon she vanishes within a sparkling, pearly palace almost as big as a thimble

7 ▲ There comes a time when she begins to feel uncomfortable. She has never heard of a maturing molt, but soon she is undergoing the process

8 ▲ She "explodes" right out of her skin into th form of a weird creature that quickly . . .

9 ▲ . . . grows wings and develops into the grotesque "ghost" of a bug

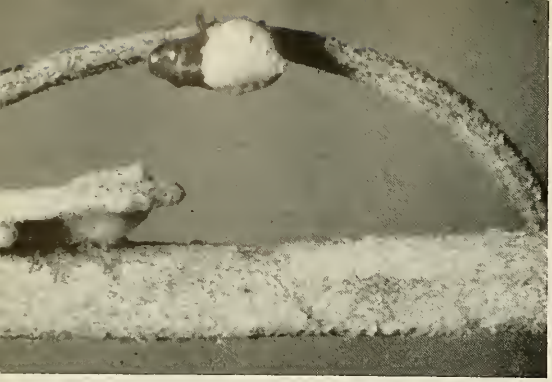
10 ▲ Even her ovipositor, which will harden to pierce twigs and lay her eggs beneath the bark, is now only a soft projection at the hind end

11 ▲ Slowly she materializes into this queer, bald-faced creature. Her scientific name is *Clastoptera tricincta* Doering. Some call her a spittlebug

12 ▲ In the South there are two generations a year. The eggs of the second do not hatch until the following spring

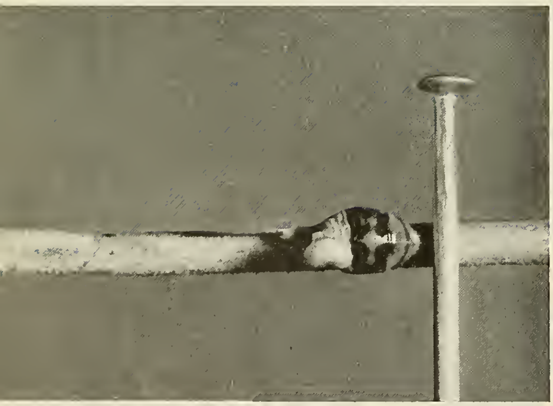
13 ▲ Tricincta also has a cousin, similar in appearance but she wears clothes of a sort—a tight, dark red "shell." This species is *Clastoptera lineatocollis* Stal.

14 ▲ This Kid Party, attended by both species, shows that the "garment" first appears in infancy as a thin, red helmet or hood



15 ▲THE HOOD lengthens and thickens with each molt. And when the sweater gets too tight, the "teen-ager" discards it and grows another. But . . .

16 ▲. . . every Red Ridinghood has her Wolf, and in this case the Wolf appears in the guise of a predatory larva which . . .



17 ▲. . . attaches itself to the hapless bug in the manner of a leech. The head of a pin looks as big as a railroad spike in this Lilliputian world

18 ▲SOMETIMES a small froghopper picks up a hitch hiker almost as big as herself, but seldom, if eve does she die as a result of feeding the lazy parasit

19 ▲WITHIN a few days the larval "star boarder" at tains its full growth and pupates near-by. It goes into its transformation sleep in . . .

20 ▲ . . . an odd shaped puparium, both ends of which are flattened. But in about a week . . .

21 ▲ . . . out pops an adult predatory fly

22 ▲ But in most cases, this froghopper, like its cousin, lives happily and is finally transformed into a winged creature of the air. And while . . .

23 ▲. . . waiting for Mother Nature to complete its coming-out dress, the little rascal appears to ride pickaback on its own shed skin!

24 ▲ The more finished it becomes, the more fantastic it appears—a grotesque goblin or a "double-ender" bus going *which* way?

25 ▲ Two guesses! Now that you have seen the life history of the froghopper, take a second look at this strange creature the next time you see one

◄ A LARGE MOUNTAIN GORILLA in the American Museum, an animal that differs slightly from the West Coast Gorilla

A.M.N.H. photo

Gorilla-land

The people who live where gorillas are almost an every-day occurrence say that they won't attack unless you run. But could *you* follow this advice?

By A. I. GOOD*

THE following observations on the gorilla are based on a residence of over 35 years in French Cameroun, West Africa. They are written as a popular picture of a most interesting animal, and make no pretense of being an exhaustive or scientific study. The most we can say is that the information is for the most part first-hand, and personally authenticated.

The gorilla is not uncommon in southern Cameroun. Here, in the great equatorial rain forest three or four degrees north of the equator, he finds his natural habitat. He lives alone or more often in small bands in the heart of the forest, miles away from populated localities. But follow a thin thread of a footpath extending scores of miles through the forest, with only occasional villages strung along the path miles apart, and you will find the gorilla common. Here you will often see beside the path the trampled and shredded stock of a banana tree, which a gorilla has pulled down to get the tender central shoot. Here, fifty feet to one side, he roars at the sound of some traveler passing along the trail. Here you are likely to see a couple of shaggy "gray-backs" crossing the road ahead of your caravan and disappearing into the forest undergrowth at the side.

In such a locality two of us rode our bicycles for fifteen miles one day, trusting the sudden "squawk" of our bicycle horns to scare off any gorilla we might meet, as the natives confidently assured us they would. (I must say they had more confidence than we did.) On the way we met two men and a woman. The men were each armed with a spear and a cutlass, and the woman was walking between the two men, instead of plodding along in the rear, as would have been her normal position. Gorillas were said to "fairly live" on that road, but they must have been visiting elsewhere that day, because the trip was uneventful, except for a snake.

*THE REVEREND A. I. GOOD was born at Libreville, Gaboon, West Africa, about fifteen miles from the equator. His father—a Presbyterian missionary at Lambaréné, French Congo,— was the first white man to explore parts of the interior of Southern Cameroun.

Interested in everything connected with natural history since boyhood, he collected butterflies with his father at Lambaréné as soon as he could hold a butterfly net.

He is a graduate of the College of Wooster (Ohio) and the Western Theological Seminary in Pittsburgh, and has been a Presbyterian missionary in the Camerouns for over 37 years, engaged mainly in evangelistic and church work. His chief missionary contribution has been the translation of most of the Old Testament into the Bulu language of Cameroun. As a side interest he has collected insects, reptiles, and mammals for the Carnegie Museum, fishes for the Stanford University Museum, and birds for the Cleveland Museum. He is a fellow of the Royal Geographical Society, an associate member of the American Ornithologists Union, and a dyed-in-the-wool collector who can never quit collecting.—ED.

Where the population is sparse and the gorillas numerous, they may become quite a scourge to the people, as they are very destructive to banana gardens. Even a large banana garden may be almost ruined if a band of gorillas elects to spend several days in it. Since firearms are prohibited to all natives except a favored few, their only recourse is to noise. And so to save a garden, they must be continually on the watch. From time to time they must spend several days beating on tin pans, drumming and yelling, to discourage some old gorilla who has a craving for fresh banana shoots.

The gorilla is on the list of animals protected absolutely by the government, no one being allowed to kill it at any time unless furnished with a scientific permit. Theoretically the natives are also under this rule, but practically no one pays attention if they succeed in killing one with their primitive weapons. Occasionally a French official, upon special petition by the people, will even send a native soldier with a rifle to kill one or two gorillas that have become unusually destructive to gardens in some particular locality. However, comparatively few are killed in all these ways, and the gorilla enjoys practical immunity to danger from man and seems fully as numerous as ever. In my judgment, these strict conservation measures are good, as the gorilla deserves protection. On the other hand, considering how very few are taken for scientific purposes, some of the present strictness might well be relaxed for such collectors as can furnish proof that the specimens are to be used for scientific or educational purposes, as the effect on the total gorilla population would be negligible. More are killed and eaten annually by the natives, and completely wasted for the scientific world, than scientific collectors would ever request.

When I was in a section of country southeast of Ebolowa where gorillas were very common, the natives told me that gorillas made a rhythmic sound at night while asleep, which was loud enough to be heard for considerable distances and was rather terrifying. They believed that this "snoring" must give some measure of protection to the sleeping gorilla, as nothing would attack an animal that made noises like that.

I was somewhat skeptical and said, "Well, I want to hear it for myself."

Sure enough, one evening about nine o'clock, one of my men came into my hut and said, "Come out

Continued on page 44

➤ West Coast Gorilla (400 pounds) and man (150 pounds). The gorilla's head is twice the size of the man's, its shoulders twice as broad. But its legs are shorter

Photo by A. I. Good

▼ The West Coast Gorilla is lighter in color, and its arms are slightly longer. (From an exhibit in the Academy of Natural Sciences of Philadelphia)

Courtesy Academy of Natural Sciences of Phila.

◂ It was noticed that the lizard's skin had loosened all over as shown in this picture. Somehow during the next few minutes the animal disposed of the skin from its head

Photographs by the author

A

An unusual photo series

IN the southern states the lizard known as *Anolis carolinensis* is common about porches and backyards It is a small creature only a few inches long, and like the true chameleons (none of which live in the United States), it is prone to change color before the observer's eyes, most often from a fine brown to a bright green or the other way around. It is inoffensive and harmless; indeed, it can even be consid-

▾ It then looked as shown in this photograph, with the skin split down the back

▾ Next the lizard reached back and pulled off the main body covering. It ate this as rapidly as possible. In this picture a bit of this lot of epidermis was still sticking out of its mouth

"American Chameleon" Sheds its Skin

By Ivan R. Tomkins

ered beneficial, for its food is largely flies and similar insects.

Lizards shed the outer layer of skin at times, as do snakes and other reptiles. This series of pictures, made in the photographer's backyard in Savannah, shows this behavior. So far as we know, the happening, seldom observed, has never been photographed before.

On this particular morning, three of these lizards were hunting flies in a flowering quince, when it was noticed that one individual had the skin loosened all over. The lizard did a lot of running up and down among the branches while shedding, which made it very difficult to follow the action with a camera and keep the subject in focus and close enough to have an image of satisfactory size. Few cameras are versatile enough, and the photographer considered himself lucky to obtain a reasonably clean series.

It is recorded that in captivity, when other anoles are present in the same cage, one individual frequently removes the skin from another; but in a natural state they more often dispose of the skin without aid. All geckos normally devour their skin, so far as is known, but among the iguanids only the supposedly more primitive genera are known to eat the skin.

▼ Then it gave attention to the skin on the front feet, clearing this off with some difficulty. After trying several different positions, the lizard hung from a twig by the hind feet, pulling at the loose skin on a front foot, as shown here

▼ The next and last operation consisted in reaching back and catching hold of the loosened skin from the hind legs. Limited flexibility in the spine made this difficult, and the creature had to move around a lot and try several times. At last the skin came off in one piece like a pair of trousers

THE LAST OF A SERIES ON THE FLOWERS OF THE FOUR SEASONS

The "PLUM FLOWER

THE so-called "plum flower" is the Chinese emblem of winter. Although in some regions it grows wild, it is doubtless as well known in its dwarfed cultivated form. By skillful twisting and training, Chinese gardeners are able to produce the potted specimens, which are prized as New Year's decorations.

The common name for this plant, *mei-hua,* means literally "plum flower," and that is why people call it "plum blossom." It belongs to the genus *Prunus,* but some uncertainty seems to prevail as to which species it is. This plant fills a place of special esteem because it is the Chinese national flower. When the Central Political Council of China chose to honor the *mei-hua* in this way, they had in mind that its five

"The branch of plum blossoms is broken; yet there is no one in heaven or earth to carry my flowers to him."

—Li Ching-chao (A.D. *1081-1140)*
(Translated by Helen Wiley Dutton and used with her permission)

Courtesy, Walker Art Center

➤A TWISTED old *mei-hua* tree and two ill-tempered dogs decorate this flattened vase of greenish-white jade (Eighteenth Century)

Chinese Symbol of Winter

The last of the "flowers of the four seasons" is the symbol of winter and the herald of spring. It fills a place of special esteem because it is China's national flower

By MABEL IRENE HUGGINS

petals were to represent the five groups of which the Chinese nation is composed — the Chinese, Manchus, Mohammedans, Mongolians, and Tibetans.

But this is not the only interpretation, as may be seen from the following delightful paragraph by Madame Chiang Kai-shek in her book, "This Is Our China":

"On New Year's Eve, my husband and I took a walk in the surrounding mountains. We discovered a tree of white plum blossoms, flowering profusely. What an omen of good luck! In Chinese literature the five petals of the winter plum portend the five blessings of joy, good luck, longevity, prosperity, and (to us most desired of all) peace! The General carefully plucked a few branches and carried them home. When our evening candles were lighted, he presented them to me in a little bamboo basket—a New Year's gift. The plum blossoms had looked graceful and lovely on the tree, but massed in the basket by candle-light they took on an indescribable beauty, their shadows on the wall making clean, bold strokes. . . ."

The Chinese share with us the feeling that winter is the end of the year. However, to them the *mei-hua*, blossoming in spite of snow and ice, serves as a forerunner of the next year's beginning. Nine hundred years ago Yen Shu, a Sung-dynasty poet, recognized this when he wrote:

"Plum blossoms disclose news of spring."

We have seen that the peony, lotus, and chrysanthemum have a practical as well as a spiritual place in Chinese life. However, this is not true in the case of the *mei-hua*. This, the last of the "flowers of the four seasons," holds itself aloof from everything that has a semblance of utility.

Like the other *ssŭ chi hua*, however, *mei-hua* appears alone or in

▼ A BLUE AND WHITE GINGER JAR decorated with the prunus or "plum flower" motif. K'ang Hsi period (A.D. 1662-1723)

Author's collection

Courtesy, Walker Art Center

▲ THE FULL MOON is represented by this jade-trimmed pewter teapot. On its reverse is a line of verse which says, "In the moonlight it is difficult to distinguish between falling *mei-hua* petals and snowflakes"

juxtaposition with other flowers and birds in the art of China. A favorite flower and bird combination is the *mei-hua* and the magpie, bird of good omen. The motif has been effectively applied to porcelain bowls.

Sometimes the flowers are put to unexpected uses in unexpected materials. Perhaps the *mei-hua* is most familiar to the West on the blue and white jars which are decorated with what used to be known as the "hawthorne pattern," the design which might better be called "cracked ice," because it represents ice floes going down-stream and carrying with them the *mei-hua* which have fallen from overhanging trees. We are accustomed to the *mei-hua* on porcelain but are unprepared to find it executed in wood and accompanied by wooden "cracked ice." However, three centuries ago in a Peiping palace a long-forgotten craftsman made a wooden grillwork partition of "cracked ice" decorated with *mei-hua*. The plain wood from which he made it has the simplicity of the five-petalled *mei-hua* combined with the austerity of icy coldness, and produces an effect of harmonious beauty.

Author's collection

▲ Tang Ti, a contemporary painter, "wrote" these gnarled branches of pink *mei-hua*

▼ An heirloom from Szechwan, embroidered with the Chinese flower of winter: a blue cloth headdress cross-stitched in white

Anna G. Granger Collection, A.M.N.H. photo

A.M.N.H. photo

▲ A ROUND SCREEN of white nephrite bearing a bamboo and prunus design in low relief. Ch'ing Period: A.D. 1644-1912. (Morgan Collection)

BAMBOO, the Philadelphia Zoological Garden's large lowland gorilla

Courtesy Zool. Soc. of Phila.

Gorilla-land

Continued from page 37

and listen to a gorilla snoring." I stepped out into the village street, listened, and shortly heard a voice like the syllables, "Bup-bup-bup-bup-bup-bup," repeated rapidly. It resembled more a sound made by the lips and began rather low, rising to a crescendo, and dying down again. While it was not a loud sound where I stood, it sounded at least a half-mile away, and had I been near at hand, it would have been very loud and would certainly have kept me from whatever produced it. I have no reason to believe that this sound was made by anything else than a gorilla. It sounded like one. It was repeated for perhaps ten seconds or more every three or four minutes until I grew tired of listening and went to bed. I must say that I can well believe this to be a form of snoring, and a huge enough snore to be worthy of the animal that is reputed to make it. I have not happened to see mention of this noctural exercise by any other writer on gorillas.

In this same section of the country I came upon something I have never seen before or since. This was nothing more or less than a gorilla "scarecrow." So prevalent were the gorillas and so destructive were they to banana gardens that in one corner of a garden, the people had constructed the rude effigy of a man. The body was made out of pieces of bark roughly tied together; a vine around the middle formed a waist, and a fair representation of a hat was placed on the figure. Then, with white clay from a stream, they had whitened him. Whether they thought a white man would have more effect than a black man, I don't know. Cameroun and Ivory Coast natives often daub white clay on themselves for ceremonial occasions or as a sign of mourning. They had built a little roof over the figure, and from a short distance it looked quite like a man sitting under his little shelter, watching his garden. I asked if it were effective, and the people answered, "Yes, for a while." But after a few weeks, unless they changed his position or renewed his make-up, the gorillas would finally cease to pay attention to the "scarecrow," or should we call it a "scare-gorilla?"

How does a gorilla sleep? Never having desired to investigate too closely into the private domestic arrangements of the gorilla, I cannot say in general what his sleeping accommodations are. But I do know that on occasion, at least, he makes for himself a sort of bed. Like his lesser cousin the chimpanzee, who sometimes uses broken-off branches to build a sleeping-nest in a tree, the gorilla also builds a sleeping-nest, but on the ground. I was taken through an abandoned banana garden by a man who knew the forest and its inhabitants well. The garden was growing up to "bush," and a huge gorilla regularly stayed here. As we clambered through the dense brush, seeing fresh signs of gorilla on every hand, we came upon what might be called a platform of branches with a hollowed-out place in the middle, and at once my man said. "This is the gorilla's bed." He had broken off branches all around as far as he could reach, piled them into this platform, and evidently laid himself down on the middle, where either by design or by his great weight he had left a hollow. The "bed" had been used very recently and probably for several nights, but for how much longer it would be used, I had no way of knowing.

I was out hunting one day in the forests bordering the Campo River, or as the natives call it, the Ntum, and we had been following wild pig tracks for a long distance. Just about the time we lost them, a native hunting a mile or less away shot off a gun. We were retracing our steps when we came upon the tracks of a gorilla who had evidently been startled by the gunshot and had decided to get out of there. He had simply torn through the underbrush of the forest without picking a path, and for a hundred yards he had cut a swath four feet wide, only turning aside for trees!

Well back in the interior of Cameroun, in the region where the Nlong Mefogo River empties into the Nyong River, I separated from my carriers one day and rode my bicycle on a side path through the forest to a town where I wanted to see some people. As I approached the village, I noticed a recently made clearing beside the path, with a central clump that remained uncut, and I wondered what had been going on. In the town, I found seven gorilla skulls whitening on the thatch roof of a hut. Here is the story of those seven skulls. Five or six days before, a band of gorillas had come and settled down in the forest just beside the path leading into this town, virtually closing the road. I was told that they had attacked passers-by, most of whom escaped by fleeing, but finally they wounded a native policeman coming to the town. At last the situation became intolerable, and the whole male population of the town turned out. Two days before my arrival, they had gone out with their cutlasses and spears. First they surrounded the gorillas; then they cut the undergrowth in an ever decreasing circle about them. When they got the gorillas well crowded into the center patch of the circle, the animals started to break out, and the natives killed the whole lot with spears. The road was opened once more to traffic, the town had a grand feast on gorilla meat, and that was the reason for seven fresh gorilla skulls whitening in the sun on the roof. I was glad I had not come about four days earlier, riding my bicycle along that lonely forest path.

It is a common practice of mine to go out collecting butterflies or other insects during the noon hour immediately after lunch. Others take the usual hour's siesta of the tropics, but for me the change of thought and scene is a rest.

One day at Metet I made my way past the hospital and its wards filled with patients, and into the forest along a path leading back to a spring two or three hundred yards in the forest. It was good collecting along the path; various forms of Lycaenidae, the Little Blues, were especially numerous that day, and an hour passed quickly. I was beginning to think that it was about time to get back to work.

I was standing in a small clearing along the path, perhaps a hundred yards inside the forest, examining some "bug" that I had caught, when I rather subconsciously became aware of the continued and anxious clucking of a chicken that had wandered into the edge of the forest from the hospital town. Something made me glance up along the path leading out of the forest, and I saw what I took to be a large boy coming down the path. I gave him but a cursory glance and resumed the examination of my "bug." Then something made me glance up a second time at the approaching figure, and to my horror I saw that it was no boy at all, but a full-grown gorilla standing on the path *between me and home,* regarding me intently. So this was what that hen had been clucking at for the last five minutes. No wonder she was disturbed.

Now what does one do? My first impulse was to run, but the only way open was along the path farther into the forest. Besides, every native with whom I had ever discussed the matter had said, "When you meet a gorilla, whatever you do, don't run. If you do, he will certainly chase you, and being at home in his own forest, he will catch you. Stand up to him, and play the man." All this passed through my mind in a moment, as I stood there in the little clearing through which the path led. I was armed with a butterfly net, a cyanide bottle, and a pair of tweezers. The gorilla was very slowly moving down the path toward me, perhaps sixty feet away.

I decided to try a threatening attitude. So I raised my butterfly net above my head, and brandished it at the gorilla in what I thought a menacing manner. He seemed much interested in this new development. Monkey-like, he cocked his head to one side, then to the other, to get a better look—and *came on down the path.* I decided next to try the effect of the human voice. I again raised my net threateningly, waved it most vigorously over my head, and yelled. (And didn't I mean it!) The gorilla was still interested. He came still farther down the path, until he was just forty feet from me (I later measured the distance). He looked at me a long moment while I wondered what I should do next, and then—he stepped into the bush at the side of the path.

Then I *ran.* I ran back along the path leading to the spring, even though it led farther into the forest, because I knew there was another almost parallel path that led back to the Station from there. A log that had recently fallen in a storm was across my route three feet from the ground. I cleared it without touching it, but stumbled just beyond, rolled clear over and onto my feet again, and kept right on going, still holding on to my butterfly net and bottle. I reached the spring and started back along the other path at full speed. But it was steeply uphill, and halfway back I had to slow down to a walk, gorilla or no gorilla. I got back to my house so totally out of breath that I could not tell for a few moments what had happened. My fellow missionary, Dr. Johnston, and I grabbed our rifles, called two or three natives, and went to the scene of the encounter. The men easily found the tracks of the gorilla, and could see that when he had side-stepped into the bush, he had gone straight away into the forest. But he couldn't possibly have been as scared as I was. Further examination revealed that he had been feeding about that neighborhood for some time. He had probably known of my presence and been watching me during a good part of the hour that I had been collecting there. And just think, during the time I had made little excursions again and again off the path and into the forest in pursuit of my butterflies. I wonder how close I had been to him without knowing it. Well, that's Africa; sometimes the unexpected isn't around the corner, but around the next tree.

The Bulu people of southern Cameroun strongly claim that there is a distinct animal, a cross between the gorilla and the chimpanzee. They have names for all the principal animals of the country, and this has a distinct name. The gorilla is called *nji* or *ngi,* the chimpanzee *woc,* but the hybrid they call *ebot.* They describe it as usually very large, combining the characteristics of the gorilla and the chimpanzee, but claim to be able to distinguish it from either. I have never seen it, and no scientific collector has ever described a hybrid of this sort—indeed, the story will probably not be taken seriously unless tangible evidence is produced. But the natives are emphatic, and they usually know their animals.

It seems undoubtedly true that the gorilla does not usually attack human beings without provocation. There may possibly be exceptions to this, but the general rule holds. However, if wounded or cornered, he becomes a very dangerous animal. Those who live in gorilla country do not consider him the terror of the jungle and do not think one's life is endangered by setting foot in the forest where he lives. Even so, I imagine that it would be difficult to stand before this huge ape without emotion. In the sections where gorillas are most common, the natives seem not to be afraid of them and pay little attention to them. Of course, they see them almost every day. They tell me, and I have heard this over and over, that occasionally a big male gorilla will make a pretense of attacking, but that it is bluff. He will approach to perhaps 20 or 25 feet, act threateningly, roar fiercely, stamp on the ground, turn his rear on you in a disgusting manner while watching you over his shoulder, but will not push the attack home if you stand up to him. He does not like to have you around and evidently wants to scare you off his premises, but if you don't scare, he will finally go away. The natives always carry a cutlass or a spear on any excursion into the forest. Armed only with these, a man will go off alone through gorilla-infested forest and seemingly think nothing of it.

"Oh!" they say, "if he roars at you, yell back at him. If he threatens you, threaten him, and he'll go off after a little while."

All right, friend gorilla—but you don't look it.

LETTERS *Continued from page 4*

that fish can be caught in this way. Have you anything on this subject?

Pittsfield, Mass. LESLIE M. CAIN.

The following information is offered by Dr. E. W. Gudger, well known for his rare knowledge of fishes and strange ways in which they are caught:

Mr. Cain's inquiry about "cuddling" fishes refers to a practice widespread in time and space, of which I happen to have personal knowledge.

In the 1870's, the streams around my home town, Waynesville, on the high plateau of Western North Carolina, abounded in fishes—trout among them. A mile away, my playmate, John Norwood, lived near a lovely brook, in which he and I ("barefoot boys") used to wade and "grabble" for fishes—such was our term for it. I was not much good at it, but John felt unde· stumps, roots, stones, and the banks of the stream, and brought out fishes. Whether he "cuddled" or "tickled" them, I cannot now recall, but he was almost unerring.

John Norwood did not know that he was doing what his English forebears had done centuries before. Shakespeare in his *Twelfth Night* (1602) wrote in Act II, Scene I,

"Lie thou there [on the bank of the stream] for here comes the trout, that must be caught with tickling."

and John Bunyan (1628-1688) speaks of the various snares, lines, angles, and hooks used for catching fishes, and ends that

"They must be grap'ld for, and be tickled too
Or they will not be catched, whate'er you do."

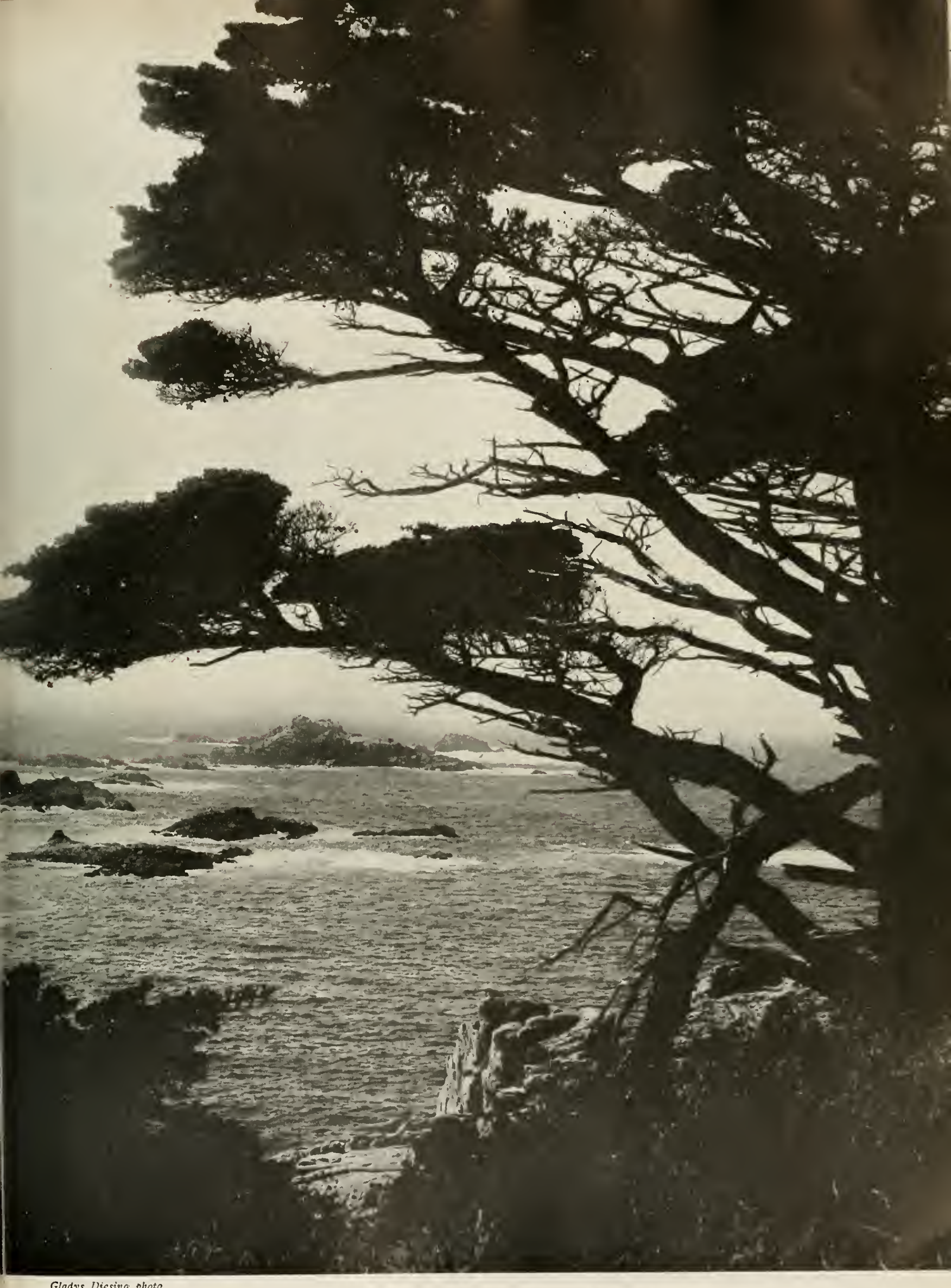
I have other English references to "tickling" trout in both the early and the late 1800's. Indeed, Richard Jefferies in 1892 figured a poacher lying on the bank with his arm and hand in the water. He tells how the hand is lowered gently so that the fish may not be frightened, how the fingers are passed quietly underneath its body, and how the fish should be gently rubbed. "This rubbing soothes the fish so that it becomes perfectly quiescent. Then . . . the poacher snaps . . . his thumb and finger, . . . if he can possibly manage it, through the gills"—and the fish is caught.

This manner of catching fish is very old, probably older than Shakespeare's day. Indeed, it is said that Aelian (who flourished about 120 A.D.) speaks of this fishing. It is known to have been practiced in Panama in 1699, in China in 1872, in Borneo in 1912, and later in various places in the South Seas. But in the Central and South Pacific there is a form of tickling—of all fishes—*sharks*. This is so extraordinary that it needs a paragraph of its own.

The method now to be described has been recorded by many South Sea travelers at many places and over many years. One account may be paraphrased: On a hot day a shark will go out of the warm lagoon to the cool water of the outer reef and stick his head into a cavelike recess in the coral rock and lie there asleep. Marking down the latter end of such a shark, a native diver takes in his hand a strong rope, noosed with a slipknot at one end, and dives into the water. The shark, being head-in under the coral, does not see anything, but by and by becomes aware of a delicate tickling along his side, and he stays quite still and enjoys it. Thus the native tickles the shark as boys tickle trout in England and for the same purpose—to distract the shark's attention while he gets the noose around its tail. The diver then rises to the surface, and the shark is hauled up and dispatched.

THARP'S CABIN: A hollow Sequoia log which was converted by Hale Tharp in the 1850's into living quarters on the edge of what is now called Log Meadow, where he pastured his cattle

Gladys Diesing photo



Gladys Diesing photo

▲ Monterey Cypress, one of our rarest trees: a scene on the Seventeen Mile Drive, near Carmel, California

SEARCH FOR EARLY MAN

Continued from page 15

Weidenreich, to bring my specimens to the Rockefeller Institute in Peking for comparison. The Geological Survey agreed. Our studies there, in 1939, proved that Davidson Black had been right. The resemblance between these two early human types was even greater than we had formerly believed. We were also able to demonstrate that Dubois' interpretation of his own find was wrong. The thick piece of bone that he had thought to be part of the ear was actually only the remnant of a thick bony ridge. X-ray pictures of the new skull revealed sutures not visible on the surface which proved that my reconstruction was correct.

But *Pithecanthropus* II was not the only find. In 1938 came No. III, from a new site not far from the locality that yielded No. II, and certainly from the same level. It is only a small fragment, consisting of the back of a juvenile skull. And in 1939 we found *Pithecanthropus* IV, the back part and upper jaw of a crushed skull, and this specimen came from the lower level. The barren hillside where this find came to light seems dull and uninteresting. But this is a very important specimen, enabling us for the first time to make a trustworthy reconstruction of the entire skull. This skull is larger and heavier than either II or III, and has been called *Pithecanthropus robustus* by Dr. Weidenreich.

Early in 1941 one of our collectors sent us part of an enormous human jaw, which had likewise been found in the lower horizon. For years I had kept some large isolated teeth which I felt could not belong to an orangutan; but human teeth of this size seemed against all theory. Now, however, we had a jaw that surpassed a gorilla's in size yet showed unmistakable human characteristics. I carried the fragment in my pocket for days to get accustomed to the idea! We had discovered a giant, which we named *Meganthropus palaeojavanicus* (*Megas* meaning "great," *anthropus*, "man"). It was only one step farther to recognize the enormous teeth from China as human.

The political clouds had gathered, and the dark time of the war had come. In the first month of 1942, a request came from my American friends to evacuate our most important finds to the U. S. A. But it was already too late. After the surrender of Singapore, we had to give up Java, and I, being in the military service, became a prisoner of war in the hands of the Japanese. We were forced to work in our office during the first month of the occupation, and we were able, with much difficulty, to conceal at least part of the material. We put some jaws among other, unimportant specimens and substituted casts for some of the originals in the safe. The Japanese later became suspicious, but never discovered the truth. The upper jaw of *Pithecanthropus* IV was hidden by my wife; the rest of the skull and the big jaw were protected by my Swiss colleague, Dr. W. Mohler, and the tooth collection, with *Gigantopithecus*, went to Rolf Blomberg, a Swedish friend of ours, who packed them in milk bottles for better protection. The Japanese, feeling sure they would win the war and keep Java, treated our museum and its collections fairly well. Only one of the Solo skulls was sent to Tokyo as a birthday present for the Emperor, but even this was recovered in Japan just a few weeks ago.

When the atomic bombs had done their work and Japan surrendered, I came back to life again. I was deeply moved to find my little family alive, saved by Destiny through the terrors of the Japanese occupation. My happiness was complete when I learned that all my precious specimens had been saved. Large parts of my collections, many of my books, and all of my clothes had been stolen, but Early Man had survived the disaster.

Because of the damage caused by the Japanese, however, it was impossible to continue my scientific work in Java. It was very fortunate, therefore, that through the generous efforts of my American friends, especially Professor Weidenreich, I was able to come to America to continue my research. The Rockefeller Foundation, which already had helped us in Java, gave me a grant to work out my finds in this country, in collaboration with Professor Weidenreich, at the American Museum of Natural History in New York. The Viking Fund provided us with traveling expenses. The Netherlands Government kindly gave me permission to take all the available material from Java to America. And so we came to this country, bringing with us for study and comparison a whole branch of our family tree.

We left Java with all of its troubles in time to arrive in the United States during a shipping strike. And here, Early Man had his last difficulties—passing through the picket line in Philadelphia.

These new finds, the oldest remains of man yet discovered, are surely about 500,000 years old. They show us a new aspect of human evolution, for they indicate that man's ancestors were giants and that we reached our present physical proportions through a decrease in the size of our jaws and teeth—a conclusion wholly unsuspected until now. Much work must be done before we can come to definite conclusions. This story tells you only how these finds were made; it does not deal with their significance. But Professor Weidenreich and I hope to give readers of NATURAL HISTORY Magazine further information as the story unfolds.

How to Avoid Saving Money

by DANNY KAYE

To avoid saving money, the first thing is to cut off all your pockets. (Or throw away your purse and keep your lipstick in your snood.) Thus you will have to carry your money in your hand. Which will insure that you—1. spend it, 2. lose it, 3. get it taken from you—*quicker!*

Also to be ovoided like crazy are piggy banks and sugar bowls. Keep these out of your home! The kiddies in particular are victimized by such devices, often saving quite a bale of moolah. Be stern even if the little ones cry—remember what money could do for them! And be sure to avoid budgets. It is best to draw your pay and walk down Main Street buying anything you don't particularly hate.

Above all, don't buy any U. S. Savings Bonds —or it's *impossible* not to save money! These gilt-edged documents pay fat interest— 4 dollars for 3 after only 10 years! There is even an insidiously easy scheme called the Payroll Savings Plan by which you buy bonds *automatically*. Before you catch on, you have closets full of bonds. You may even find yourself embarrassed by a regular income! Get-gat-gittle!

Danny Kaye

IF YOU MUST SAVE

SAVE THE EASY WAY...

BUY YOUR BONDS THROUGH PAYROLL SAVINGS

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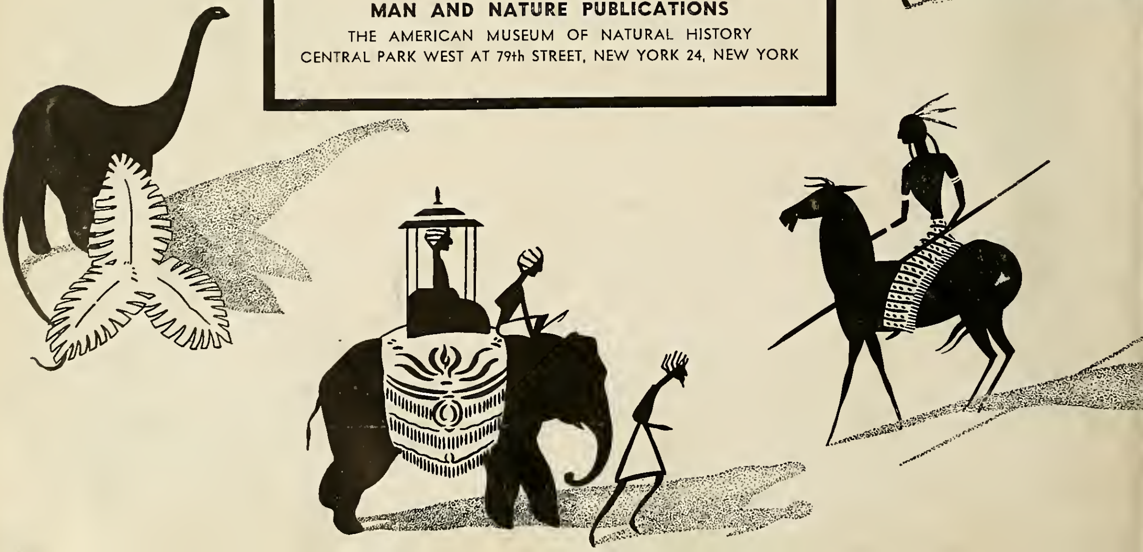

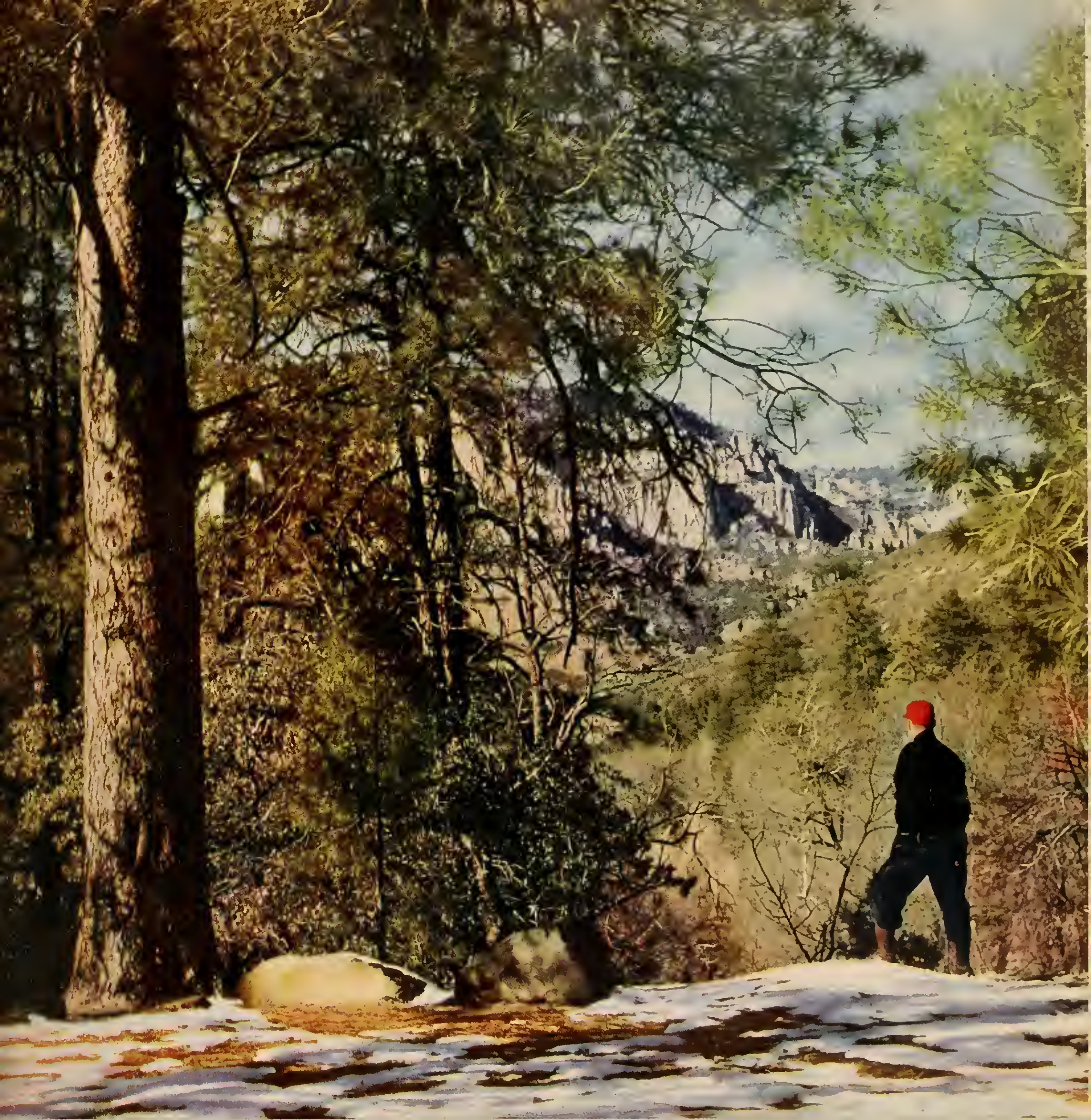

February **NATURAL HISTORY** 1947

The "Bambi" of the Perfume World · Coca · Joshua Tree

Indian Metal Arts · Lincoln on a Totem Pole · Caracaras

L E T T E R S

Snowhouse Size and Temperature

Mr. Belmore Browne's article on the snowhouse is very interesting, but no information is given on the diameter of the inside, the width of the sleeping platform, or the clearance between it and the inside of the "king block." I would like to know how much these measurements may vary and how many men, six feet tall and equipped with gear, can sleep in the snowhouse per foot of the diameter.

LAWRENCE J. MEAD.
Darien, Conn.

There is considerable variation in the size of snowhouses built by Eskimos. The Eskimos in Northern Greenland, for instance, build snowhouses only for temporary use while on the trail. Eskimos in some other regions live in them continuously through the winter and build snowhouses 18 or 20 feet in diameter and from 9 to 11 feet high. When the family group is large, several domes are generally built close together and connected with passageways.

Therkel Mathiassen measured a snowhouse at Pingerqalik that was 21 feet in diameter and 12 feet high. And there is record of one 27 feet in diameter and 12 feet high, but it was too big for the material and had to be supported by battens.

By describing a circle in the snow with a cord, it is possible to keep the form more regular. Of course, if the dome goes higher than you can reach, it is necessary to stand on something. But where the snow is firm and deep, the floor is excavated after the house is built, and the height inside near the door is then greater than might be suspected from the appearance of the house from the outside.

Floor plans of Eskimo snowhouses indicate that the platform, more often than not, takes up more than half of the room. The purpose of the platform is, of course, to provide a "bench" and sleeping place high enough to be warmer. Headroom and temperature are the main factors in determining its height.

The number of men who can sleep in a snowhouse is approximately the same as the number that can sleep in a tent of the same shape and size.—ED.

° ° °

SIRS:

There seems to be some controversy regarding the warmth of the Eskimo snowhouse. In "Let's Build a Snowhouse" by Belmore Browne, the snowhouse is described as "the warmest, strongest, most dependable, stormproof emergency shelter known." However, in "Canada's Caribou Eskimos" by Donald B. Marsh (*National Geographic Magazine*, January, 1947), it is stated: "In winter the temperature within the igloos fell as low as 30° below zero. Though they were sealed tight against polar winds, these snowhouses were almost as cold as outdoors."

Which author is right?

LAWRENCE RYEL.
Milford, Mich.

° ° °

SIRS:

The article by Belmore Browne on the snowhouse was very interesting. However, . . . Donald B. Marsh's article on the same subject . . . gives a diametrically opposite view . . . I would suggest that these two authors get together to reach some kind of an agreement.

C. T. MINNICH.
Grand Island, Neb.

° ° °

SIRS:

. . . I find it difficult to reconcile Belmore Browne's discussion of the temperature inside a snowhouse with what Donald B. Marsh has to say about igloos occupied by Caribou Eskimos, who must know how to build a snowhouse!

(MRS.) C. E. ARCHER.
Tampa, Fla.

Donald B. Marsh and Belmore Browne are both right. A snowhouse, like any other house, has to be heated before the air inside reaches the temperatures Mr. Browne gives.

The Eskimos sometimes do not have enough fuel or the desire to heat their houses in this fashion. The inland Caribou Eskimos, in particular, are often short on fuel. Unlike the coastal Eskimos, who burn seal oil, the Caribou Eskimos depend on caribou tallow for fuel. The following description is from Knud Rasmussen, who was one of the first scientists to live among the inland Caribou Eskimos:

"The only form of winter dwelling known to the inland Eskimos is the snow hut; but having no oil or blubber, they are unable to heat them, though the thermometer in the cold season may often fall below minus 50°. During the long, dark evenings, their only light is a sort of primitive tallow dip, made of moss and caribou fat."

Most Eskimos living in snowhouses generally have more fuel (seal oil) and keep them much warmer than this. White men often like to make a snowhouse still warmer and, especially with kerosene or gasoline stoves, can raise the temperature more rapidly. Mr. Browne's figures are dependable. But remember that the outside temperature should be very *low* to permit raising the inside temperature very *high*. Otherwise the cold will not continue to penetrate the snow wall well enough to prevent melting. The inside of the snow wall must remain at 32° F. or lower. A relatively thin layer of insulating air protects it from the warmer temperatures inside the house, and the Eskimos sometimes improve this insulating layer by pegging skins to the wall.—ED.

Bees

SIRS:

In your November number there is an interesting article by F. W. Lane on "Strange Uses for Animals," in which the author states that ". . . during the first world war, German troops in East Africa used bees to fight the British soldiers, but how this was done, I have not been able to ascertain."

I know the following about this: In November, 1944, the English attacked Tanga, the most northern port of what was then German East Africa. It was done from the seaside, and troops, mostly Indians, were landed just north of the town and approached the town through a sort of half-jungle such as is often found near settlements in Africa. There were a lot of beehives in the trees. The bees incidentally became disturbed and attacked the British troops in great numbers. In popular accounts, the bees are accredited with having saved Tanga for the Germans. Probably the Germans liked the idea that the bees had fought on their side, and the British liked the idea that they were not beaten by the Germans but by bees. However, from what I have read and learned from discussion with people in East Africa, it does not seem that the bees really influenced the outcome of the battle.

More than a year later, Tanga was taken by the British approaching from the northeast along the railroad. If the bees were active this time, the results seem not to have been worth mentioning.

(DR.) N. H. VAN DOORNINCK.
Washington, D. C.

Snakes and Stuff

SIRS:

. . . I have just passed my 79th birthday, and, having been a student of wildlife from my earliest recollection, I can hardly wait the month for the arrival of your magazine, always with the knowledge that you will bring some information of extreme interest.

Continued on page 96

"We're on a real rush job"

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BELL TELEPHONE SYSTEM

NATURAL HISTORY

The Magazine of the American Museum of Natural History

FREDERICK TRUBEE DAVISON, President — ALBERT E. PARR, Director

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Andean coca and its addicts

THE COVER THIS MONTH

This brilliant example of the color photographer's art shows a view in Oak Creek Canyon in central Arizona. The Canyon begins about 15 miles southwest of Flagstaff and is flanked by the Coconino Plateau. On top of the plateau is a yellow pine forest, which follows the canyon for a few miles. Here U. S. Route 79 drops from 7000 to 2500 feet through white and red sandstone cliffs.

Within 25 miles of this spot lie such interesting points as Meteor Crater, Walnut Canyon National Monument, the Lowell Observatory, Sunset Crater, Wupatki National Monument, Cathedral Caves, and the highest point in Arizona (Humphrey's Peak).

The picture was taken on December 20, 1945, by Thomas Peters Lake, of Alexandria, Virginia. A 4 x 5 view camera was used, with an exposure of one-fifth of a second at f:20. In order to balance the composition, the photographer himself stood in the picture and operated the camera by an electric release.—ED.

You will find NATURAL HISTORY Magazine indexed in *Readers' Guide to Periodical Literature* in your library

PUBLICATION OFFICE: American Museum of Natural History, Seventy-ninth St. at Central Park West, New York 24, N. Y.

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NATURAL HISTORY is published monthly (except July and August) at New York 24, N. Y. by the American Museum of Natural History, Seventy-ninth Street and Central Park West. Subscription price $4.00 a year, single copies fifty cents. Subscriptions to Canada, Newfoundland, and all foreign countries $4.50. Entered as second class matter March 9, 1936, at the Post Office at New York, under the Act of August 24, 1912. Manuscripts and illustrations submitted to the Editorial Office will be handled with care, but the publisher cannot assume responsibility for their safety.

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YOUR NEW BOOKS

NEW GUINEA HEADHUNT • PATH OF SCIENCE
THE NAVAHO • MASTERS AND THE SLAVES

THE MASTERS AND THE SLAVES

- - - - - - - by Gilberto Freyre

Alfred A. Knopf, $7.50

THIRTEEN years ago Gilberto Freyre published in Brazil a study of that country's population—its ethnic origins, its miscegenation, its adjustment to local conditions. Under the title of *Casa Grande & Senzala* and in the original Portuguese, it appeared in four editions in rapid succession. In addition it was published in Spanish. And now in the present translation it becomes available to the English reading public. To those who heard of it by reputation alone, this will be a welcome opportunity to explore it at firsthand.

Professor Freyre essays to evaluate the significance of each of the three principal elements in the formation of the basic structure of Brazilian population: the Portuguese colonizers, the native Indians, and the Negro slaves. These are described in their characteristic features, in their relation to each other, and in their response to the local conditions provided by Brazil. From the commingling of these elements has emerged a new people, compounded of them all and moulded by the peculiarities of culture, climate, food, and soil.

To develop his thesis and to provide a background for understanding the processes he describes, Freyre has levied tribute from an exceptionally wide range of sources. History, sociology, anthropology, economics, physiology, nutrition, and literature, among other fields of inquiry, are made to yield direct or indirect evidence. Detail on detail, often rich and full of human warmth, is laid on to heighten the lights and deepen the shadows. The whole effect is more like a work of literature than an objective scientific treatise. Even the style is complex, dense, and involved.

To an outsider it is difficult to estimate the justness of Professor Freyre's treatment of his subject. Much depends upon what sources he has used and, more important, which ones he has ignored. Are the emphases he has given to certain facts correct or distorted? Such judgments can be made only by one as familiar as the author with the literature and the sources he has investigated. Where the discussion has centered on subjects with which I enjoy a slight familiarity, I have detected a somewhat uncritical use of authority and a failure to cite significantly pertinent works. It may perhaps be asking too much of any author covering so wide a range of topics to display a professional knowledge of each one.

But whether or not Freyre has in every instance pictured justly the composite elements of a complex story or even truly depicted the major trends, he has written a rich, absorbing, and highly rewarding account of his people.

H. L. SHAPIRO.

NEW GUINEA HEADHUNT

- - - - - - by Caroline Mytinger

The Macmillan Co., $4.00,
441 pp., 8 illust.

READERS of Miss Mytinger's book, *Headhunting in the Solomon Islands,* entranced by the humor and charm of her style, will enjoy her New Guinea adventure. Headhunting in her books is the innocent, peaceful pastime of painting portraits of men and women whose late ancestors had been cannibals and had gathered human heads as trophies. In New Guinea the subjects of a few portraits were prisoners to be tried for nostalgic relapses to the traditional gastronomic customs of their fathers. Many outlying posts in southwest New Guinea were visited, in some of which the native Papuans had never seen white women; and even where there were a few such women, the preference of the artist and her companions for slacks and bathing suits was a bit confusing.

Even more information on native life and customs will be found in this volume than in the Solomon Islands book. Yet the adventures narrated are equally vivid and occasionally "hair raising." The reader will meet with black magic in its most tragic roles, the gruesome craft of tatooing, and the terrors of the witchcraft racket. Some insight is given into the Papuan sex problems; and there are less moving accounts of fire-making, unique methods of setting heavy wooden piles on soft earth without the aid of machinery, and the function of the canoe in implementing Papuan culture. In an illuminating way, the author discusses suicide as a Papuan complex, the weird appearance of certain albinos, and some of the possible reasons why native arts decline so quickly when contact with Europeans is achieved.

The author's humor arises from skillful exaggeration and unexpected, often audacious choices of words and analogies. If there are dull pages, they revel in the details of anatomy and in descriptions and comparative notes on civilized versus native attitudes, such as delight anthropologists. If the reader is amazed at the fanatic urge of Miss Mytinger and her companions to paint the heads of a few vanishing savages, he need but recall Catlin and a long procession of artists down to the present whose zeal for rescuing such vanishing types rivals the sacrifices of missionaries to save a few savage souls.

C. W.

NEW ENGLAND'S BURIED TREASURE

- - - - - - - - - - by Clay Perry

Stephen Daye Press, $3.50,
348 pp., 56 illust.

"CAVEMEN" include all sorts of naturalists, apparently. In all its ramifications, the art or science of "spelunking" is one of the broadest that one is likely to encounter. All of the sciences of the earth's surface, including botany, zoology, geology, and the like, have special subterranean phases that may be the subject of study for people who have a general interest in caves. Some of these have banded together to found the National Speleological Society, and this volume represents the first of an authorized series of publications to be known as "The American Cave Series."

Perhaps because New England's notable caves are few in number, the author has extended his field to include many man-made openings in the earth. Since the denizens of the underground world can live equally well in man-made openings, the biologist naturally finds equal interest in them. Many mines are mentioned in the work, some of which mineral collectors like to visit. The latter, however, will find little of interest in them and usually are wiser to spend their time on the dumps. Now that we have read of some of the hazards of cave-crawling, this reviewer is confirmed in his impression that the collection of minerals *outside* the old mine tunnels is a healthier occupation.

The difficulties Mr. Perry encountered in assembling local historical information on the small crime waves associated with caverns and integrating it into a readable whole are obvious. With such varied aspects of science and history held together by the slender thread of speleology in a travel guide, the book becomes a veritable Caesar's wife. It makes an interesting guide to special aspects of the New England states. No doubt subsequent works of the same series will be able to concentrate more largely on caves, reducing the emphasis on the man-made openings, murderers, counterfeiters, and Tories. True caves, with interesting travertine deposits, are almost exclusively found in limestones, and since New England has never been rich in lime formations, there is room for other matters. We feel that when Mr. Perry gets to some of the other states, he will have his hands full, and the bats and the spiders will be considered of less moment than the dripstone formations.

F. H. Pough.

The navaho

- - - - by Clyde Kluckhohn and Dorothea C. Leighton

Harvard University Press, $4.50, 258 pp., 15 illust.

Dr. Kluckhohn, Professor of Anthropology at Harvard University, has been studying the Navaho Indians, or "The People," as the Navahos call themselves in translation, for more than 20 years. He is author of *Beyond the Rainbow* and *Navaho Witchcraft*. Since 1942 he has been an expert consultant to the United States Office of Indian Affairs. Dr. Leighton, the co-author, is a psychiatrist whose chosen field has been the social sciences with special reference to the Navahos. She and her husband, Dr. Alexander Leighton, published *The Navaho Door* in 1944.

Every page of the book under discussion shows that it is a thoroughgoing study. The treatment is sympathetic and intimate, but it maintains an unsentimental and unbiased approach.

The Navahos form the largest Indian tribe in the United States and now number about 55,000. They have increased with surprising rapidity since 1868, when there were probably only 10,000 to 15,000, and they are still increasing at a rapid rate. A most serious problem has developed as to how these people are to make a living and how they are to live with the white Americans.

In order to approach this crucial problem intelligently, this study has investigated the past history of the Navahos, their sources of livelihood in their crowded land, what the people look like, how they dress, and how they live in their "world of the hogans." Moreover, the book discusses the relation of the Navahos with the people around them, both Indian and white, and explains how they actually live in two worlds. The authors offer valuable observations on education, medical services, and many other considerations. They analyze in a very common-sense manner the place and meaning of the supernatural, as envisioned in Power and danger, things to do and not to do, myths, ceremonials and rites. Then follows a chapter on the Navaho language and one on the Navaho view of life.

The volume is illustrated with a score of well selected photographs. Altogether it is an outstanding book.

Clyde Fisher.

The path of science

- - - - by C. E. Kenneth Mees, with the co-operation of John R. Baker

John Wiley and Sons, $3.00 250 pp., 7 illust.

To be a successful scientist today requires concentration of effort and long training. To be a successful historian likewise is an absorbing task. Who then shall write the history of science? The danger is obvious when a specialist writes outside the field of his specialization. A book with the title *The Path of Science* calls for authority in both history and science. The author and his cooperator are well established as research scientists, but they would hardly be considered authorities in the field of history. Yet, they make their point well that the history of man is in no small part the history of man's scientific endeavors.

Here is an attempt to show that scientific progress or, rather, man's progress in scientific thinking, is the only real advance, the only true progress in man's relatively short existence upon the earth. The prehistoric period and the early history of man are reviewed very briefly. The method of science and its development are given consideration. Separate chapters are devoted to the growth of physical, chemical, and biological ideas. However, this reviewer believes that the real contribution of this book lies in the chapters on the production of scientific knowledge and on applied science and industrial research.

Especially interesting is the discussion of research programs and their problems. One may not agree fully with the author's proposals regarding the functions of a research director, but one cannot help feeling that more of the scientific method might profitably be applied to the execution of research programs. Since science is never supposed to close the door on a single fact or endow it with immortality, we should always admit the possibility of more productive methods for enlarging man's scientific knowledge. This is not the only book of its kind to appear recently, nor do we suspect it will be the last. What is important is that our men of science are taking the time to consider the relation of their activities to mankind in general. The cracks that are widening in the base of a number of "ivory towers" give promise of benefit to all of us.

John R. Saunders.

Science since 1500

- - - - - - - - - by H. T. Pledge

The Philosophical Library, $5.00, 357 pp.

The aim of this book, written by the Librarian of the Science Museum of London, is to provide material chiefly for university students and research workers. There are 25 chapters besides a few pages of bibliography. The method of treatment is a combination of the chronological order and subject-matter divisions; for example, mathematics is discussed not only historically but in a systematic manner at several places in the book. To write even a small treatise on such varied subjects is a difficult undertaking for one person, and one that requires extensive training.

In addition to mathematics, physics, chemistry, and biology, the author has also covered astronomy and to a lesser extent geology. There is much detail on experimental sciences, microscopy, evolution, Darwinism, genetics, ecology, systematic botany and zoology, embryology, biochemistry, the chemical revolution, quantum mechanics, kinetic theory, relativity, and cosmology. The interrelations of the sciences and of the scientists are well brought out. On page 45 there are notes on "villainous" scientists.

The book is written in a systematic and scholarly fashion, is well documented and heavily dated (as a historical work needs to be), and the author's vocabulary is rich. While the language is straightforward and clear, the text is necessarily heavy reading. The illustrations are fairly interesting and several maps show how birthplaces of scientists are grouped particularly around certain regions. Some charts are rather unique in revealing the connection between master and pupil; a study of these shows, for instance, who taught Bunsen, and what men were his pupils.

Pledge's history contains an immense amount of facts. It summarizes excellently, although unobtrusively, the innumerable situations developing through the years, and it stresses the "unfinished" character of many sciences.

HUGH S. RICE.

VOICES IN THE WOODS

- - by Mabel and Eugene Swope

The Paebar Company, $2.50,
186 pp., 11 illust.

DELIGHTFUL and useful well describes Mabel and Eugene Swope's unpretentious little book *Voices In The Woods*. The Swopes were the gentle, kindly, and hard-working persons who developed the well-known Roosevelt Bird Sanctuary, under the sponsorship of the Audubon Society, at Oyster Bay on Long Island. Commencing his efforts in 1924, Mr. Swope labored faithfully for fifteen years to establish a twelve-acre woodland area for the enjoyment, protection, and propagation of song birds. The site is adjacent to the burial place of Theodore Roosevelt, and the Sanctuary is a memorial to our bird-watching President. The book charmingly describes the joy, inspiration, devotion, and tribulations that attended the establishment of this model wildlife haven.

The free-flowing, informative narrative makes it abundantly clear that Mr. Swope was primarily concerned in the welfare of song birds and that his attention to a not always appreciative public necessarily came second in the line of duty. He properly considered that the difficult task of making the Sanctuary acceptable to as many species of birds as possible was his initial and continuing major responsibility. The work is described in happy fashion, with many philosophical, genial, and sometimes frankly sentimental and faintly opinionated comments on life in general and bird-human relationships in particular. Enemies of his jealously guarded feathered charges, whether people, cats, predatory birds, or snakes, were summarily dealt with.

This is a pregnant and highly worthwhile book for the sanctuary and outdoor educational builder and for all who are nature- or conservation-minded. It is to be regretted that the proofreading, illustrations, and format of the volume do small justice to its meaningful contents. And, oh, I nearly forgot "Fussy," the little white dog that contributed a great deal both to the Sanctuary and to the book, as an intelligent, never failing warden and protector, and as an all-round interesting and cheerful "character."

WILLIAM H. CARR.

RUMBLE OF A DISTANT DRUM

A True Story of the African Hinterland

- - - - by Mary L. Jobe Akeley

Dodd, Mead Company, $3.00,
364 pp., 21 illust., 1 map

UIMBIA GIKUNGU was Carl Akeley's gunbearer over a period of more than 15 years, and to him this book is dedicated. But the story is of a much younger African, the boy Mihigo, from the Kigezi District of Uganda, who begged to join Mrs. Akeley's expedition. Almost the only position open for such a young child would be that of helper to the cook. The party had come from Nairobi to the gorilla forest on the Kivu Volcanoes, and now had re-entered Uganda on the sad journey eastward after Carl's death.

At Kisolo the ten-year-old Mihigo joined the party, ready to do whatever work might be given him. Mrs. Akeley observed him closely on her way to Kampala, Lake Hannington, and Nairobi. That was truly an adventurous journey for him. To fathom the thoughts of such an African child is no simple task, but here a brave attempt is made.

Mary Akeley gives us not only the story of this boy's joys and tribulations,—they form the main body of the book—but she also lets her fancy roam through the next 16 years. She pictures another great adventure in which he may well have taken part. By 1940 Mihigo would have been 24 and ready to play a courageous part as a soldier in freeing Abyssinia. What might be more natural, after that, than to see him return to his village and settle down again as a man of consequence, with family and cattle?

For all I can say,—and I knew several of the Africans involved—the story is true. Now that Mary Akeley is back revisiting the Albert National Park, she will certainly feel tempted to push on the few miles to Kisolo and look up Mihigo.

JAMES P. CHAPIN.

Fantastic Lily

Brilliantly beautiful when fed by the rains and serving as hospitable host to desert wildlife, the Joshua tree has fought a persistent battle against the opposition of man and nature

By CATHERINE AND DICK FREEMAN

All photographs by the authors

"THE most repulsive tree in the vegetable kingdom" is what John C. Fremont called the unique tree yucca, or Joshua, of our southwestern United States. Perhaps his lack of acquaintance with this stiff, well-armored desert dweller led him to make such a rash statement. Surely, no one who has seen a Joshua forest in bloom would ever subscribe to such a slanderous description of this most unusual and interesting plant.

As with all desert plants, this giant lily's destiny is controlled by the supply of water available each season. If the rain gods decree a small supply, *Yucca brevifolia* produces few or no blossoms and uses up most of the reserve moisture in its stalks and leaves until the whole plant takes on a dry, parched appearance, producing the "stiff, ungraceful form" that may have called forth Fremont's description. But when water is abundant, the plants usually in March, burst into glorious bloom and present an unforgettable sight.

Life in a desert is at best not simple and easy, and any plant surviving for so many centuries as has the Joshua must be well fortified by Nature to preserve itself. The Joshua has proved itself excellently equipped, not only with its sharp bayonets, which keep away many unwelcome guests, but also with its rigid form, which makes a sturdy fight against the very frequent gales that sweep the desert, especially in spring. Until man arrived to plow the ground and to destroy these trees, not only for useful purposes but for pure vandalism, the tree yucca was making a very successful fight for existence. Against this enemy Nature had not prepared the plant, and in the Antelope Valley around Lancaster, California, acres of tree yuccas have been destroyed. Unfortunately, the largest ones ever known to exist have been found here, so unless public opinion is

◀ The flower cluster, with its undeveloped buds, at its most lovely stage of growth. The bracts are tinted delicately on the outer surface with ashes-of-roses and within with a pale lemon-yellow

roused to save them, they will probably be lost for future generations. There are two large and exceptionally beautiful groves, one east and one west of Lancaster, both located on private holdings which well deserve the public interest.

Some of the groves have not been menaced in this way, and, happily, a large forest above the Coachella Valley, part of the most southerly stand of the plants anywhere, has been set aside by the Government as the Joshua Tree National Monument.

Some 30 yuccas are found in central and southwestern North America, but the Joshua tree is one of the few that reach tree size. It is found mainly in California, almost entirely within the Mojave Desert, but also extends east into adjacent Arizona, Nevada, and the extreme southwestern corner of Utah. Found nowhere else in the world, it is indeed a unique plant, and by that very fact it deserves protection as a rarity.

At present the Joshua tree grows only on or at the base of high desert mesas or lower mountain slopes, where the precipitation averages eight to ten inches a year. This corresponds very generally to the upper edge of the Sonoran Zone. But in ancient times when moisture was more abundant, tree yuccas were found over a much wider area and at much lower altitudes. Scientists have found evidence to show that these plants once grew in sections of southern Nevada where they no longer are found, at a time when the giant ground sloth (*Nothrotherium*) roamed the land.

Many pioneers who made early acquaintance with the Joshua were not so critical as Fremont, and a tale told of the naming of the Joshuas by the early Mormon pioneers is pleasing, if not wholly reliable. A group of these hardy pioneers, according to the tale, were trekking across the Mojave in search of a spot Brigham Young had seen in a dream. The vision had told him that at the foot of a great arrowhead on a mountain side the Mormons should plant a colony. This proved to be San Bernardino at the foot of the great natural arrowhead above Arrowhead Springs.

The party was almost famished and worn out from their hardships when they came upon the great tree yuccas near the present town of Hesperia, California. The sun which had been blazing hot became suddenly overcast, and the leader, feeling it was "a good omen from the Lord Almighty," said, "It is as if the sun stood still as Joshua commanded." These great trees seemed to be lifting their arms to Heaven in supplication, and the

▼ Camping among the Joshuas is a very pleasant experience. The fragrance of the blossoms scents the air, and their beauty surrounds the camp

F OUR SOUTHWEST

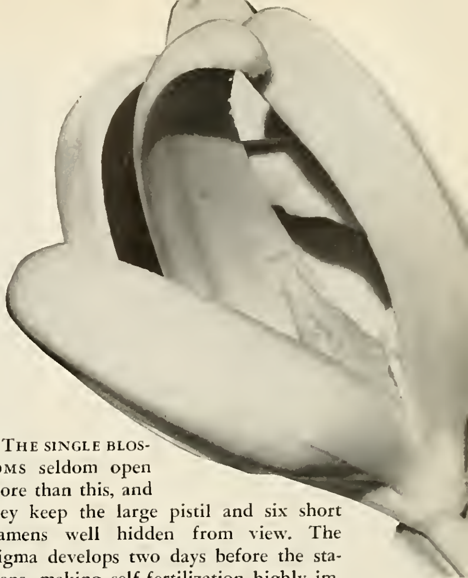
▲ IT IS DIFFICULT at first to distinguish the developing "bud" at the end of the branch. It looks like unfolding leaves and is the same color

◄ THIS VIEW of the swelling panicle shows the soft, suede-like texture of the bracts as the buds within push outward against them

travelers would soon come to the end of their journey. True enough, the next day in the Cajon Pass they found water, and not many days later, near the end of the same pass, they found the immense arrowhead on the mountain pointing to their journey's end.

The term "cabbage tree," applied by early pioneers, may have been used because of the cabbage-like appearance of the young stalk of buds, though to many it appears more like a huge artichoke, the size of an ostrich egg.

This large bud bursts out from the end of each branch, swelling rapidly into one of the most perfect creations of Nature. The buds are inclosed in soft suede-like bracts which are often tinged with delicate ashes of roses on the outside and the loveliest lemon-yellow on the inside. As the panicle develops,



THE SINGLE BLOSSOMS seldom open more than this, and they keep the large pistil and six short stamens well hidden from view. The stigma develops two days before the stamens, making self-fertilization highly improbable

A GREENISH CAST comes over the full-blown panicle, and an insistent, cloying, somewhat earthy, mushroom odor fills the air in the vicinity

AN ESPECIALLY HEALTHY YOUNG JOSHUA in very full bloom. The age of this plant cannot be computed, as yuccas do not have tree rings showing annual growth. Some believe the Joshuas live to ages ranging from 600 to 1000 years or more. But this is problematic

the ivorylike flowers press out against the bracts, clambering each for its own place in the sun. The panicle becomes so densely crowded with blooms that the flowers seldom open out except where the stems lengthen, allowing the flower a little more room. A greenish cast comes over the blooms as the panicle develops to maturity, while within each blossom the six feathery anthers are covered with heavy, yellow pollen.

However, as with all yuccas, the plant does not pollinate itself, for the pistil develops some time before the stamens, making self-fertilization impossible. The small pronuba moth (*Tegeticula paradoxa*) has adopted the Joshua as her own and, after laying her eggs within the ovary walls, ascends the pistil to force a ball of pollen into the stigma. The larvae do their share by eating only part of the seeds, and the rest, thrown out on the desert floor, develop into new Joshuas to continue the cycle.

But the Joshua does not depend entirely on these seedlings for its generation. In addition it sends out runners from the root system, which develop young plants. These grow up about the parent plant, making rather crowded groups or thickets as the older plants droop with age. Although this is a much more successful method of reproduction, these young plants that have developed from runners are semi-succulent and have an enemy which prevents many of them from reaching maturity.

A beautiful butterfly (*Megathymus yucca navajo*) finds them a very tender host for her young larvae. In some unaccountable way she knows which young plant is of this kind and which is a seedling. As the seedling does not have much root, the young larvae could not burrow down deep enough, so the parent chooses the sprout from the runner. She deposits her egg, and the larva, on hatching, burrows to the base of a leaf, consuming the heart of the sprout before burrowing down into the root. Here it enlarges and extends its burrow as the plant dies. Then the larva creates an extension chamber up through the center of the dead sprout. This extension is made of soft, white silk which is covered on the outside with refuse or the chewed-up inner pulp of the plant. Within this silken chamber in mid-September the larva ceases feeding and covers itself with a flaky, white substance which is slippery like soap. Here it passes the winter, pupating in January or February to emerge in late March or April. Fortunately this butterfly seems to prefer yuccas located in foothill canyons, so the plants on the open deserts have a much better chance to develop into the great forests we find there.

The tree yucca grows to a height of 16 to 30 feet, sometimes with a spread of 20 or more feet and a trunk of from one to three and a half feet in diameter. The size

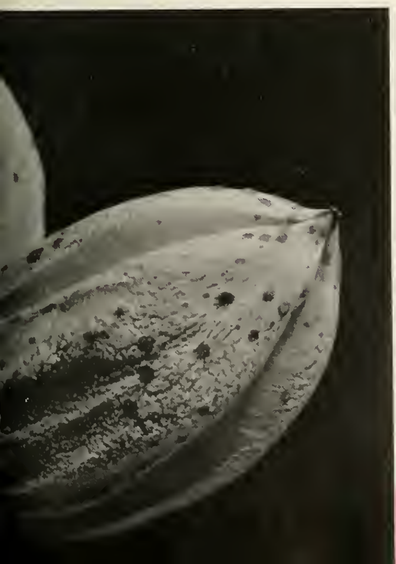
▲ JOSHUAS often assume curious shapes, usually when growing under hostile conditions or near the margin of their range. This one, with arms outstretched, strangely resembles a cross

➤ A CLOSE-UP of the capsules or fruits still in the green stage, showing the persistent perianth. The dark spots are probably evidence of parasitic larva, which injure the plant tissues just beneath the surface. Fungus growth, perhaps, may also make such spots

◄ As THE OVARY and its seeds develop to maturity, the once beautiful bracts and petals shrivel and become dry and brittle. They do not break off, however, but persist on the stem, often remaining as long as the pods and giving a most ragged appearance to the stalk

▼ WHEN CONDITIONS ARE FAVORABLE, the developed ovaries, or pods, crowd the stalk as densely as the waxen blooms did before them. The pods remain intact on the stalk until they become dry and brittle. When finally broken off, perhaps by winds, they go rolling over the desert, scattering their seeds as they break

▲ RANGE of the Joshua tree



▲ The adult female butterfly (*Megathymus yucca navajo*) lays her eggs in the young sprouts that develop from runners of the Joshua. This butterfly has a two- to three-inch wing spread

➤ The larva of the "navajo" butterfly creates an extension chamber of "silk" up through the top of the dead sprout. This extension is covered with refuse that gives it a brown, dried-up appearance

▼ The bark of the Joshua tree looks much like the bark of an oak

varies decidedly according to locality. The very largest, according to various authorities, have been found east of Lancaster, California, some tales claiming heights of even 65 to 80 feet.

The age of tree yuccas is also a subject of considerable speculation. One estimate places the age of a venerable giant in the Lancaster area at well over 1000 years. Mr. W. A. Chamberlain of Victorville, California, says that an eighteen-inch Joshua which he transplanted near his cottage reached a height of fourteen feet in 20 years.* In 1929 he planted seeds from this tree in a sort of nursery he constructed. They all sprouted and in 1938 ranged from ten to fifteen inches in height. He also says that sprouts developing from the runners grow much more rapidly, one five year old shoot being nearly three feet in height. Most authorities seem to agree that they may live to be several hundred years of age, but there seems to be practically no definite information on the matter.

The young plant grows up to some four to ten feet before it bears its first blossom, which causes a new branch to form where the flowering occurred. This branching occurs again and again at each flowering, until at maturity the tree forms a beautiful, well-rounded crown on a columnar trunk about eight to fifteen feet in height. It is supported by a vast system of small roots which penetrate downward and sidewise for great distances to absorb water. These form a most effective support against frequent winds, and the plant is very seldom uprooted. Frequently the tree drops one branch after another. The branch seems to become too heavy for its strength and lowers itself, eventually becoming prostrate on the ground. Lack of moisture may have a good deal to do with this. From this prostrate position it continues to bear blossoms and de-

* Desert Magazine, July, 1938.

▲ THE BRANCHES of this very large tree have drooped. Even on the ground they continue to bloom and branch, refusing to give up life

➤ WHEN THE CAPSULES reach their full maturity, they break off and go rolling over the rough desert floor. The frail outer covering is soon broken to let the seeds escape and lodge in many scattered spots. Old flower stalks, however, often remain on the tree for several years—gaunt reminders of past grandeur

velop new branches, showing great tenacity of life.

These fallen limbs, often thick and dense, furnish an excellent protection for numbers of desert animals. Wood rats climb among the reflexed dead leaves, which sheath and protect the trunks. These they often gnaw off and use as debris above their burrows, probably to protect themselves against coyotes and other enemies. Oftentimes one will find the buds or flowers

Continued on page 94

LINCOLN on a Totem Pole

▲ ABRAHAM LINCOLN, as commemorated by the Raven Clan

The strange story of how the Tlingit Indians honored the man who freed the slaves

By VIRGINIA S. EIFERT
Editor, Illinois State Museum

AMONG the many ways in which Abraham Lincoln has been honored by the world, one of the strangest is the story of how the Alaskan Indians carved his figure in heroic proportions as part of a memorial totem pole.

Kindly, inscrutable, dressed in glossy black, with a tall hat on his head, and with legs abnormally short where they joined the uncarved shaft, Lincoln stood on his high perch on a small Alaskan island. The snowy mountains rose behind him; the curving shore with its busy tides lay at his feet; the northern suns and storms beat upon his wooden features. And somehow the tradition of Lincoln remained vivid among a people who knew nothing about this man but one important thing: he had freed them from slavery.

The story goes back to the year 1867, when Alaska, with much public criticism and general misunderstanding on the part of the people of the United States, was purchased from Russia for $7,200,000. People called the purchase "Seward's Folly" and agreed that it was a most unwise extravagance. The Civil War had ended only a few years before, and the country still labored under heavy war debts and the costs of reconstruction. It was not the time, said the critics, to spend money on an "icebox," a land so far to the north that it was believed useless for human habitation or profit. The people of the United States at that time knew as little about Alaska as the Alaskans knew about the events that had taken place farther south on the American continent.

After the purchase, and after the Russian flag had come down at Sitka and Kodiak and Baranof, a United States revenue cutter was sent to the newly acquired territory. Shortly after the cutter had passed through the Portland Canal near the boundary between British Columbia and Alaska, the captain discovered a flotilla of high-prowed, brightly painted, wooden canoes paddling through a channel in the Prince of Wales archipelago. The canoes with their killer-whale designs and their raven prows were filled with people—young men and old in their peaked rain hats; plump young girls and stolid old women wrapped in bright blankets; fat, sloe-eyed children and wolfish-looking dogs that moved restlessly in the cramped space. Jumbled with them in the long canoes were wooden boxes decorated with raven designs; carved ceremonial masks, great potlatch spoons; otter furs; and other treasures of the tribe. But this was not a peaceful migration. As though they were being pursued, the people in the boats looked back with terrified eyes.

The captain hailed the leader of the fleet and from him learned a strange story. These were members of the Raven Clan of the Tlingits, who had been harassed by a group of the predatory Eagle Clan of the same tribe. For years the Eagles, aggressors and warriors, had preyed upon this group of Ravens, had triumphantly captured numbers of them, and had grown rich and powerful in the slave trade. At last the Ravens could bear the tyranny no longer. With the hope that they might escape the far-ranging boats of the Eagles, they had started out to find a new place to live.

When the captain heard their story, he explained as simply as he could that, because the United States now owned Alaska and its islands, no one could be held there in slavery. A man named Abraham Lincoln had said:

". . . I do order and declare that all persons held as slaves . . . are and henceforward shall be free . . . and that the Executive Government of the United States . . . will maintain the freedom of said persons."

The leader of the Tlingits translated the remarkable news to his people. There was a hasty conference while the rough sea rocked the canoes, and an Indian child wailed. Then, as the cutter moved on, the canoes followed it as far as the cluster of islands south and west of the archipelago. There the Tlingits waved good-bye to the cutter and landed their boats on several small, uninhabited, mountainous islands.

When the Ravens landed on their new home islands, they were at first afraid and uncertain of what the Eagles might do. Nevertheless, they set about building houses. Some, in true Tlingit tradition, housed several families and were as large as 20 by 60 feet. The floor was excavated to a depth of four feet, and cedar poles were set at each corner. Rafters were laid across the poles, and roughhewn planks several inches thick, cut from near-by trees, were fastened upright for walls, while others were laid on the roof. The roof planks were loose and often had wide cracks between them. The doorways were small and low, the house-fronts decorated with elaborate raven designs. Inside the house, planks were laid on the excavated earth floor, in the center of which was a fire pit several feet deep. Lacking a chimney of any sort, the smoke sought outlet between the planks, so that the ceiling soon became blackened and sooty. Shelflike beds were concealed either behind skins that hung from the ceiling at one end of the room, or behind painted wooden screens. Under these beds were the carved and painted wooden boxes that held supplies of food and clothing.

The low houses of the village faced the bay, and the mountain rose behind them. Daily as the tide backed out, it would leave a broad expanse of wet sand in which were clams and pectins, together with all the debris that the sea leaves when it goes back for more. At low tide, the women and girls would stream down from the village to fill their baskets with shellfish, odd bits of shells, driftwood, and other things found scattered there. Then as the tide crept back, inch by inch, moving in more and more rapidly from the Pacific, the beachcombers would return to their houses. The waves at high tide lapped only a few feet from their doorways.

With their homes built, the people looked about further to learn what the islands offered and found that they were as well stocked with food as were their old haunts. They found fish plentiful in the shallow waters off the curving, sandy shore; the present village would serve as a base for halibut fishing in season. The tribe would need to travel to the mainland for the salmon fishing, perhaps, and for catching the little smeltlike candlefish they called *eulachon*,

➤ LOWER FIGURES on the Lincoln totem pole. These are connected to the carving of The Emancipator by a 31-foot connecting shaft

but they could build villages at both these places. Families would go in their long canoes, taking with them the roof planks of the houses to be used ready-made on the new dwellings at the distant fishing grounds.

In the Alaskan sun the long strips of thin red salmon would dry, or, if the rains came too soon, the drying would be completed on racks laid across the smoky ceilings. The people would catch thousands of *eulachon* along the coast, put them in vats with water until the fish began to rot, and then throw in hot stones so that the fat would rise to the surface. When this layer of grease cooled, it was skimmed off and stored in jars for use as a sort of butter all winter. For centuries the main winter food of the Tlingits had been dried salmon, toasted over the fire and eaten with plenty of fish butter.

With their villages established and salmon drying in the sun, with a good supply of *eulachon* butter, and plenty of halibut, with blueberries and salmonberries from the mountain meadows behind the village, and shellfish from the bay at low tide, the Ravens were well settled. The old customs of the people were reasserted, and totem poles arose beside the houses of the wealthier people.

Since earlier days, the Tlingits had been expert totem-pole carvers. The symbolism of totems was part of their deepest beliefs. The totem poles were carved with the totemic animals of the family or clan, such as the bear, wolf, killer whale, or eagle, together with other figures relating to mythological or more or less true incidents. On each pole of the Raven Clan was a great carved raven, who was believed to be the creator of heaven and earth.

As the tribe realized with growing amazement and thankfulness that what the American captain had said was true—that the Eagles no longer would enslave them—Chief Ebbetts called his people together.

"Here indeed is a wonderful thing," he said in measured, sonorous tones. "For many months there have been no raids from our enemies. We are safe. It is fitting, in consequence, that we show our gratitude. Let Tleda, who speaks with his chisel, carve a memorial to this man who has freed us."

So Tleda, the totem-pole artist, went to the forest and selected a splendid Alaskan white cedar that rose straight and true from its roots, a tree whose trunk had no faults or angles. He superintended the cutting of the great tree and directed its hauling to the village. There, with the branches and bark stripped off, and the aromatic wood laid bare and smooth, Tleda started to work on the totem pole. He used a flint adz and simple carving tools, and day by day he worked.

But he had many pleasant interruptions, for it was customary for a totem-pole carver to be entertained by the man for whom he was making it, to be feasted and given many gifts. A totem pole represented a great deal of money, not only in entertainment and gifts for the artist but in his actual pay, which, in furs and blankets, sometimes amounted to the equivalent of several thousand dollars. Totem artists were pampered and well paid.

Tleda worked. He carved the traditional figure of Mother Tlingit at the base, and added a pair of jutting wings painted with raven designs. Above Mother Tlingit he carved a great raven and then a bear, because Chief Ebbetts' family was of the bear. Above that he smoothed a 31-foot connecting shaft, and at the top he carefully chiseled the figure of a man he had never seen. The garb was strange to the Tlingit artist, and dull, too—a sleek-fitting, black garment. But the hat was something like a Tlingit rain hat, so Tleda carved it extra tall and well. Perhaps he achieved the likeness of the man's features from a picture given to the tribe by the captain of the cutter, for the face of the finished figure was easily recognizable as that of Abraham Lincoln. Yet the features were also unmistakably Indian—wooden, stylized, rigid—a Northwest Coast conception of the Emancipator of Slaves.

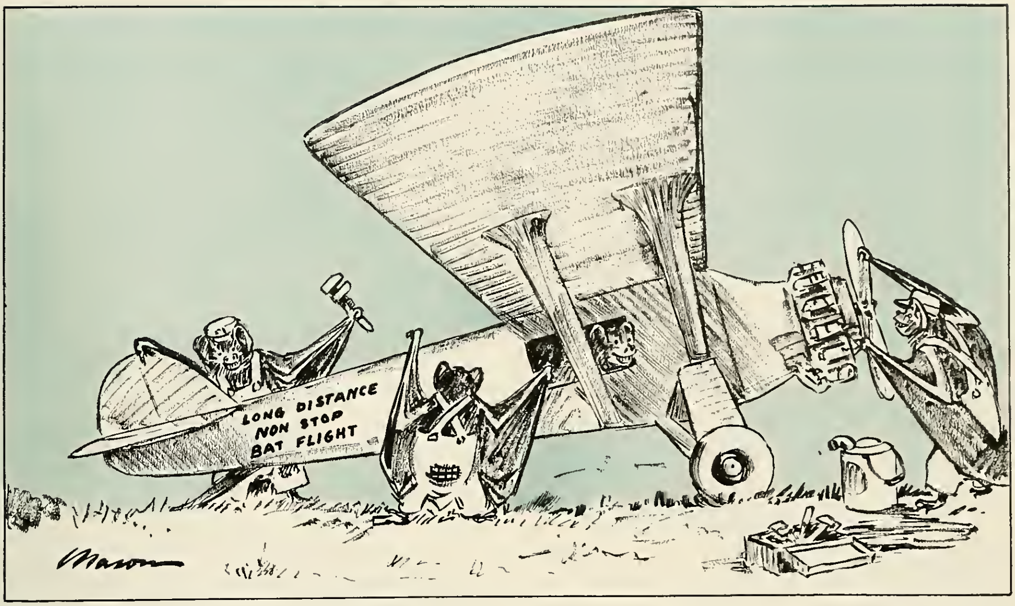
To color his finished carving, Tleda used the paints that his forebears had used for generations—red paint ground from cinnabar ore to color the nostrils and ears of the bear, the inside of the raven's great beak, and decorations on the wings; black paint from black ore for the frock coat of the man from Illinois; white from lime for his shirt front and collar; green-blue from disintegrated copper ore for the raven's wings and face. He mixed each color with salmon-egg oil and painted carefully and painstakingly.

When at last the new totem pole was finished, Chief Ebbetts gave a great potlatch party, to which he invited everyone in the village. For a week he entertained them lavishly with food, gifts, and dances. As a climax to the party, the 50-foot totem pole was lifted into place. High above the Tlingit village, then, the figure of Abraham Lincoln looked serenely out across the bay.

On neighboring islands, some of the other tribes who had been freed of enslavement also made memorial totems honoring Lincoln. Thus the black-coated figure rose here and there along the shores of wild North Pacific islands, among the family totems that honored the bear, the killer whale, and the raven.

For many years Alaskan storms and winds beat against the old memorial totems depicting Abraham Lincoln. The paint faded, and the wood turned brown and cracked here and there. No one knows what happened to the original, but three generations of the Raven Clan preserved the tradition by making other Lincoln memorials. Then as totem poles lost favor among the Indians, to whom they became as outmoded and ludicrous as the ancestral plush album on the parlor table or the crayon portrait on the wall, hundreds fell into ruin and none were built anew. Three of the old Lincoln totems, however, are still known to exist. One is in the museum at Juneau, one in the small native Alaskan village of Saxman, and the third is the one shown at the beginning of this article, in the Illinois State Museum.

NON-STOP FLIGHT



By John Eric Hill
Drawing by
G. Frederick Mason

Two closely related species of our bats are noted long-distance fliers. The red bat (*Lasiurus borealis*) is the better known. During its migrations, it often enters houses, and hardly a year goes by that several are not brought in to various museums or universities. It is a medium-size bat with pointed wings that stretch nearly a foot from tip to tip, and it weighs about half an ounce.

The red bat, including its various races, has a very wide range, being found from Argentina and Chile to the southern edge of the arctic tundra. A tree-dweller, it is found, during the summer, almost wherever trees grow in the New World. The more northern bats go south in the autumn, often flying across large bodies of water.

Bats usually migrate at night, but on several occasions naturalists have seen daytime flights. Sometimes the bats have been sighted in flocks; on other occasions individuals have been seen flying steadily along, taking advantage of favorable winds, instead of darting here and there in pursuit of insects. Other observers have seen them in the evening, struggling against winds along the sea shore. Now and then a flock numbering about a hundred of these bats, exhausted by their long flight, may land on a ship that is several days out at sea. Red bats are occasionally observed on Bermuda, which is about 600 miles from the North American coast.

So it is not so extraordinary that the red bat is found on the Galápagos Islands, about 500 miles off the Ecuador coast, a form that is probably specifically different from the ones on the mainland. Tropical bats of this group, however, are not known to migrate. Probably one day long ago a storm swept several of these bats so far out to sea that they found the islands. They could hardly see land very far off; nor could they find it by the method they use to avoid obstacles—hearing their own echoes.* But they may have been able to smell land or the scent of flowers at some distance.

The hoary bat (*Lasiurus cinereus*) is the largest of our northeastern bats. It looks much like a large red bat, but instead of the rich, chestnut coloration, the hoary bat is dark brown with a heavy frosting of whitish. The hoary bat is absent from the tropics but is found in the temperate forests of both North and South America.

Hoary bats once set a record for non-stop flight among mammals, for they reached Hawaii, some 2500 miles from the California coast. Think what small chance there was that these storm-tossed voyagers could make landfall in the vast Pacific! Marvel at the endurance of a flying mammal weighing less than an ounce and without supplies of food or water! It was a miracle of chance. Yet today hoary bats are established in these islands, the only land mammals that reached Hawaii by "natural" means.

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*See "Bat Radar," Natural History, September, 1945.

HIS *Perfume* STIRS THE WORLD

The story of the most fascinating aroma on earth—a wildlife epic suffused with romance, drama, and cruelty. But the little musk deer at last has science on his side

By Jennie E. Harris

HOW did a tiny deer in the highlands of central and eastern Asia ever become connected with the perfume on my dressing table?

The answer lies so far back in antiquity that it's lost—perhaps as far back as the beginning of Chinese history.

Here is a shy, sensitive creature, about the size of a half-grown Bambi, scarcely 20 inches tall at his shoulders, wandering among rhododendrons at an altitude of 8,000 feet and higher. The little animal has no antlers. Two curving teeth project from his upper jaw like ivory daggers. His body springs amazingly fast; his hind quarters are always elevated for easy leaping. And near the base of his abdomen is that walnut-sized pouch that puts his life in constant peril.

This pouch holds a quantity of musk-grains tiny as millet seed when dried, as large as peas when moist. When he rests on a rock, the musk is exposed; and when he darts away, the sun, heating the rock, diffuses the scent, giving evidence of his recent presence. The perfume is strongest when the musk is a fresh, oily, gingerbread-like substance, and one tiny grain of it can perfume millions of cubic feet of air.

He leaps high among the junipers, rhododendrons, and birches, nibbles at moss and lichen, and sags upon the forest floor, his coarse, grayish-brown hair blending with the leaf-shadows which render him obscure. But his dark eyes are wary, for he must hiss and be off on all fours at the first strange sound or smell.

Musk hunters trail him with dogs and guns. They observe where he feeds, noting how gentians and primroses are thinned out a little and how a stringy, white lichen that festoons trees shows signs of his nibbling. They set snares and traps where he might return to dine. Or they hurl arrows tipped with aconite to stop his sure-footed bounding.

To trap numerous deer, hunters build a palisade of prickly bushes in a suitable defile. Then they spread out fanwise in all directions and rush back screaming and waving their arms—frightening the timid deer, in an ever-narrowing arc, on and on into the trap of greenery.

THE MUSK DEER

Drawing by Museum Illustrators' Corp

The high-up deer remains cautious. Perhaps he manages to elude dogs, guns, snares, traps—even the deceiving palisade. He stays deep among the thickets, eating lichen or the musk-tasting sumbul roots. But what's this sudden, weird, sweet music? It is like bird music, but music from a bird he has never heard before. It draws him from his hiding, and when he is out in the open, seeking the source of that wild music, the hunter lays down his flute. The little deer's love of music has been his final betrayal.

Sportsmen seldom aim at a musk deer, though his venison is a great delicacy, and his coarse, brittle, hollow hair makes resilient mattresses for Tibetan travel. But commercial musk-hunters think little of sportsmanship. They want his musk—that most powerful, penetrating, and enduring odor known. They want the money musk is worth—$560 a pound as it reaches the market, according to a recent Du Pont Company report; $40,000 a pound if it could reach its final destination in a pure form.

The musk is often adulterated. The hunter leans over the dead deer and cuts away the little pouch with its covering of hide and hair. Then, instead of continuing down the trail, he rushes the pouch to a near-by hut while it is still soft, still newly taken. He pokes and stretches its natural opening so as to be able to remove the grains with as little loss as possible. The minute the fresh musk is exposed to the air, it expands and effervesces. If he tried to poke the true musk back into the pouch, the pouch might not hold it all. Besides, he is not ready yet. First, he mashes up acorns, fried liver, dried peas, dried grain, or dried blood with the moist, oily musk, making a curious dark mass. He stuffs part of this mixture among the membranes in the pouch, and the rest he puts into another pouch of hide and hair which he has faked.

Then he rubs his smelly hands in satisfaction. He knows that the mashed acorn, liver, peas, and blood will take on the peculiar, powerful scent of the musk and will themselves impart that scent to whatever they touch.

After this hasty preparation, he takes the trail; but the smell of the perfume is on him, and the knowledge that he has extracted musk is on other men's minds. All along the downward trail, the brown nut passes from man to man, from murderer's hand to murderer's hand.

The caravan that transports the musk radiates the musk-scent, announcing the journey as clearly as would a streaming light or a ringing bell. Bandits swoop down upon it like vultures; whole caravans have been wiped out and merchant trains wrecked for a few pouches of musk.

Musk has been taking a toll of 100,000 deer a year—females as well as males, although the former do not have the musk pouch. Except for his two canine teeth that give the appearance of tusks, the buck resembles the doe, and those two teeth are not easily descried at rifle distance.

Although the musk develops in the male only after he is two years old, hunters capture young deer, too. The white-spotted little creatures are born one or two at a time and go bounding off on their solitary way within six weeks. Even if the animal is snared rather than shot, so delicate a creature can easily be injured before it is freed.

Does the deer smell the musk upon himself—that perfume stronger than he is, from which he can never quite escape? The odor is part of his mating lure and is most pungent in spring, when the pouch holds a soft, unctuous, light-tinted mass. Later, it becomes darker and grainy.

Musk is said to be the most fascinating of all scents to man. Mohammed wrote in the Koran, about 600 A.D.: "The Seal of Musk. For this let those pant who pant for bliss." Empress Josephine, Napoleon's wife, used musk as her personal perfume. Years afterward, the walls of her apartments still gave aromatic proof of this. Even with extreme adulteration, its odor is highly, magnetically sweet.

Chinese buyers, suspecting adulteration, are reported to enlarge the natural opening in a pod with a thick, blunt needle. With a

A SYNTHETIC CHEMISTRY has finally taken the price off the musk deer's head: one of a battery of vacuum stills used to isolate usable perfume components from crude substances

hooked, silver needle, they probe about inside for any foreign substance the needle might touch. They extract a tiny sample, examine its color. Pure musk is yellow, yellow-red, reddish-brown, or purple. They smell it. The scent of pure musk is luxurious, rich and full. They rub a tiny bit between a moistened thumb and forefinger. Pure musk won't form a paste, but stays intact. They test the pod for its pliability; if all is unmolested inside, the pod responds to touch, shrinks away, and seems to quiver a little. In addition, there are tests of fire, caustic potash and soda, and ammonia solution.

Musk is sold in "pod" or "grain." According to encyclopedias, grain musk means the substance removed from the pod, and it includes hair. The pods are packed, 20 or 30 in a cannister lined with tin, and covered with silk of a peculiar Chinese design. Tonquin Musk from Tibet is usually highest in esteem; Cabardine Musk from China or Russia is next in importance.

The dried pods give off little odor, but pods soaked back to natural plumpness exhale their intense, penetrating scent. Musk must throw off particles of itself to be smelled at all. Yet scientific experiment proves that a few grains of musk will perfume a large hall for years without appreciable loss of weight.

The muskrat trapped in our United States marshes has musk; and musk odor is strong in the Australian musk-duck and other animals. The Ross Allen Institute at Silver Springs, Florida, has received requests for musk extracted from alligators and has supplied samples. Yet, no musk has qualities for perfumery comparable to that of the little musk deer.

The musk deer lives in a setting of bewildering beauty. At altitudes of 8,000 feet and higher in the Himalayas northwest of Szechwan grow forests of rhododendrons found nowhere else in the world. There are parasitic rhododendrons with snow-white bells seven inches long; great tree rhododendrons 30 feet tall, with creamy-tinted flowers and pale pink bark that peels off in flakes, leaving a stem smoothly gleaming like silk; rhododendrons with flowers of vermilion, scarlet, crimson, rose, purple, yellow, or white, strewing the ground with color; and dwarf rhododendrons. Ferns and fernlike bamboos climb the slopes, and there are bronze and green junipers. Perhaps in the far background, Kanchen-junga or the Everest group soars majestically into the glacial blue of the sky.

Such are the scenes that form the homeland of the musk deer, across the highlands of central and eastern Asia and into southern Siberia. Apparently, he has a highly refined appetite for certain flowers, roots, leaves, and lichens. He possesses, it would seem, in his little aesthetic soul, a love for flute music, and in his pouch he carries the most powerful, most exalting "fixative" known.

Perfume makers tell us that a perfume never contains a single odor: It would not be perfume if it did; it would be blatant, brassy, harsh. It must be softened, toned down by other odorous notes and mellowed, so that the result is a subtlety of fragrance.

All perfumes contain selections from odor-types called "sweet," "acid," "burnt," "goat,"—which means that often the vilest odors enter the most enchanting perfumes. Yet, these are utilized in such a way that their own unpleasantness is canceled out, and they enhance the desirable effects of other odors. Moreover, most fragrances have short lives, and there is a belief that musk adds permanence to other odors with which it is mixed. There is some debate as to whether any of the so-called "fixatives" actually do this, but the word has become well established and can hardly be avoided.

There are three other animal products comparable to musk: civet, castor, and ambergris. Ambergris is produced by the sperm whale. It apparently results from some illness, and it is either ejected by the whale to float ashore or is found inside a harpooned animal. It seems to have something to do with the whale's diet of squids and may be comparable in some ways to a gall stone. Most pieces of ambergris weigh only a few ounces or pounds, but lumps weighing 100 pounds or more are sometimes found. One piece, found by a London merchant in 1898, weighed 270 pounds and sold for about $80,000. Fatty and clammy-looking, ambergris cannot be adulterated without easy detection. Its odor is said to be earthy, and it helps to mellow other odors in perfume. It is usually yellow, gray, or black on the outside, with gold, yellowish red, or other colored specks showing through the cracks.

Castor comes from the Canadian and Russian beaver. Canadians trap beavers mostly for their fur, so that castor in Canada is largely a by-product. Both male and female beavers have castor. It is yellow when fresh and later turns reddish brown. The smell is balsamy and the taste bitter. It imparts an "oriental note" to perfume and helps in blending.

Civet smells horrible. Yet, it must be rather pleasant in extreme dilution if early Italians and Spaniards used it, as we are told, to perfume gloves. It comes from the male and female civet cat of Abyssinia and India. The cats are teased while enclosed in a cage too small for them to fight back. This angers them to the extent that they pour forth their scent, much as does our American skunk when attacked.

Photos courtesy Du Pont Company

▲ FINISHED SYNTHETIC MUSK, or "Astrotone." Its development in the Du Pont Company laboratories has made available a material as powerful as the intrinsic essence of natural musk and far less expensive. This amount is worth less than $200; pure natural musk would cost many thousands of dollars

Attendants remove the secretion from time to time without harming the cats.

J. C. Andersen of New York wrote me that civet arrives packed in buffalo horns covered with parchment at the top. This safeguards the peculiar smell. Usually 20 to 30 ounces are in a horn, and the price at present is around $7.00 an ounce. Civet helps to round out a perfume's bouquet and is thought to give it a lasting quality.

Musk, however, is more important than civet, castor, or ambergris. Its influence in perfume is subtler, more powerful. As many as seventeen components may enter a single perfume; musk harmonizes and blends these into a single fragrance and makes that fragrance richer and more appealing. Perfumers say that musk "exalts" all other perfume materials. It enhances the perfume-sorcery, imparting to it a "warmth" and "vitality" as no other single substance can.

With 100,000 musk deer slain each year, what is the future of the little animal? It seems incredible that he should have been able to survive the increased demand for perfume. We now have perfumes in shampoos and shaving lotions; perfumes in paints and insecticides; perfumes in beverages,

Continued on page 94

Mating of the BLACK SLUG

A photographic series of rare scientific interest, showing a pair of creatures that are both father and mother in one

▲ Two Black Slugs were caught in the beam of the light on the trunk of an oak tree. Circling head to tail, they were preparing to descend on a cord of mucus

By Lynwood Chace

With photographs by the author

ONE of the essential steps in nature photography is, first of all, to find the subject. This usually requires a good deal of hunting about the fields and forests. Searching for subjects at night has always held more adventure and fascination for me. As soon as darkness closes in on the landscape, I like to equip myself with a powerful searchlight and head for the country, sometimes with some special place in mind to explore.

Most times my trips were without results; but my reward came one night when I was hunting in a small grove of Black Oak trees not far from my home.

I was flashing my light in every nook and corner to make certain

◄ Launching themselves into space. As they descended, they twisted their bodies about each other and twirled back and forth in a semicircle. Their bodies were in constant motion, with movements more rapid than normal

◂FROM AN OPENING at the side of the head, their male organs began to protrude

▾ THE SLUGS had extended the viscous cord to about eighteen inches. This evidently represents about the maximum, as the author later checked a number of other performances

not to overlook any creature of interest that might be out. I aimed my light at an oak tree that had been blown over by a hurricane and slowly moved the beam of light along the slanted tree trunk and upward. Suddenly my light flashed upon two small black objects. I moved a few steps closer in order to get a better view of my discovery, and much to my surprise saw that there were two Black Slugs. Just what they were up to I did not know; but whatever it was, I was determined to get some photographs.

I hurried back to my home, where, in the basement, I had a 200-foot electric light cable which I used especially for night photography. I inserted one end of the cable into the light socket and then speedily began unrolling cable and walked to the spot where I had located the slugs. Reaching my destination, I hurriedly assembled my equipment and was soon ready for whatever might happen.

I now flashed a floodlight onto

the slugs in order to get better illumination. On close inspection I saw that the slugs were in a circular position, with each slug's head to the other slug's tail. I brought up my camera and photographed them in this peculiar position, as I wanted to get whatever occurred from the beginning. With camera in readiness, I watched them for some time; then suddenly the two slugs began to twine their bodies about each other and to lower themselves downward from the bark of the tree by a strand of viscous cord. Just what was happening I could not comprehend for a while, but as I watched this strange act I gradually solved the mystery. I was actually watching,

▲ As the procedure reached its culmination, each male organ flared to the shape of a disc, about the size of a quarter. It was pearly white in color, with iridescent shades of pink, blue, and green. At the climax, the two slugs separated the lower halves of their bodies

➤ Here they are slowly crawling back up the viscous cord toward the bark of the tree. At this point, it appears to be the duty of one slug to cut the cord where it is attached to the tree. This it does with its mouth, and the cord falls to the ground for the first time in my life, the odd love-life of the Black Slug—a process the more curious since each individual possesses a complete set of male and female organs.

The two slugs now began to extend the cord, at the same time twirling back and forth in a semicircle. By now the cord was extended eighteen inches from the bark of the tree. At this level they stopped lowering themselves, and were dangling free from the tree trunk on the viscous cord.

I had been maneuvering my camera all this time, getting shot after shot of the various happenings. Then the most astonishing thing I ever saw took place—the male organs began to appear from the side of each slug's head. As these protruded, they coiled about each other. By now they were extended three inches in length, and remained so. The ends of the organs began to flare out into the form of a disc about the size of a quarter. The color of the organs was an iridescent pearly white, with delicate shades of pink, blue, and green. Now the edge of the discs began to develop a scalloped pattern, all of which sparkled and glittered under my photographic lights like some rare tropical flower. At this stage the love drama had reached the climax. The slugs began to draw their male organs back in.

When the male organs had completely disappeared, the slugs began to uncoil their closely entwined bodies, after which they turned to head upward. They slowly crawled up the viscous cord of mucus until they reached the bark of the tree.

When they finally were back onto the tree, it appeared to be the duty of one slug to cut the mucus cord off where it was attached to the bark of the tree. This was done with the mouth, and the cord fell to the ground, having served its purpose.

▼ A BLACK SLUG and its eggs. They are laid an inch or so under damp earth in a densely shaded place. Baby slugs about one-eighth inch long hatch from them. The adult is about six inches long

METAL ARTS OF THE INDIANS

How the prehistoric Americans, with only the crudest instruments and transportation facilities, developed great skill as metal workers and produced designs that merit the attention of modern artists

By Eugene W. Nelson

THE flint arrowhead has come to be such a popular symbol of the American Indian that it is difficult to realize that our foster ancestors ever achieved anything worth while in the fields of mining and metal working. Yet, it is a fact, well established by years of painstaking field work and research into old Spanish documents, that as metallurgists, the aboriginal inhabitants of North and South America ranked high among the prehistoric people of the world.

Before Columbus ever sailed, the Red Men knew and used tin, gold, silver, copper, mercury, lead, platinum, and even meteoric iron. The Indians of the Great Lakes region carried on extensive copper mining activities. The Aztecs mined large quantities of gold in Mexico. And the Peruvian Indians took much copper and tin from workings in the Potosi region of Bolivia. Both the Aztecs and Peruvians had learned something of the science of smelting ores, and they were proficient at melting metals and casting them in molds. The Peruvians had even learned how to make bronze, a harder metal, by mixing tin with copper, and they cast and forged this useful alloy into many beautiful and serviceable articles.

It has been difficult to reconstruct the true picture of the metal industry in America before the time of Columbus for at least two reasons. First, the Spanish Conquistadores effectively stamped out the two greatest existing civilizations, the Aztec and the Peruvian, and with them most of the arts and sciences of these peoples. Second, the Spanish priests who came with the soldiers demolished all but a pitiful handful of the Aztec and Mayan pictorial writings which may have contained valuable information concerning the attainments of those races in metal working and the routes by which they carried on their extensive trade in metals.

Thus, most of what we know today on this subject has been reconstructed by archaeologists working from Alaska to Patagonia and reasoning back from such discoveries as they made. For instance, a copper spearhead found in a Florida burial mound must be analyzed to determine whether it was made from the extremely pure, free copper from the Great Lakes region, or whether it was made from copper contaminated with the impurities characteristic of Mexican and Peruvian ores.

Again, metal objects that have been chiseled or forged, or worked in any other manner, must be examined carefully to see if steel tools were used. If so, they were made *after* the arrival of Columbus, since no steel tools were employed by the Red Man. Fragments of meteoric iron, however, had been worked to some extent by the Eskimos of northern Greenland, the Mound Builders, and others in South America.

In spite of the handicaps, archaeologists have succeeded in putting together a fairly complete picture of the metal working achievements of the American Indians. And it might be well to mention here that no Indian tribe or nation ever possessed a "lost art" of hardening copper. They hardened their copper just as we do today—either by alloying the metal with tin to form bronze, or by pounding the copper while cold.

Copper in its pure or "free" state was known and used over large areas of North and South America. Considering the climate, the Arctic Circle would scarcely be a place where you'd expect to find much metal working. Yet, in 1776 when an adventurous young Englishman named Samuel Hearne penetrated into the country several hundred miles northwest of Hudson Bay, he found a small tribe of people

Photo by AMNH

▲ IT WAS ORNAMENTS such as these gold figures and bells from Costa Rica that excited the Spanish Conquerors, encouraging the conquest and destruction of New World cultures

known as the "Copper Eskimos." These Eskimos lived on a river which Hearne named the Coppermine. The natives were quite skilled at making weapons and household utensils from nuggets of pure copper, which are thought to have been torn from the parent veins by glacial action and deposited on the surface of the ground when the ice melted.

Hearne collected a large number of examples of the skill of the Copper Eskimos and sent them back to England. These have since been lost. Fortunately, when Donald A. Cadzow was conducting an expedition into northwestern Canada for the Museum of the American Indian in 1919, he met a small party of Copper Eskimos. From these people—descendants of the group whom Hearne had seen—Cadzow learned how their smiths operated. All copper implements were hammered from copper nuggets by means of a beach pebble held in the hand. The object roughed out was then rubbed against a large boulder to smooth and finish it. Considerable skill was shown in using this primitive equipment in the manufacture of gaff hooks for catching salmon, ordinary fish hooks, ice chisels, snow knives for making snowhouses, adzes, and arrowheads. When Cadzow visited these people, they were just beginning to feel the impact of the white man's civilization, but their copper-working methods were those used by their forefathers. Thus, Cadzow's expedition was also a trip back into time!

In copper resources, the Indian

tribes living around the Great Lakes were far more fortunate than the Copper Eskimos. Enormous quantities of free copper were to be found on the Keweenaw Peninsula of Northern Michigan and also on Isle Royal in Lake Superior. For centuries before the first white men arrived in America, these copper deposits were worked by various tribes of Indians, including the Algonquins and the Winnebagos and, doubtless, numerous other tribes. Many of the ancient Indian copper mines on Isle Royal have been explored. From a close study of the remains, archaeologists have worked out a fairly clear idea of how the Indians mined copper. Of course, the Red Men did not practice mining as we do today, with mile-deep shafts, elevators, explosives, and high speed drills. To them, a mine was usually a shallow trench dug into the side of a hill. These trenches were from 200 to 300 feet long and seldom over 25 feet deep. Since the pits had to be dug either with wooden spades or stone picks, it will be seen that copper mining among the Indians was a strenuous business from the first.

As the trench progressed, veins of pure copper were exposed in the walls. A fire was kindled under these veins, and when the rock was hot, the Indians dashed cold water onto it from baskets or wooden bowls. The action of the cold water on the heated rock cracked the matrix and enabled the miners to hammer the copper loose with heavy, two-handed stone hammers. These hammers did not have hafts, but were held and swung in both hands. Thousands of such stone mauls, too battered for further use, have been found on the Isle Royal sites.

All the debris caused by this method of mining had to be cleared away with wooden paddles or shovels. When necessary, the Indians used a ladder, made from a tree by cutting the branches off at a sufficient distance from the bole to provide footholds.

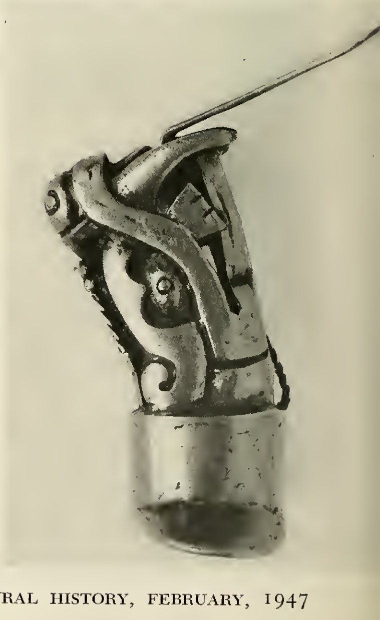
The chunks of copper obtained by this laborious method were probably transported by canoe back to the various Indian villages. There, the skilled artisans—men too old for the hunt or the warpath—worked the metal into tools, weapons, and ornaments.

Such was copper mining among the Indians of North America in the Great Lakes region. Their method of working the red metal was much like that of the Copper Eskimos—by hammering it with

▲ Gold trophy given to professional ball players; probably Mexican. The plaque at the top represents an Indian ball court with a player at each end

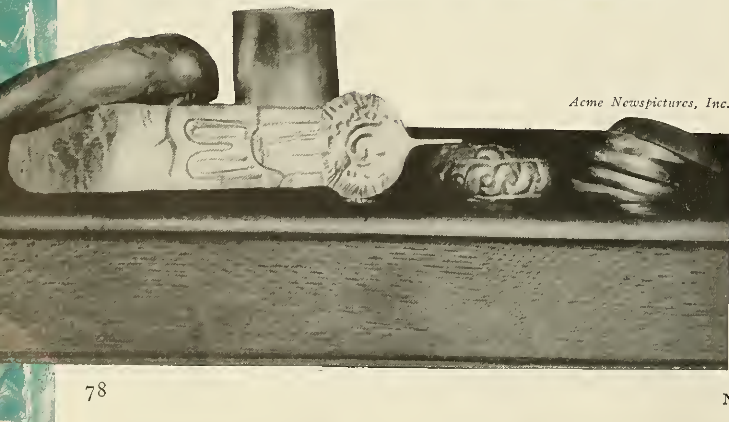
➤-A gold lip ornament found at Oaxaca, Mexico. It is about 2½ inches long and was worn through a hole in the lip. The flange at left-hand end prevented it from slipping through

Courtesy of The Museum of The American Indian



▼ A diadem of gold with a golden plume, worn by a *cacique,* or chieftain of old Mexico. Golden bracelets and other ornaments are also shown. These works of art were taken from the tomb of six Mixtecan chieftains near Monte Alban, Mexico

Acme Newspictures, Inc.



stones. However, these Indians showed much more inventive thought and skill in their work. They were able to polish their copper instruments with fine sand until the metal acquired a beautiful luster. They also learned that if they hammered a piece of copper long enough, it would become noticeably harder than it was before. The Indians did this to the edges of their knives, arrowheads, and other tools and weapons. It was this practice that led many people to believe that the Red Men had been able to harden copper by means of some "lost art."

Not only were the North American coppersmiths skilled in making weapons and ornaments from copper nugget, they also displayed remarkable skill in beating out large, thin plates of the red metal and embossing beautiful designs on them. This embossing or repoussé work was done with a sharp bone or an antler point, the copper sheet being placed on some yielding surface, such as a piece of buckskin laid on sand. One example of such ornamentation, found in a mound in Georgia, is the representation of an elaborately costumed winged god that closely resembles one of the Aztec deities. Analysis proved that it was of Great Lakes copper.

Many other objects recovered from mounds located all the way from the Ohio Valley to the Gulf of Mexico show that the Indians realized the practical value of sheathing, both for purposes of beautification and for protection. A pair of copper ear ornaments overlain with a thin sheet of silver were found in a mound in Florida; copper beads skillfully wrapped in silver foil were uncovered in Ohio, and two wooden figures of hummingbirds, sheathed in copper of uniform thickness, are now on exhibit in the United States National Museum. The silver foil used on all of these objects was cold hammered from free silver, as was the copper sheet.

Clever as were the North American Indians of the Great Lakes district in mining and working free copper, they never learned to melt and cast the metals they found. Neither did they acquire the art of smelting metal from its ore by the use of heat.

Turning our attention to the much higher civilization of Mexico, we find that the Indians there had a greatly extended knowledge of metallurgy. The Aztecs mined large quantities of gold by washing it from river sands with gourds, much as the forty-niners "panned" it much later. The Aztecs, also, were experts at melting and casting gold, silver, and copper. They even knew how to solder and weld one metal to another.

Gold was the main metal of Aztec land, as Cortez learned; and there are still in existence a few pictures in the ancient books of Aztec picture-writing that show their goldsmiths at work. In one of these, reproduced here, the smith is depicted as blowing down a long tube to make the fire hot enough to melt his gold, for these people did not know the principle of the bellows. This is one instance where Egyptian metal workers were ahead of the native American craftsmen, for the bellows was discovered in Egypt sometime before 1500 B.C.

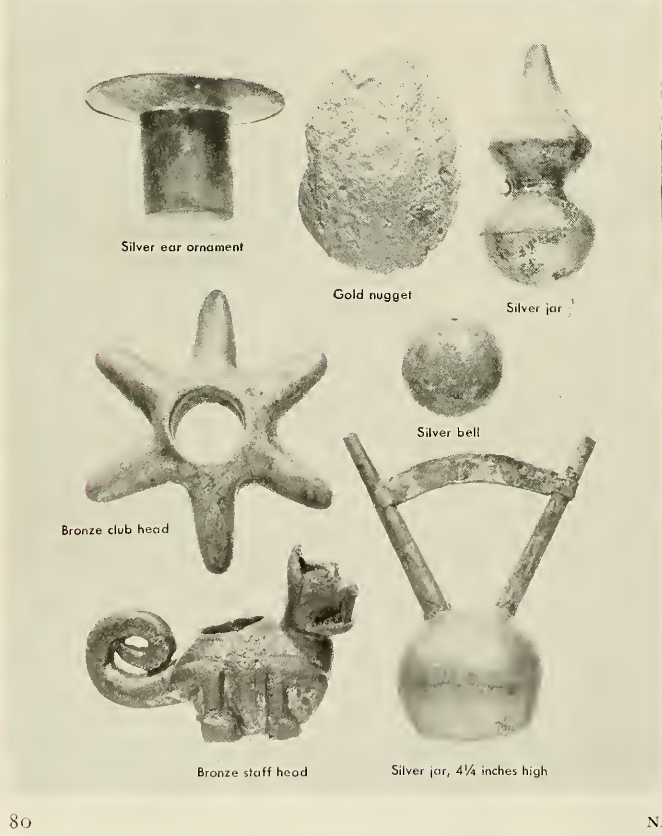
Nevertheless, the Aztecs were

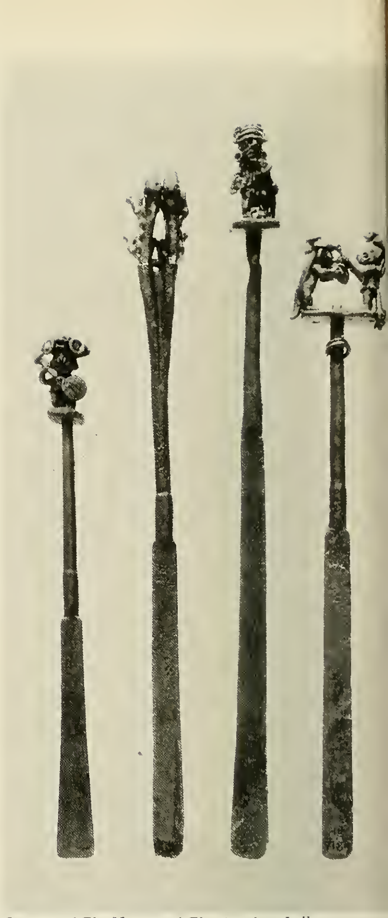
▼ GOLD AMULETS from Costa Rica. As metal rather than artistry interested the Europeans, most of the finest gold objects were consigned to the melting pot

Photo by AMNH

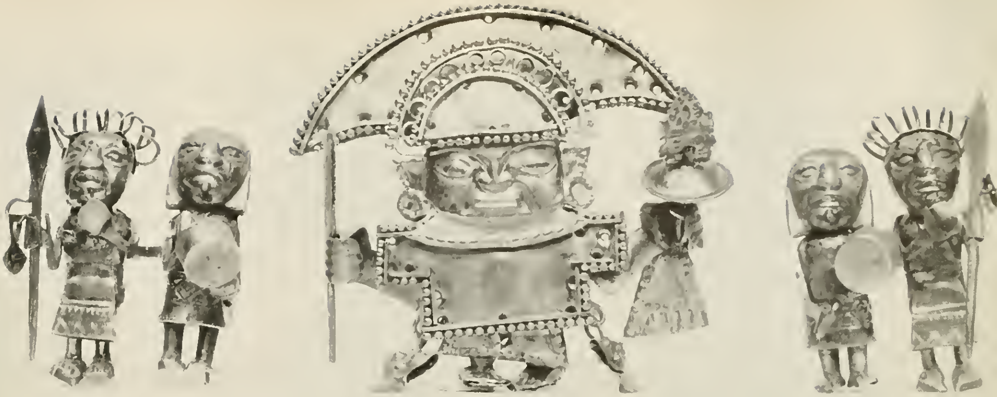
Courtesy of The Museum of The American Indian
▲ SOLID GOLD BREAST ORNAMENTS produced by Indians living in Colombia

▼ A VARIETY OF FIGURES produced by Inca metal workers. From Trujillo, Peru
Courtesy of The Museum of The American Indian





Courtesy of The Museum of The American Indian
▲ BRONZE "CHISELS" from Chan Chan, Peru. They were probably used by hand instead of with a hammer, to judge from the ornamentation. The longest is twelve inches



Courtesy of The Museum of The American Indian

▲ GOLD EAR ORNAMENTS produced by the goldsmiths of old Peru. The central figure is two inches high

▲ EGYPTIAN METAL WORKERS using a bellows to produce hotter fire, by treading on inflated skins: a drawing dating from about 1500 B.C.

▼ AN OLD SPANISH PICTURE showing South American Indians working metal in their shop. Some of the scene may have been colored by the artist's knowledge of European metal shops. But basically, it is probably a fairly accurate portrayal. Neither the Incas nor the Aztecs learned the principle of the bellows

Courtsey of The Bettmann Archive

▼ ANCIENT BOWLS of solid silver made by the Incas, from Cuzco and the coast of Peru. The larger one is 5¼ inches in diameter

Courtesy of The Museum of The American Indian

▲ **COPPER from the Great Lakes region provided the Indians in various parts of North America with metal for tools and ornaments. These copper sheets, embossed with representations of human heads, were uncovered in an Oklahoma mound. (Greatest length: 9½ inches)**

fine artisans, and they knew how to cast molten gold to produce hollow castings. The Spaniards were so impressed with the beauty of some of the articles turned out by Mexican goldsmiths that they sent these products back to Spain to be preserved for exhibition purposes. This was contrary to all customs and instincts of the Conquistadores and is, indeed, a superb testimonial to the Aztecs' skill.

The Mayans of Yucatán—who surpassed all of the other native Americans with respect to architecture, mathematics, writing, and astronomy—had only the most superficial knowledge of metallurgy and metal working. This was no doubt due, in part at least, to the fact that Yucatán is a limestone peninsula with only a thin covering of top soil and no vast mineral resources comparable to those in the Great Lakes region.

However, late in Mayan history, between 700 A.D. and the arrival of Columbus, some metals were imported into Yucatán, probably from Mexico. Then the Mayans learned how to cast and hammer out small ornaments, but they never became leading metal workers.

It has by now been fairly well established that metallurgy in America before the time of Columbus was originated by the ancient inhabitants of Peru and Bolivia who, for lack of better identification, are usually referred to as the "Pre-Inca People." From this locality in South America, the knowledge of how to work metals is supposed to have traveled northwards, probably up the Pacific Coast, until it reached Mexico and finally perhaps, the less civilized tribes in what is now the United States. This theory is more interesting since historians are quite generally agreed that the Americas were populated by tribal movements from *north* to *south*.

There are two important reasons for believing that American metallurgy originated in the Pre-Inca times. First, the oldest metallic artifacts yet found in the Americas (seven copper clamps once used to hold together building stones) were located among the ruins of Tiahuanaco, a very ancient city on the shores of Lake Titicaca in Bolivia. Analysis shows these clamps to be pure copper, and it is estimated that they may be 2000 years old. Second, metallurgy reached its highest development in the region now embraced by Peru, Bolivia, Chile, and Argentina.

The Peruvians obtained some of their gold by mining, but they got most of their supply—and it was extensive—in the same way that the Mexicans did—by washing it out of the gravels of rivers. The Peruvian miners exercised considerably more ingenuity, however, than did their Aztec colleagues. During the dry season, they would lay a stone dam across a section of the stream. Then, when the rains and melted snow turned the feeble trickle into a raging torrent, the sand and gravel would pile up behind the dam, and they could wash the gold out of it during the next dry season.

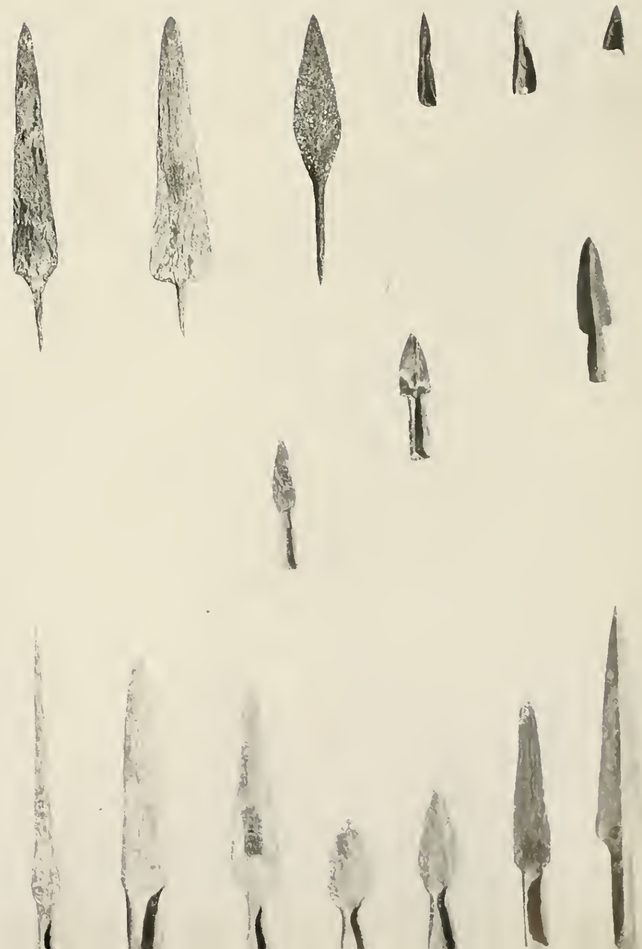
A great quantity of silver was mined, although the mines of the metallurgically-advanced Incas and Pre-Incas, being mere pits and trenches, were no more pretentious than those of the Indians in the Great Lakes regions. Hundreds of these excavations have been found throughout the Inca territory, the greatest number being in the Potosi region in southern Bolivia.

In addition to their use of copper, gold, and silver, the Peruvians used lead in constructing the weapon known as the bola, which consisted of a number of weights tied to the ends of a thong or cord, so that when thrown, it would entangle the legs of an animal. They obtained small quantities of mercury from cinnabar and employed tin in the manufacture of bronze. Herein lies the greatest difference between metallurgy in ancient Peru and in other parts of North and South America. The only real bronze implements ever made in

◄ Copper axes and chisels produced by the Great Lakes Indians. Some of the ax heads have their edges bent over to simplify attachment of a handle

▼ Spear points and arrowheads hammered from copper nuggets by Indians of the Great Lakes

Courtesy Milwaukee Public Museum



the Western Hemisphere were manufactured by the Incas and Pre-Incas. This discovery marks the Peruvians as the leading metal workers of America because bronze is so much harder and, therefore, more satisfactory for tools and weapons than is pure copper. To these Indians, bronze was what steel is to us, and they used it as the all-purpose alloy.

The Peruvian craftsmen also learned the difficult art of *smelting* the various ores of copper and tin in order to obtain pure metals—something that no other nation of native Americans on either continent ever achieved. The ruins of hundreds of Peruvian mines and furnaces have been located, so many of them, in fact, that metal working is believed to have been one of the main industrial occupations of these people.

One interesting craft that the Peruvian goldsmiths learned was that of plating the base metals with gold and silver. By mixing gold or silver dust with mercury, they formed what we today call an "amalgam." In applying this, the surface of a copper or bronze vessel was first treated with a fruit or vegetable acid to remove all dirt and grease and to roughen the surface slightly, so that the gold or silver amalgam would adhere bet-

Continued on page 95

◄ AUDUBON'S CARACARA taking flight from the nest. The photograph shows how the slotted tips of the wings are spread, the tail fanned out, and the feet extended backwards. Kissimmee Prairie, Florida

CARACARAS of the Florida Prairies

Though disappearing, this southern hawk can still be observed in some parts of Florida

By HUGO H. SCHRODER
Photographs by the author

AUDUBON, in whose honor the Audubon Caracara was named, first saw these birds near St. Augustine, Florida, in 1831. They range across the southern borders of the United States, through Mexico to western Panama; and a related subspecies goes on into South America. However, their range in Florida has been greatly reduced. Most of them are to be found in the prairie regions that are now almost entirely occupied by cattle ranches. Their nesting range is restricted to the central and southern parts of the state.

Almost invariably the caracaras in Florida choose a cabbage palmetto for their nest site, and they usually build anywhere from 20 to 50 feet above ground.

Securing photographs of a caracara nest in a cabbage palm is a difficult problem. Climbing the tree is not exactly a pleasant matter, because there are scores, or even hundreds, of boots—dead ends of leaf stalks—still attached to the trunk. These are dry and sometimes insecurely attached to the trunk, and the climber must break them away in order to be sure that his climbing irons will dig into the trunk for a secure foothold. Clearing away the boots looses a shower of debris which rains down the climber's neck. It is almost impossible to get high enough to look down on the nest, and far enough away at the same time.

I have seen only two caracara nests that were not in cabbage palms; both were in small oaks. In one of these, only 15 feet above ground, I was able to photograph the nest and eggs. A friend of mine found a nest in a saw palmetto only 7 feet above ground, but these cases are the exception.

I have seen caracaras give chase to other birds that flew too near their nests, especially vultures. Just recently I witnessed a determined caracara pursuing a turkey vulture, but in this case no caracara nest was visible in the vicinity, and why the bird chose to attack the vulture was a mystery. Four other vultures were about, yet the caracara concentrated on its original victim in the most prolonged attack I have ever seen among these birds. It followed the vulture up and down, back and forth, circling or diving whichever way the buzzard turned, and seldom far behind. The vulture relied on its superior ability to maneuver, and the caracara had to resort to continued wing motion to gain on the other bird after it dodged. I saw the caracara hit its victim a number of times, but usually it was outmaneuvered. The birds disappeared from view, but a little later we drove eastward about 2 miles and again caught up with them. The caracara was not as determined in its pursuit as it had been perhaps 10 minutes earlier. It gave up the chase just as we neared the spot where both birds crossed the highway.

The nesting season of the caracara in Florida usually extends from December to April. However, on December 27, 1931, Joseph C. Howell and I found a nest near Lake Jackson, on the Kissimmee Prairie, which contained a youngster about 5 weeks old. Its parents must have nested in October. On April 7, this nest had another set of eggs. Ordinarily only one brood is raised, but second sets may be laid if the first eggs are destroyed, or taken by collectors, who prize them for their handsome markings.

There are too many gunners who have the mistaken notion that all hawks, or hawklike birds, should be killed on sight. Because caracaras frequently remain within easy gunshot, they offer a tempting target to the wanton killer. Once, after photographing the birds, we were talking about our experiences to the neighboring ranch foreman, and he said he wished we had used a gun on the birds instead of a camera. He told about having shot several caracaras on his property. Between 1931 and 1941 there were several caracaras nesting on this ranch each year. Now there were no nests at all. And in the spring of 1946, when we returned to the "hammock" where we had photographed caracaras the year before, we could find no trace of these birds anywhere in the vicinity. Possibly they were victims of the foreman's gun.

While they never have been common birds anywhere in Florida, they certainly used to be more widely distributed than they are now. When the first paved highway through the Kissimmee Prairie was being built, and for some years thereafter, it was possible to see a number of caracaras in flight or at rest along the highway; and there were always burrowing owls along the roadway east of the Kissimmee River. During several trips over this highway in 1945 neither caracaras nor burrowing owls were seen between the Kissimmee River and the pine woods at the eastern border of the Kissimmee Prairie, although the trips were made during the normal nesting season of these birds. Fortunately there were still some caracaras on the open prairie, away from the well-traveled highway.

▲ A NEWLY HATCHED CARACARA voices its disapproval at being removed from the ne

▼ A YOUNG AUDUBON'S CARACARA edging away from the nest in a small oak tree, tr ing to get away from the photographer in the treetop

◄ CLOSE-UP of the tiny, white flowers, *Erythroxylon coca*

COCA

Is the "divine drug" of Incaland, which seemingly makes the Indians of the Andes invulnerable to heat, cold, hunger, and thirst, a boon or a bane?

By WILLIAM H. HODGE*
Associate Professor, Department of Botany, Massachusetts State College

VISITORS to the Andes of Peru and Bolivia marvel at the universal use of coca. The dried, oval leaves of this plant invariably occupy a prominent place among the commodities offered for sale at every Indian market in the smallest village as well as in the largest of sierra cities, and the coca "counter," above all, is one that is sure to have customers. For the coca habit is more universal among the Andean Indians than the tobacco habit is among civilized peoples. Coca is not to be confused with our cocoa and chocolate, which come from the seeds or beans of a different plant, the cacao tree. Coca is a shrub whose leaves yield cocaine.

Almost every adult male and many an adult female of the Quechua and Aymara people (the dominant Indian groups of the old Inca civilization) chews coca leaves. And so continual is the habit that the cheeks of the average Indian often have become permanently distended and distorted. In fact, with a wad of coca leaves inside his mouth, the *serrano* reminds one of a chipmunk with packed cheek pouches.

The use of coca was first witnessed in Peru at the time of the Spanish Conquest. Nearly all the chroniclers mentioned the use of the leaf in their records, the first being Oviedo in 1535, who wrote: "They carry an herb, the leaves of which can sustain them two days without eating or drinking, by merely carrying these in their mouths . . . this herb they call *coca* . . ." A few years later the Bishop of Cuzco, Father Vincente Valverde in a letter to his Emperor, included these descriptive lines: "There is a leaf of a small tree which is like the sumac tree of Castille; it is an article which the Indians always have in their mouths when walking, and they say that it sustains and refreshes them in such a way that when they walk in the sun they feel no heat; and in this country it is worth like gold and it is the principal tax for tithes."

Even if we had no direct evidence of the antiquity of the use of coca in Peru, we would still find sufficient proof in some of the realistic drawings that adorn much of the interesting pottery produced by the Andean civilizations before the time of Columbus. Today, coca is seldom if ever used in coastal

*DR. W. H. HODGE was educated in New England and received his doctorate at Harvard, but he can almost call Latin America his second home. Plant collecting has taken him all the way from Hudson Bay to Peru, Ecuador, and Colombia. His son at the age of six months had traveled through ten Latin American countries. Dr. Hodge searched for quinine during the war and was a visiting professor at the National University of Colombia. He has done extensive research on the flora of the Lesser Antilles and on the names, folklore, and uses of plants as related to the customs of the island Caribs.—ED.

Peru, where the population is no longer predominantly Indian. Not so in the past, for many portrait vases from that section depict the customary accessories of the coca addict—the woven coca bag, the gourd (*poporo*), and the limey ingredient (*llipta*). A vase in Lima's National Museum of Archaeology even shows a man, apparently a wounded warrior of Nazca, with a characteristic cud, or *aculli*, of coca bulging within his left cheek. Actually, the woven bags themselves and the easily recognized leaves, in an excellent state of preservation, are found now and then in the burial mounds of Peru's coastal desert.

The modern coca addict uses the same basic equipment as did his ancestors, though it may vary from place to place. In the Andean highlands (roughly the area of the old Inca realm), the universal carry-all for the dried leaves was, and still is, the beautifully woven and colorfully designed coca bag, or *chuspa*. This was originally woven from alpaca or vicuña wool, but now it is generally made from the wool of sheep. The *chuspa* is either slung over the shoulder or tucked under the Indian's woven belt, where he can conveniently extract a few leaves from time to time as the need arises. In the northern Peruvian Departments of Cajamarca and Amazonas, the coca bag is a modern leather affair. A limey, pastelike substance, called *llipta*, always comprises a part of the coca cud. This is made by burning bones, shells, or plants (Cecropia leaves are used in the lowlands). In a pinch, the ashes of a campfire will serve. Usually, the lime is carried in a small ornamented gourd, called *poporo*, but among the sierra peoples the *poporo* is more often a small pear-shaped container made of cow's horn. This is used in conjunction with a toothpick-like bone or stick used for transferring the lime from the container to the moistened wad of leaves in the mouth. The chemical action of the lime evidently aids in extracting the alkaloid contained in the leaves and enables the user to get the maximum effect from his chew. Coca leaves used without *llipta* are said to give no reaction whatever.

Ever since the accounts of the chroniclers, it has been generally thought that the chewing of coca gives "extra strength" to its addicts and dispels fatigue. The sierra Indian will undertake a long, arduous trip without a thought of food, but never will he start without a full coca bag. He believes that coca chewing supplies the energy needed for accomplishing the normal day's work on the precipitous 12,000-foot trails of the high Andes, where men from normal elevations would begin to think of using supplementary supplies of oxygen.

The importance of coca to the Indians of the *altiplano* (high plateau) was early recognized by the Spanish conquerors who, it is claimed, found this "divine" plant reserved for the sole use of select ranks of the Incas—the royalty, priests, and warriors. These were the very groups that were eliminated after the arrival of the Europeans. Thus coca became available to the Indian commoner, who accomplished so much more work with its stimulus that the avaricious Spanish taskmasters introduced a daily ration of coca leaves for all Indian laborers. Even today, in many a locality, the Quechua worker accepts a job with wages on the tacit understanding that his

Photographs by the author

◄ Rows of coca plants under cultivation near the Inambari River. Seedling plants are shaded with palm thatch until they are several months old coca pouch will be kept full by his employer.

Indian carriers on the trail, workers in the fields, and laborers in sierra towns take time off periodically to indulge in their favorite chew, and the first thing that catches the eye, on such occasions, is their little woven bag with its store of dry leaves. An observer in the eastern Andes of southern Colombia records that the first chew is taken at daybreak and that its effects last about four hours. In fact, so definite is the period that natives tell the time of day by stating whether it is the first or second half of the first, second, or third *mambeo*, the twelve-hour day being divided into three four-hour *mambeos*. Distances are also measured in *cocadas* rather than in miles, a *cocada* representing the distance that can be traveled on one chew.

Most boys and girls begin the habit around the age of ten when Peruvian children are usually thought ready for adult tasks, and observers have even seen mothers give their weaning babes a few scraps of coca leaves. Besides functioning as a masticatory, coca serves as the universal family remedy. The leaves, brewed into a tea, act as a sure cure (according to those who use it!) for all the common ailments to which flesh is heir.

Although coca had been used for centuries by the advanced civilizations of the Andes, it was not known until 1884 that the leaves contained a local anesthetic—cocaine. In succeeding years, the leaves found a ready market in the production of this valuable drug. Like the South American rubber and cinchona trees, the coca plant was introduced to the Far East, especially Java, where the plantations out-rivaled anything the older Andean civilizations may have produced. More recently, synthetic substitutes with anesthetic properties similar to those of cocaine have been discovered, and since these have a superior "batting average" for medical purposes, they have largely supplanted natural cocaine. Thus coca again finds its greatest commercial popularity among the peoples of its Andean homeland.

Anyone who has had the opportunity to compare the active and responsive non-coca-chewing Indians of the Andes with their stuporous coca-chewing cousins has observed a big difference. The latter prove by their devotion to the habit and by their slow reactions that their coca leaf chew is not only habit-forming, but also a narcotic substance.

The United States Government strictly controls the importation of coca leaves into this country. All narcotic alkaloids must be removed before the extract from the leaves is sold for harmless flavoring purposes. The formulas used in the manufacture of the various "cola" drinks are carefully guarded secrets, but the customer can rest assured that all deleterious substances have been removed from any extract from coca leaves that may be used in them.

Coca leaves are obtained from South American shrubs belonging to the genus *Erythroxylon*. More than a hundred species, widely distributed in the world's tropical regions, have been described in this genus, but only *Erythroxylon coca* and its variants contain sufficient alkaloid to be of economic importance. As with so many economic plants long cultivated, the original area of distribution of this species is imperfectly known, though its homeland was probably somewhere in the great basin of the Amazon. Richard Spruce, pioneer botanist of that region, reported seeing wild coca plants there, and apparently the majority of the tribes of forest Indians, whose territory borders the eastern ranges of the Andes, have long used the leaves as a masticatory. These Indians of the lowland, therefore, may have been the first to cultivate the shrubs, but the more highly civilized Andean peoples certainly have developed its use on a far greater scale. At present, coca plants are cultivated in scattered districts all along the eastern slopes of the Andes from southwestern Bolivia to the snowy cordillera of Santa Marta on the Colombian shores of the Caribbean Sea. In the highlands the leaf is chewed whole, but the primitive Indians in some parts of Amazonia chew the leaves only after they have been pulverized.

Coca remains an aboriginal crop both in production and in use. In the Andes, there are no large coca plantations; there are only small plantings of an acre or so, owned and cultivated by individual Indian families. In the forested lowlands of the Amazon, coca shrubs are grown like the staple root crop, *yuca* (*Manihot*), in small home gardens adjoining the thatched family hut; but the bulk of the coca crop is consumed, not by the sparse jungle Indians but by their more advanced highland cousins of Peru and Bolivia. Therefore, the majority of *cocales*, or coca plantings, are located as near as possible to the consumer market, as on the slopes of the forested eastern valleys such as the Huallaga, Urubamba, Paucartambo, and Inambari, which are closest to the population centers of the sierra country.

Erythroxylon coca is a tropical shrub and cannot endure the cold of the barren, treeless highlands. Under human care it will compromise and grow up to 6000 feet in that belt of evergreen mountain forests known as the cinchona zone, which covers the rugged ravines of the eastern Andes. The region of coca cultivation is largely an uninhabited frontier area separating the cultivable lands of the highlands from those of the lowlands. Thus it is that *cocales* are usually found in isolated clearings in beautiful mountainous and forested country where the only visitors are wandering *cascarilleros* (cinchona bark cutters), prospectors for gold, or owners of *cocales* journeying to harvest the crop or to arduously fell a bit of forest for a new plantation.

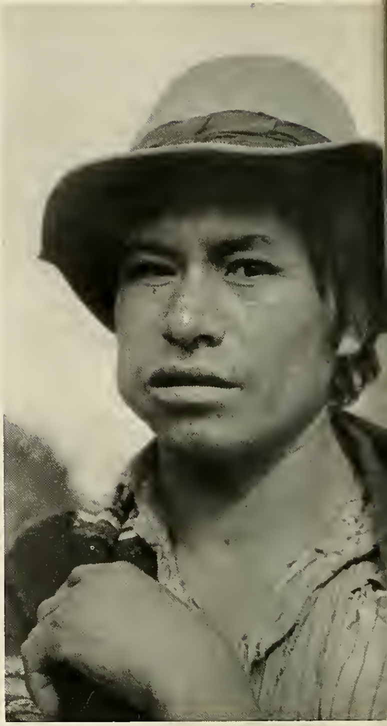
If let alone, branching coca shrubs will attain a height of about fifteen feet, but the pruned plants encountered in plantations average between three and six feet. The oval, elliptic leaves are about an inch to an inch and a half in length. They are thin in texture and bear a strong mid-vein with a curious pair of paralleling pseudoveins.

◂An individual shrub of a northern variety of coca, showing the average size of this species, cultivated in Medellín, Colombia

▾Indians en route to coca plantations, loading up after spending a night in a typical thatched shelter along the trail. The valley of the Huari-Huari River (*background*) is characteristic of coca growing regions in southern Peru. The trail was used long ago by Spaniards searching for the gold of old San Juan del Oro

The clusters of tiny, white flowers appear in the leaf axils and are followed by attractive red berries resembling those of our much cultivated hedge barberries (*Berberis*).

The Indian planters of Bolivia and Peru believe that the shrubs do best on well-drained soil. For this reason (and because flat land is scarce), one sees *cocales* on very steep slopes that are often terraced with rocks in old Inca fashion. The seeds are usually planted in shallow trenches and are shaded against sun and rain by palm leaves. As soon as the seedlings are well started, they are transferred to the growing site, a piece of ground that has been thoroughly cleared and marked off, in checkerboard fashion, with a series of evenly spaced, circular holes. New *cocales* are always recognizable by the pattern made by the vertical rows of holes. Each hole contains several plantlets.



➤ QUECHUA INDIAN with a wad of coca in his cheek. Cheeks often become permanently stretched from the constant use of it

The new shrubs yield their first harvest during the second and third year. After that the plants never quite attain a permanent state of vegetable respectability because every three months, just when they begin to have a full leafy cloak, their branches are stripped stark naked. For this reason, coca shrubs in cultivation are far from attractive. In the midst of a verdant forest, they impress one as straggly with their array of pale, yellow-green, anemic looking leaves clinging to a gnarled assortment of slate-gray, lichen-covered branches. In spite of this treatment, the shrub stands up remarkably well, and a plantation usually bears year-in and year-out for an average period of ten years. On a fertile site, a plantation may continue to flourish up to an age of twenty years.

Between pickings, *cocales* are left quite alone, but at the trimonthly harvest time the owners, who usually live in villages in the cool sierra just above timberline,

◄ A COCA "SALESWOMAN" waits for business in her stall in the open market at Huayucachi, in central Peru. Copper or brass scales are used for weighing out the leaves

▲ COCA-LADEN LLAMAS off for market in the Sierra of southern Peru

◀ A FUNERAL VASE representing a wounded warrior, showing that the people chewed coca in earlier times. (Excavated at Nazca and exhibited in the National Museum of Archaeology in Lima)

set off to their coca *chacras* for a week or more of activity. One such coca center in southern Peru lies in the Province of Sandia, and here on the rough trails one can meet whole Quechua families—father, mother, and children with their kitchen utensils, the family mule or llama, and mongrel dog—trudging toward their coca plots in the mountain forests. Though often requiring as much as two or three days' travel on foot over trails unsurpassed for precipitousness and roughness, the family looks upon this recurrent visit much as we would to a weekend jaunt or excursion to the out-of-doors.

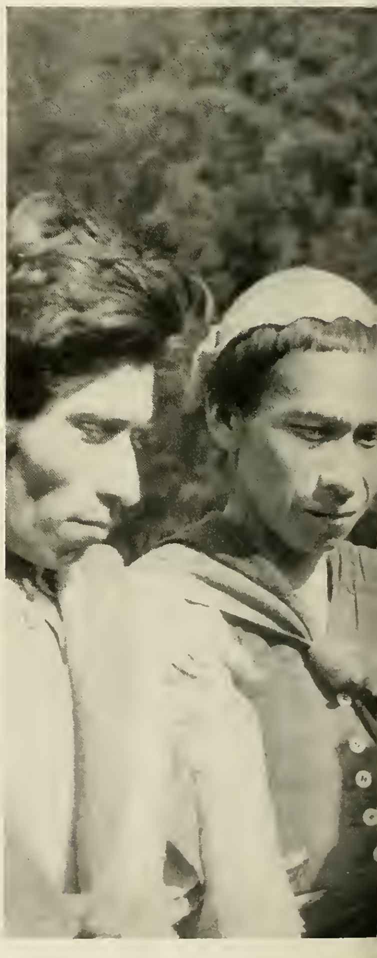
Once at their woodland plot, the family sets up the simplest housekeeping in the tiny, thatched hut that is the accessory of every *cocal*. The first sunny day is the sign for gathering the leaves, and in this task everyone lends a hand, especially the women and children.

Leaves are plucked by hand and are collected into the attractive, handwoven, woolen manta or shawl, called a *llyclla*, which is worn by all sierra women. When full, the *llyclla* is carried to the crudely paved drying yard where during good weather the leaves are spread out in the sun. This process is carefully controlled. With a crude rake or, more often, by means of the shuffling of bare feet, the leaves are moved frequently to ensure even drying. And if rain, which is abundant, threatens, the leaves are quickly raked into the combination coca shed and home. With good sun the leaves may be sufficiently dry after a single day in the open. Following this, they are raked into a mound in the shade of the shed and allowed to undergo a sweating process for several days. After another hour of drying in the sun, the crop is ready for market.

While the womenfolk oversee harvesting, the man of the family is busy in the task of clearing the plantation of the many weeds that have sprung up since the last visit. These are piled around the coca plants and serve as green manure and mulch. At last all work at the *cocal* is terminated for another three months. If the plantation measures a half hectare (about 1¼ acres) and is yielding its first crop, the family will collect about 50 pounds of dry leaves. As the shrubs increase in size, the yield also rapidly increases, and the same plot will easily give ten times its initial crop.

Dried coca leaves are pressed by hand into crude cylindrical bundles weighing 25 pounds each. Banana or heliconia leaves usually form the waterproof wrapper. Over rough Andean country a small mule can carry four of these typical little bundles, but as often as not, an additional bundle will be strapped to the back of each adult. For their labor, the family will be able to sell their harvest at about twenty soles ($3.30 U. S.) per bundle. This is considered a good price, especially among people who seldom earn more than 35¢ a day when working for wages. Inasmuch as the demand for the leaves is a steady one in all the Andean highlands, the growing of coca has always been an attractive proposition.

Peru is probably the largest South American producer of coca leaves; yet nearly all her production is



consumed internally. Only about 3% of the crop is exported, and the majority of this goes to the United States for use in flavoring soft drinks. During the period 1930-1940, the annual internal consumption of coca leaves averaged 5000 tons; the average annual export in leaves was about 165 tons, and in unrefined cocaine nearly one half of a ton. The value of the yearly crop is more than half a million dollars.

The consequences of inveterate coca chewing have been much discussed, but no experiments have been made to determine the exact physiological effects. As one writer has summed it up, it "removes for a day or even for several days the pangs of hunger, and at the same time frees 'energy' for prolonged physical exertion." Perhaps Antonio Vasquez de Espinoza, writing about coca and tobacco in 1628, covered the question when he said, "I consider each of them a vice and an abuse, while admitting that, used temperately and in moderation they are wholesome."

Wholesome or unwholesome, the people who appear to have been addicted to this "divine" stimulant made many important contributions to civilization. So we can only speculate as to whether it was partly *because of* or *in spite of* the use of coca that the Incas developed a textile art unsurpassed in beauty or workmanship anywhere in the world; that they constructed massive buildings and amazing terraces of finely polished and fitted stonework; that they domesticated the Western Hemisphere's only beast of burden, the llama, and managed to bring into cultivation one of the world's most important foods, the potato.

➤ A FUNERAL VASE from the famed Chan-Chan region, near Trujillo. The Indian has a coca bag slung over his shoulder, and in his hand are the container for lime and the stick used in carrying the limey material to the mouth. (National Museum of Archaeology, Lima)

➤ QUECHUA INDIAN CARGO CARRIERS receiving their daily coca ration stipulated as part of their wages during the author's search for quinine bark on behalf of the United States Government. With their allotment of coca, they were able to pack about 85 pounds apiece over some of South America's roughest trails

HIS PERFUME STIRS THE WORLD *Continued from page 71*

medicines, and foods; perfumes in air-conditioning apparatus that introduce a note of outdoor freshness, and perfumes even on the hides of elephants before they perform in circuses.

Chemists, reviewing the situation, recognized the necessity of synthesizing musk. There was already artificial musk, a workable substitute. Why not, then, actual musk—musk chemically and actively the same as that from the pouch of the little musk deer, but produced in laboratories rather than among the rhododendrons? The scientists succeeded. The result is pure musk, dependable in strength and chemically appraisable, which natural musk is not.

Chemists had already added over 800 substances to the aromatic scale. They had evolved shades for each odor type, gradations as definite as the gradations of colors. They synthesized lilac perfume, even though pure lilac oil, to date, has never been extracted from real lilacs. And they synthesized lily of the valley, a perfume not existing until synthesized. Oil of lemon grass helps in synthesizing violet perfume; oil of geranium and oil of citronella in synthesizing rose. They now have synthetic musk.

Synthetic musk, called "Astrotone" as produced in the DuPont laboratories, gives the little musk deer in the Himalayas some respite from his hunters. It does not yet replace the musk from 100,000 deer a year. But it is pure, and it costs infinitely less. So the little music-loving deer, could he but know it, would surely welcome this chemical magic that bids fair to prolong his life.

FANTASTIC LILY OF OUR SOUTHWEST *Continued from page 63*

gnawed into, again, perhaps, by rats or squirrels.

Under the back and in cavities of the rotting decumbent trunks, an interesting little night lizard, some two or three inches long, called *Xantusia vigilis,* makes its home. It lives largely on termites, ants, and insect larvae, and seems entirely dependent on the protection of the great tree yucca.

Edmund C. Jaeger says at least 25 different species of desert birds make their nests in these trees. Quite common are the finches, singing gay, little songs from the tops of the branches, while the cactus wrens keep up an unmusical note which sounds something like "chuck-chuck-chuck." The cactus woodpecker and the red-shafted flicker, says Jaeger, make holes for their nests in the fibrous trunks, and these holes, vacated later, are used by the ash-throated flycatcher, western bluebird, Pasadena screech owl, and others. A lovely summer visitant, the Scott's oriole, on the other hand, is not a user of old nests but swings her hanging nest from the needlelike leaves, using the yucca's fibers almost entirely for the work.

Some rather interesting uses have been made of the Joshua. The smallest roots are a bright, rich red and, because of this, were used by the Indians in making the patterns on many of their baskets. Whether they ate the fruits and seeds of the plant as they did those of other yuccas is a little uncertain, although some references say it is probable.

In modern times the trunk has been used in the making of artificial limbs and surgeon's splints, and it has also been cut into thin strips and employed as cylindrical sheathing for young orchard trees, as protection against rodents and other pests.

In the latter part of the nineteenth century a mill was established in Soledad Pass at Ravenna for the manufacture of paper from Joshua. Enough paper was made to be sent to eastern cities and even to England for use as news print, but, fortunately for the fate of the Joshua, the quality of the product was poor, and so the business died a natural death.

Perhaps one of the most interesting uses is the making of novelties from the so-called "petrified yucca." "Petrified yucca" is a silica deposit laid down by the plant in its cell walls where it has been injured by boring insects, birds, or accidents to its branches. The hollowed-out nesting holes of birds are often completely lined with this material, which becomes harder than mahogany. It is commonly used by desert dwellers for firewood and makes a fine, hot flame, which the normal Joshua does not; but the use that Mr. W. A. Chamberlain of Victorville makes of it transforms it into a lovely work of art. Jewelry, lamps, book-ends, and gavels are only a few of the numerous things conceived by him. The material, which is full of the holes of boring insects, takes a beautiful polish, which Mr. Chamberlain decorates with hammered copper or with etched plates.

Unique and very much localized in its distribution, this fantastic yet most lovely yucca needs more publicity to protect its diminishing domain. It is a great tragedy to let our bird life become extinct, and just as much is it a calamity to lose our rare and peculiar plant-life. Better acquaintance with these desert dwellers might help to solve the problem.

METAL ARTS OF THE INDIANS

Continued from page 83

ter. After the amalgam was applied, the vessel was fired to drive off the mercury, and a gold or silver coating was left behind, greatly improving the appearance of the original object. The Spaniards thought at first that these plated vessels were pure gold, and many false stories soon got abroad concerning the fabulous wealth of the Peruvians. A large number of these legends are still believed. Actually, the figures in at least one Spanish report show that about half of one batch of "gold" loot proved to be copper or bronze after the stolen goods had been melted down and the pure gold separated from the other metals!

As yet, we have only a vague and unsatisfactory picture of how the commerce in metal was carried on in prehistoric America. But we do know that gold and copper bells of Mexican workmanship were used in such distant places as Honduras, Yucatán, and New Mexico. And copper knives of Aztec origin have been dredged from the Sacred Well at Chichen Itza in Yucatán. That trade relations should have been established between the Aztecs of Mexico and the Mayans of Central America across a distance of some 600 miles is surprising enough, but one must really marvel at the courage and enterprise of those old metal merchants who traveled clear from the valley of Mexico to the pueblos of New Mexico and Arizona. The distance is over 1000 miles, and it had to be traversed entirely on foot, since the Indians had no beasts of burden before the arrival of the Spaniards with their horses.

Much of the travel between the Central American centers was facilitated by marvelous stone highways constructed by the Mayan engineers. But it is interesting to note that Columbus, on his fourth voyage, met a large Mayan trading canoe in the Caribbean Sea off Bonaca Island. This canoe was so large that it required 30 paddlers to man it. In addition to the merchant and his crew, it contained bales of cotton goods and stacks of pottery, which the owner was taking southward to exchange for cacao and feather-work. A portion of the metal trade may quite possibly have been carried on in this manner; we cannot be certain.

We know, of course, that lump copper was transported by canoe in the Great Lakes region. The Isle Royal miners took the copper across Lake Superior and down the various rivers to their home camping grounds. After the copper chunks had been beaten into usable objects, they were distributed by traders on foot and in canoes over an immense territory. In fact, articles made of Great Lakes copper have been located all over the eastern part of the United States.

Despite the fact that the prehistoric metallurgists and miners left no imprint upon our present American civilization, except perhaps for some jewelry designs and the like, one need not scoff at their achievements in this art. The native civilizations of both North and South America are now considered to have been of fairly recent development in human history, although more primitive people had probably lived in the Americas for some 20,000 years. In fact, the Aztec "empire" (which was not really an empire at all, but a loose aggregation of tribes held in vassalage by the Aztec's superb military organization) had not been established for much more than a hundred years when Columbus sailed. It is small wonder, therefore, that the native American metal workers had not discovered any techniques of great value not already known to European craftsmen. Rather, we should admire them because of the hardships and dangers under which they developed their metallurgical arts. The copper-laden canoes on Lake Superior and the native traders who traveled great distances on foot may seem primitive and ineffectual in comparison with our modern Great Lakes ore ships and our huge smelting plants. But let us remember the tools with which the Indians had to work, and that from the artistic point of view, their craftsmanship bears comparison with some of the best we have today.

LETTERS

Continued from page 49

. . . In the article entitled "X" by Paul L. Swanson, there is a statement which I think may not be correct, namely, that there is no evidence that the mongoose will attack a viperine snake.

I had long known that most cobras (except spitters) were easy prey for the mongoose, because of their long, sweeping stroke. But I was always in doubt as to what would happen if the snake were one of our pit vipers, with its lightning-like stab, until Dr. Raymond L. Ditmars showed us his movie of the mongoose and fer-de-lance.

When the mongoose saw the snake, it started its approach like a cat. The snake coiled, ready to strike. The mongoose stretched out its neck until its head was within striking distance of the snake. The snake struck fast, but the mongoose was just a split second faster in getting its head out of danger. This continued for some time, until the snake was exhausted; then the mongoose moved its head closer to the snake. There was a movement of the mongoose's head, almost too fast for the eye to follow,—and it had its teeth in the snake's neck. That was the end of the snake.

This seems rather good evidence to me. What do you think? Could it be that Dr. Ditmar's mongoose was an exception to the rule?

After many years of experience with wild animals and especially with our American pit vipers, I find the approach must be slow and deliberate. As a boy, my approach to a young skunk was too fast, and I paid the penalty. But it was a worth-while lesson which I have never forgotten.

About ten years ago I was classifying a new consignment of snakes which had been shipped in boxes about two feet square and six inches high, covered with fine wire screen. In one box there was a very nervous Texas diamondback, *Crotalus atrox*, or coon-tail rattlesnake. I stood by this box for some time, and while the snake continued to rattle, it did not strike. My wife walked toward the box, and when she was about six feet from the snake, it struck at her, fastened its fangs in the wire, and ejected two streams of venom almost to her feet. A ringhals cobra could not have done much better.

I got the snake's fangs loose from the screen, and within fifteen minutes the snake struck at my wife again, but no venom was discharged.

Could you comment on these things?

D. P. LEFEVRE.

Cumberland, Md.

The following remarks are offered by Mr. C. M. Bogert, Chairman and Curator of the Department of Amphibians and Reptiles at the American Museum.

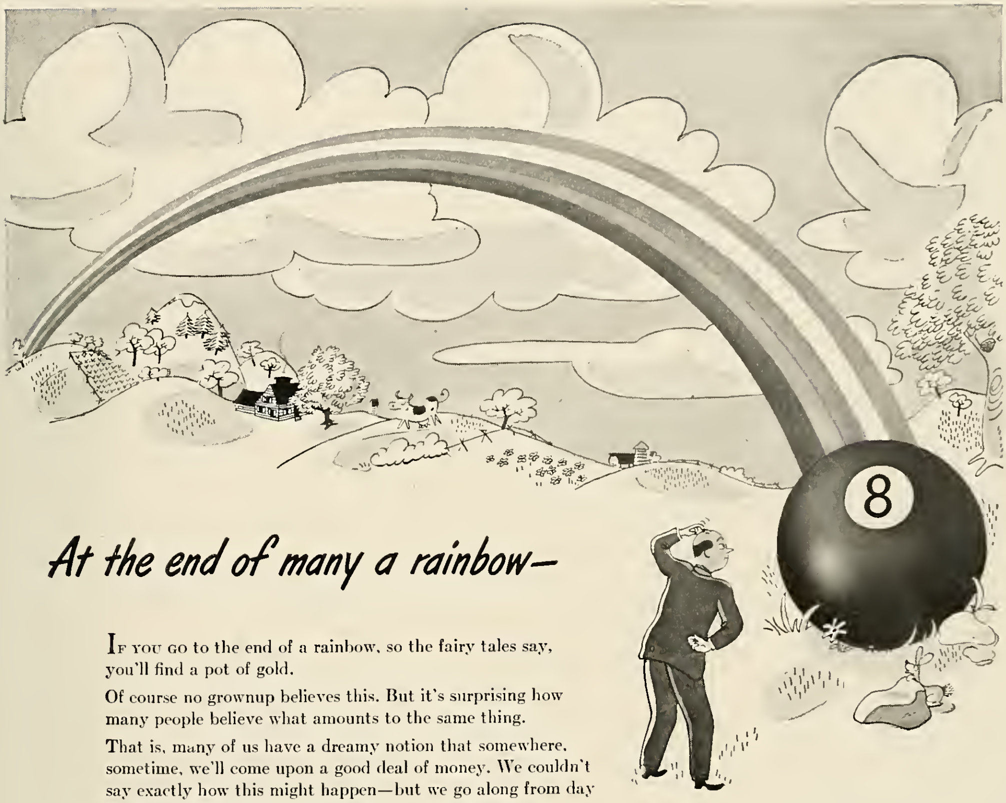
As for the motion picture of the mongoose and the fer-de-lance, it is perhaps pertinent to point out that observations on captive animals often provide quite erroneous notions of what takes place in nature. Animals that most certainly ignore each other in a native state sometimes fight in confined quarters. Many creatures will accept prey that is quite foreign to their normal peferences.

The mongoose in the motion picture may have attacked the fer-de-lance either through fear or for the more practical reason that it was simply hungry. Another more widely circulated movie shows a mongoose killing a cobra, although there appears to be little if any evidence that these mammals make a practice of preying upon venomous snakes in their native state. During his field work with the Central Asiatic Expeditions, Clifford H. Pope made an effort to learn something of the cobra's reactions when confronted by a mongoose. When he placed a large mongoose in a room with a small cobra, the mammal attacked and killed the snake. However, a smaller mongoose failed to kill a five-foot cobra. When Dr. P. E. P. Deraniyagala of Ceylon placed a mongoose in an enclosure with a cobra, the snake was completely ignored for the first fifteen minutes, but the mongoose finally chose to fight after repeated attacks by the cobra. The battle lasted 50 minutes, with both animals nearly exhausted when it was stopped. Apparently neither animal succumbed.

Such experiments, however, really prove very little. Kipling's famed story has contributed to a popular belief that the mongoose and cobra are confirmed and deadly enemies. There are exceedingly few authenticated instances of animals attacking members of another species unless food is the object, despite impressions to the contrary that might be gotten from many commercial motion pictures.

The late Dr. Thomas Barbour assumed that the apparent rarity of the fer-de-lance on Martinique in 1930 could be ascribed to the introduction of the mongoose. However, a letter we received in 1944 from the Agricultural Superintendent of St. Lucia stated that there had been an apparent increase in the fer-de-lance on that island and that the mongoose, which had multiplied exceedingly since its introduction, was seemingly valueless as a predator on the pit viper. This view is borne out by a study of the food habits of the mongoose in Trinidad, where it was also introduced. Some years ago Dr. C. B. Williams examined the stomachs of 180 mongooses and found snakes in only 18 stomachs. The snakes were virtually all harmless species; no bushmaster or fer-de-lance remains were detected, although neither of these pit vipers is uncommon on Trinidad. To the credit of the mongoose, Dr. Williams found rats, injurious insects, and crabs in its diet, but this was offset by the number of useful birds, lizards, frogs, insects, and spiders consumed. No strong preference for snakes was manifest in Trinidad, and without better evidence to the contrary, it seems unlikely that the mongoose is any less catholic in its food habits in its native Old World habitat.

The observation that a snake is much less inclined to strike at an immobile object is quite sound. Despite the heat receptors that presumably assist pit vipers in locating warm-blooded prey, and despite an acute sense of smell, vision plays an important role in the defensive behavior of these snakes. A motionless person might stand surrounded by venomous snakes and be quite safe, but one quick movement would center the snakes' attention, even though none of them would necessarily strike. Incidentally, the discharge of venom through the wire mesh of a cage has been commonly observed. Under such conditions the direction of the venom is purely a matter of chance, and the phenomenon has nothing in common with the normal defensive reaction of such "spitting" cobras as the South African ringhals. The true spitting cobras, of which there are three, two in Africa and one in Asia, have evolved specialized fangs that direct the twin jets of venom outward from the mouth. Moreover, the true spitters direct the venom with some accuracy and seemingly aim for the face of mammalian enemies, causing immediate, excruciating pain and even blindness unless the venom is promptly removed from the eyes.



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If you go to the end of a rainbow, so the fairy tales say, you'll find a pot of gold.

Of course no grownup believes this. But it's surprising how many people believe what amounts to the same thing.

That is, many of us have a dreamy notion that somewhere, sometime, we'll come upon a good deal of money. We couldn't say exactly how this might happen—but we go along from day to day, spending nearly all we make, and believing that *somehow* our financial future will take care of itself.

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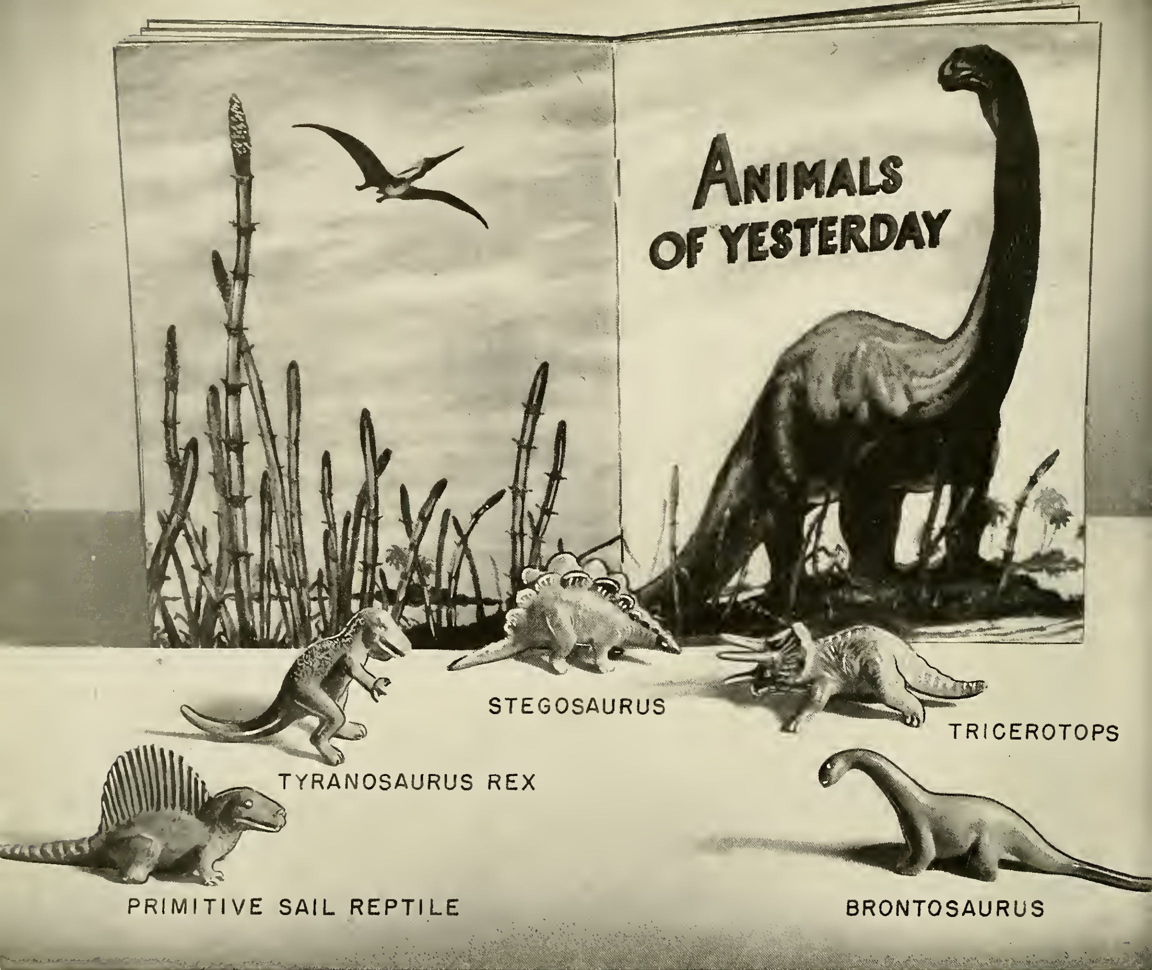

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L E T T E R S

Owls Have Stomachs

SIRS:

I thoroughly enjoy each issue of NATURAL HISTORY and read it from cover to cover. I think it is very educational regardless of one's residential location, for it contains articles of interest from every part of the world.

I was very much interested in William H. Carr's article, "Owl Friends," in the December, 1946, issue. However, I was surprised to read on page 485 that their diet had been ascertained by examination of the contents of their "stomachs." Does an owl have a stomach?

E. CECELIA JOHNSON.

Buffalo, S. Dak.

The following answer is offered by Dr. John T. Zimmer, Curator of the Department of Birds at the American Museum of Natural History:

Yes, owls do have stomachs. Like those of other birds, they are composed of a glandular proventriculus and a gizzard. The gizzard is of the "simple" type, not the solidly-walled, muscular sort found in seed-eating birds which have a great deal of heavy grinding to do; but it is still more developed than that of some fruit-eaters, in which it is virtually obsolete.

Hibernating Woodchuck

SIRS:

This is rather in the nature of an S.O.S. to the proper small mammal authority. We have as our invited guest a full-grown woodchuck living in our basement shower stall. He is apparently in a comatose condition due, I presume, to not having ended his winter nap. Every morning I expect to find he has awakened and think I had better be prepared before that time.

Our Briard sheep dog discovered him several days ago on a path in our woods. The dog loves all small animals and was vigorously licking the woodchuck when we came up. The woodchuck's eyes were open, and he was able to turn his head, but he lay spread-eagled on his stomach, unable to move his body. Believing him to be badly injured or ill, we left him alone. The following morning I found him still in the same position and very wet from an all-night downpour, which had also erased any trail he might have left. Wearing heavy gloves, I examined him for injury and found an ugly wound on his left foreleg and a few superficial scrapes on the abdomen but nothing sufficient to account for his complete helplessness. I then decided something had interrupted his hibernation but had not completely awakened him. Fearing he would freeze in so exposed a position or that he would be found by other dogs or red foxes that live near by, I put him in a comfortable open box and

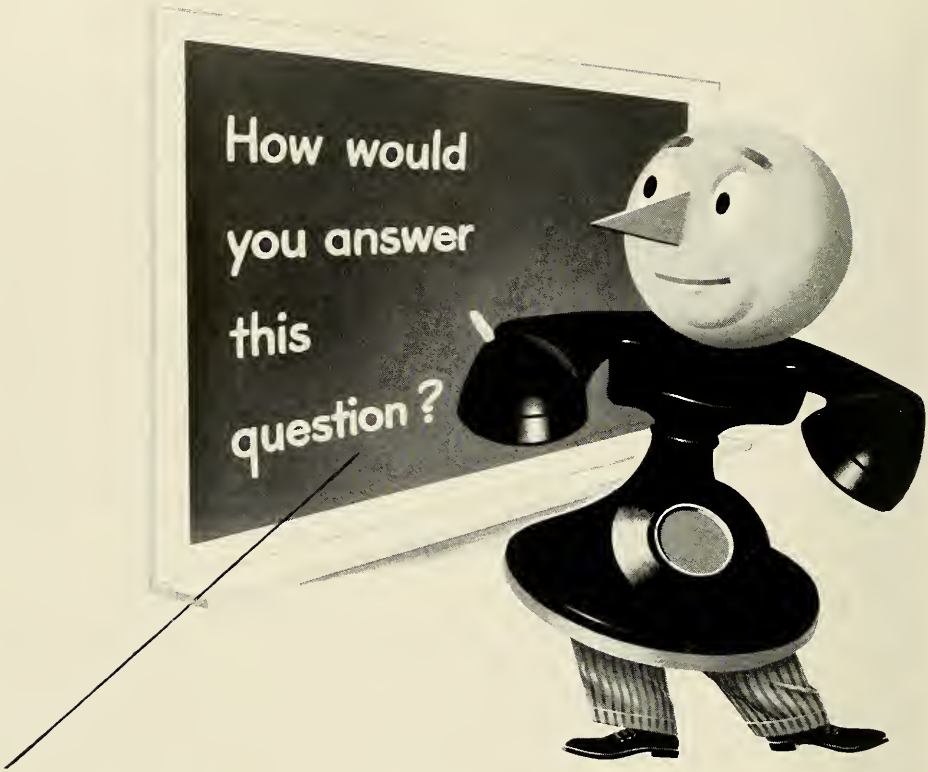
Continued on page 140

NOTICE—Readers are encouraged to submit their own photographs of natural history subjects. Those selected for publication on these pages will be paid for at $2.00 each, with full credit to the photographer. Return postage must be included.

➤ BLUE-GREEN BERRIES of the Juniper tree

▼ A JUNIPER TREE growing on the South Rim of the Grand Canyon

Photos by Gladys Diesing



How much does the telephone company earn?

We asked a number of people this question . . . *"How much would you say the telephone company makes (after all expenses and taxes) on the money invested in the business?"*

Twelve per cent said "6% or less."
Eleven per cent said "7% to 10%."
Twelve per cent said "15%, 20% or 25%."
Eight per cent said "30% or more."
Fifty-seven per cent had no opinion.

The actual figure is less than many people think. Even with telephone calls at a record peak, Bell System earnings on the money invested in the business have averaged only a shade over 5½% for the last five years – including the war years. And that's not enough to insure good telephone service.

We thought you might like to know in case you have been wondering about telephone earnings.

BELL TELEPHONE SYSTEM

NATURAL HISTORY

The Magazine of the American Museum of Natural History

FREDERICK TRUBEE DAVISON, President

ALBERT E. PARR, Director

VOLUME LVI—No. 3 MARCH, 1947

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You will find NATURAL HISTORY Magazine indexed in *Readers' Guide to Periodical Literature* in your library

THE COVER THIS MONTH

The beautiful Scott's Oriole, depicted on the cover from a Kodachrome by George M. Bradt, lives in the thorny brush regions of extreme southwestern United States and northern Mexico. It is partial to the growths of yucca which make one of its favorite nesting sites, but it sometimes builds in other low vegetation, perhaps no more than five or six feet above ground. The yucca further supplies much of the fiber from which the semi-pendent nest is constructed, with the addition of a lining of soft grasses and cottony material. Four eggs are the usual number, but there may be no more than two. They are bluish white in color, marked with spots of dark brown and lilac brown, chiefly about the larger end. When the young are hatched, the male performs his share of the work of feeding them on insects and their larvae and other choice morsels. Two broods may be reared each season.

The song of this oriole is a rich, clear whistle, at times suggesting the notes of the Meadowlark but usually more typically oriole-like in quality. This song is given throughout the day at frequent intervals, even in the heat of noon. The female is said to sing sometimes but in a softer tone. She is less colorful than her handsome mate, being olive green and brownish on the upper parts and dull greenish yellow below.

JOHN T. ZIMMER.

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NATURAL HISTORY is published monthly (except July and August) at New York 24, N. Y. by the American Museum of Natural History, Seventy-ninth Street and Central Park West. Subscription price $4.00 a year, single copies fifty cents. Subscriptions to Canada, Newfoundland, and all foreign countries $4.50. Entered as second class matter March 9, 1936, at the Post Office at New York, under the Act of August 24, 1912. Manuscripts and illustrations submitted to the Editorial Office will be handled with care, but the publisher cannot assume responsibility for their safety.

The American Museum is open to the public every day in the year without charge

YOUR NEW BOOKS

DARWIN • ANCIENT MAYA • PUMA
DEATH VALLEY • WORLD EXPANDS

THE ANCIENT MAYA
- - - - - by Sylvanus G. Morley

Stanford University Press, $10.00, 520 pp., 95 plates, 57 figs.

DESPITE wide popular interest in Maya archaeology, there has until now been no one book that could be recommended as providing a full, well-rounded, and well-illustrated account of this fascinating but very complex field. *The Ancient Maya* fills this need, not to perfection, perhaps, but in a way that will be of great value to many persons.

This is a weighty and scholarly book, such as we must expect of any serious attempt to adequately summarize a field of this kind. Maya history concerns a great and largely unique civilization, maintained throughout a period of several thousand years. It is known only imperfectly by means of an incomplete archaeological record and from a few meager written sources from the time of the Spanish Conquest. Material of this kind is difficult to present in readable form, but Dr. Morley has been able to do so successfully because of his long acquaintance with Maya studies and his great skill in organizing and presenting his subject. The 95 plates of photographs and the numerous beautifully drawn maps, plans, and text figures comprise the best selected and most useful pictorial record we have in any one book on the Maya.

It is because of its many fine qualities, and the fact that the appearance of the book alone recommends it as an authoritative study, that I feel particularly called upon to point out what seem to me to be very definite faults in *The Ancient Maya*. A portion of its readability results from the author's failure to present both sides of controversial issues, thus giving the impression that Maya archaeology is much better known than it really is. Furthermore, there is too much emphasis on the uniqueness of Maya culture. The Maya shared in cultural advances made throughout the area of the high cultures extending from Mexico to Chile and certainly did not develop their culture in as complete isolation as Dr. Morley would lead us to believe.

GORDON F. EKHOLM.

CHARLES DARWIN AND THE VOYAGE OF THE BEAGLE
Unpublished Letters and Notebooks
- - Edited with an Introduction by Nora Barlow

Philosophical Library, $3.75, 279 pages, 15 plates, and folding map

THE voyage of H.M.S. *Beagle* around the world in 1831-1836 might have been just another competent British surveying expedition. It became, in fact, one of the most important voyages in human history, because the *Beagle* carried not only the capable but bigoted master and surveyor, Robert FitzRoy, but also a young man named Charles Darwin. The voyage converted Darwin from a theological student into a naturalist, and it gave him the first glimmerings of theories that were to revolutionize human thought.

Darwin, himself, wrote accounts of the voyage in five different versions. First, he jotted down in small pocket notebooks brief comments and suggestions to jog his memory. Then, often on the same day, he expanded these notes into a more detailed and comprehensible diary. From time to time he summarized events and added personal comments in a series of letters to his family. After his return to England he rewrote the diary into a formal journal, published in 1839 as one volume of the official report on the voyage. This journal was again revised, with extensive alterations, and published as a separate work in 1845.

The diary, source of the published journal, was finally printed in 1933 under the editorship of Lady Barlow, Darwin's granddaughter. In the volume here under review, the same editor presents, in part, the remaining unpublished versions of Darwin's accounts of the voyage: the notebooks and the letters. All students of Darwin's life and work will want to study this book. All will be grateful to Lady Barlow for providing these further gleanings from a well harvested field. It must, however, be noted that the present book is a rather anomalous production. The general reader should certainly start with the journal, possibly then go on to the diary, and he should read this incomplete version of the letters and notebooks last, if at all. The specialist, already familiar with other accounts of the voyage, will find that his needs have not been kept well in mind and that the editing shows more devotion than skill.

G. G. SIMPSON.

DEATH VALLEY AND ITS COUNTRY
- - - by George Palmer Putnam

Duell, Sloan and Pearce, $2.75, 231 pp.

DEATH VALLEY is a land of paradoxes. It is the lowest, hottest, and one of the driest regions in the United States. Yet there is greater danger of drowning (from "flash floods") than of dying of thirst. It is one of the most sparsely covered regions in the world and yet it supports over 600 species of plants. Air temperatures in the shade have been known to reach 134° F., the maximum for North America. And yet the best view of Death Valley can be obtained by putting on snowshoes and climbing Telescope Peak. The relative humidity reaches absolute zero and seldom exceeds six per cent. A rain gauge in California's San Gabriel Mountains indicated that this territory once received more rain in three minutes than Death Valley ordinarily receives in a year.

However, this book is not a mere recital of facts, startling as many of them are. It deals with the history, the climate, the geology, the fauna and flora, and with such characters as Shorty Harris who called himself a "single blanket jackass prospector." Yarns as well as facts are set down with skill and zest by a man who visited Death Valley with more than a casual interest. It is not an exhaustive treatise, but it is an excellent introduction to a region of such scenic importance that it was set aside as a National Monument by proclamation of President Hoover in 1933.

Where the forty-niners struggled through with ox-drawn wagons there are now excellent roads and even luxurious hotels. The deserts, once thought of as barren wastes to be avoided at all costs, have become the winter playgrounds of countless tourists. Once called a "deadly sink," Death Valley is visited by more people than any other American desert resort, with the exception of Palm Springs on the edge of the Salton Sink. Either place is worth several visits,—and if you go to Death Valley, read this book before you tie your water bag to the car and set out.

C. M. BOGERT.

THE PUMA

Mysterious American Cat
- - - Part I by Stanley P. Young
Part II by Edward A. Goldman

Amer. Wildlife Inst., 822 Investment Bldg., Washington, D. C., $4.00, 358 pp., 93 illust.

THIS volume is written by two men who have devoted years of study to the subject and have the experience to qualify as authorities in every sense of the word. The book is sharply divided into two sections.

The first of these takes up the history, life history, economic status, and control of the puma, and Stanley P. Young develops these topics in considerable detail. The puma is a widely ranging mammal, occurring today over a spread of approximately 100° of latitude, from Patagonia to northern British Columbia. It is sly and secretive in habit, and men seldom see it even in regions where it is common. Nevertheless, it has so many attributes to challenge man's curiosity that it has been an animal of great interest to most of the primitive inhabitants of the Americas and to the people who have moved into the western hemisphere in historical times. Thus the puma is known by a multitude of names. It figures in folklore and tradition; descriptions of its habits are various and run the gamut from sober observation to mythical hearsay, and nowhere is it a creature to be ignored. Mr. Young has documented his section fully and carefully, and there is a great amount of valuable and interesting data in it.

The late Major Goldman has performed a scholarly task in defining and describing the 30 subspecies or races of this big cat now recognized by science. There is but the one full species of the puma, and the subspecific differences are never great enough to obscure the prominent characteristics that make the puma readily distinguishable from all other American cats. This section will fill a long felt need for an authoritative classification of the "mountain lion" and is the culmination of most exhaustive preparation.

The average reader will be most interested in the first section of the book; the second will make its greatest appeal to the museum man or the nature lover who wishes to go into the taxonomic details. Together these sections tell about all there is to know about the puma, and there are certain advantages in segregating the categories. The book is well illustrated.

H. E. ANTHONY.

IDENTIFICATION AND QUALITATIVE CHEMICAL ANALYSIS OF MINERALS

- - - - - - - by Orsino C. Smith

D. Van Nostrand & Co., $6.50, 351 pp., 22 figs., 28 color plates

THE chief criticism that can be raised against this book is a very minor one. The title is misleadingly difficult. Actually it is a book of the greatest value to the amateur mineral collector who wishes to learn to identify his specimens. The chief feature of the work is the classification of all the minerals described up to 1946 (and the lists really seem to be complete) into tables arranged according to two of the most readily determined mineral properties. Hardness is about the simplest test that one can make, and the specific gravity can be found by several methods not very much more difficult. With these two clues the identification of minerals is narrowed down to a dozen or so possibilities, and then the physical description will usually eliminate all but two or three. Near the beginning of the book will be found a series of tests for specific elements,—blowpipe and simple chemical tests. For the more inquiring investigators a new system of qualitative analysis is presented. This includes many tests, some of which are better than those of college qualitative analysis courses. On the other hand, the average mineral collector will not find these so useful, since comparatively few have access to adequate laboratory equipment.

The book is illustrated by a series of color plates, the notable ones being the reproductions of charcoal and plaster films and sublimates. The reviewer knows of only one previous reproduction of a similar, much more limited, series in a leaflet now long since out of print. The bead tests are also useful but have suffered in the color reproduction. The ten plates of mineral specimens are a little disappointing; too many have been crowded into a single picture, and the printing leaves something to be desired. The general appearance of the book, with its many color plates, is attractive, however, and it is the most useful work on identification for the amateur that is now available. It is a really valuable book and one that every collector should have to supplement his more descriptive texts.

F. H. Pough.

Fishing in Pacific Waters

- - - - - by J. Charles Davis, II

Sentinel Books, 127 pp., 60 illust.

Mr. Davis, who is well known as a sports writer, says that he has written this book "with the hope that this information will be of service to the beginning fisherman essaying for the first time the vast waters of the Pacific."

The book contains a great deal of information that the average fisherman cannot find anywhere else with any ease. Mr. Davis gives it clearly and concisely and illustrates it with sketches. In most cases, the sketches of the fish accompanying the pages on the various species to be caught in the Pacific, are adequate for identification, although it is regrettable that the artist did not go a bit further and put in the most outstanding diagnostic characteristics, such as the keels on the tail of the Swordfish and Marlin, the lateral line in any of the fishes, and some indication of scales where these are particularly characteristic in arrangement or shape. It was unfortunate that the pelvic fins of the Marlin do not show.

The most useful feature of the book is the simply worded and detailed descriptions of tackle and its use and the pictures of hooks, reels, fishing chairs, harnesses, and types of boats.

F. LaMonte.

The World Expands

- - - by George Howard Parker

Harvard University Press, $4.00, 252 pp.

Although the title of this book does not suggest it, the volume is the autobiography of a professor of zoology. It is very readable, and one notes the thesis of expansion in following the illustrious career of Professor Parker, who spent nearly half a century in academic teaching at Harvard University plus a decade more as professor emeritus. During this long period he was an active principal in the impressive growth of biological organization at Harvard and in the acceleration of research in international fields.

Professor Parker writes simply and convincingly. He develops his topic along the customary chronological pattern but groups in separate chapters the major factors that have influenced his life. His account of his academic preparation discloses that he early discovered what he wanted to do, and this purpose continued to be the dominating factor throughout his career. His association with "big names" in Harvard circles gives the reader most interesting sidelights upon many individuals whose work constitutes an important part of the foundation of modern philosophic thought in biology. The author traveled extensively in Europe and also saw something of Japan and China. He taught briefly in other American colleges. Throughout these moves he met people with ideas and encountered entertaining experiences.

Professor Parker enjoyed meeting people, taking long walks, and seeing something of the places he visited. His description of his professional activities is thus supplemented by numerous anecdotes and incidents of very human content, and this feature does much to eliminate the monotony that often creeps into a biography. Another factor that operates toward the same end is his avoidance of the specialist's vocabulary. The reader does not need to be an advanced student in biology to follow the author's thought.

H. E. Anthony.

"Mr. Catherwood also is missing"

The story of a forgotten celebrity who introduced two continents to the marvels of Mayan civilization and led a romantic and adventurous life as an explorer, mining engineer, and railroad builder

By Victor Wolfgang von Hagen

FOR days during that remembered month of October, 1854, the "Loss of the *Arctic*" crowded everything else off the front pages of New York City's newspapers. Day after long day, the list of the missing filled the black-bordered columns. The Stock Exchange closed its bourse, banks shut their doors, the stars and bars flourished at half mast. A funereal pall descended over the noisy city, because many of the 350 people who had lost their lives on the S. S. *Arctic* had been New Yorkers. In deference to the friends of the dead, the papers published lengthy "last actions of the missing," where one could read in full detail the final movements of almost every passenger until the cold Atlantic had swallowed the last of the victims.

It was only when the *Arctic* tragedy had been finally emptied of all its discursive juice that the editor of the *Daily Tribune*, as a sort of after-thought, ran a single, cryptic line: "Mr. Catherwood also is missing."

That was the sum of Mr. Catherwood's obituary and epitaph. The famous British-born architect-archaeologist, pioneer of Egyptology and one of the first to draw its monuments, the artist who had accompanied John Lloyd Stephens to Central America and who had illustrated his books on Maya archaeology, the friend of Keats, Shelley, and Byron, had become the victim of an outrageous fortune. In Francis Bacon's ironic phrase, he had sunk "in the stream of life."

"F. Catherwood, Arch't," as he styled himself, made his first appearance in America during the Age of Jackson. In London, in the fall of 1836, he had met a most engaging New Yorker, John Lloyd Stephens, who had just returned from a two-year journey through Russia, Turkey, Greece, Egypt, and to the ruins of Petra between the Dead Sea and the Red Sea. Stephens, being a Knickerbocker, suggested that New York was the place where Mr. Catherwood should exhibit his talents. And so he came.

In the year that Martin Van Buren was inaugurated as President, Frederick Catherwood built on Broadway a large, circular building called a Rotunda. On its walls he mounted a huge canvas, measuring 10,000 square feet in area, depicting in a continuous panorama the *City of Jerusalem*. "We hail," wrote the *Mirror's* dramatic critic, "with no small interest the permanent establishment of panoramas in this city."

This fad for "panoramas, dioramas, and poluphusikons, where the eye is pleased without the brain being unduly exerted," had a great hold on the public, for they were the newsreels of their day. Battles, coronations, cities, ruined or modern, were painted on curved canvases and exhibited to the public. In America, Catherwood exhibited the panoramas of Jerusalem and the Holy Land and the ruins of Thebes, Damascus, and Baalbek. One entered Catherwood's panorama for seven and a half cents. For five cents one purchased a pamphlet with a panoramic engraving explaining the larger one.

Mr. Catherwood, the proprietor, was there to help, too. At scheduled times he made his way to the rostrum and, in strong British accents, perorated on the mural. He was always dressed simply in a high-collared black frock coat—a man in his late thirties whose face showed the pocked ravages of the tropics. Speaking was definitely not his métier, and he was rarely autobiographical; yet bit by bit New Yorkers who frequented the panoramas learned the broad outlines of his life.

Frederick Catherwood was born in 1799 in Hoxton Parish, London, of parents middle class and republican. At fifteen he was articled out for five hard-working years to Michael Meredith, architect, under whom he learned his profession. He later attended classes at the Royal Academy, where he exhibited his first picture in 1821. Then, infected with the Romantic movement in architecture, he took the road to Rome. There he was swept into the *conversazioni* of poets, noblemen, and blue stockings—not enough distraction, however, to prevent him from putting in a year of hard architectural study.

From Rome Catherwood went to Greece, where he drew to scale many of the classical ruins. Later in Athens, while making casts of Hellenic bas-reliefs, the Greco-Turkish War boiled over, involving, like a hurricane, everyone within its orbit. Catherwood quickly took leave of Athens, stowing away on a falooka which crossed the Mediterranean and put in at Alexandria. For a young artist of 24, passionately interested in art, archaeology, and architecture, Egypt, with its thousand-mile concourse of enigmatic ruins, offered an exciting prospect. The Rosetta Stone, the key to Egyptian hieroglyphics, was still undeciphered, and archaeologists were "antiquarians." Alone ahead of him was Giovanni Belzoni, the Mocha-coffee merchant who, with his battering ram technique, was breaking into ancient Egyptian tombs, treading on "golden plated mummies as thick as leaves in Vallombrosa."

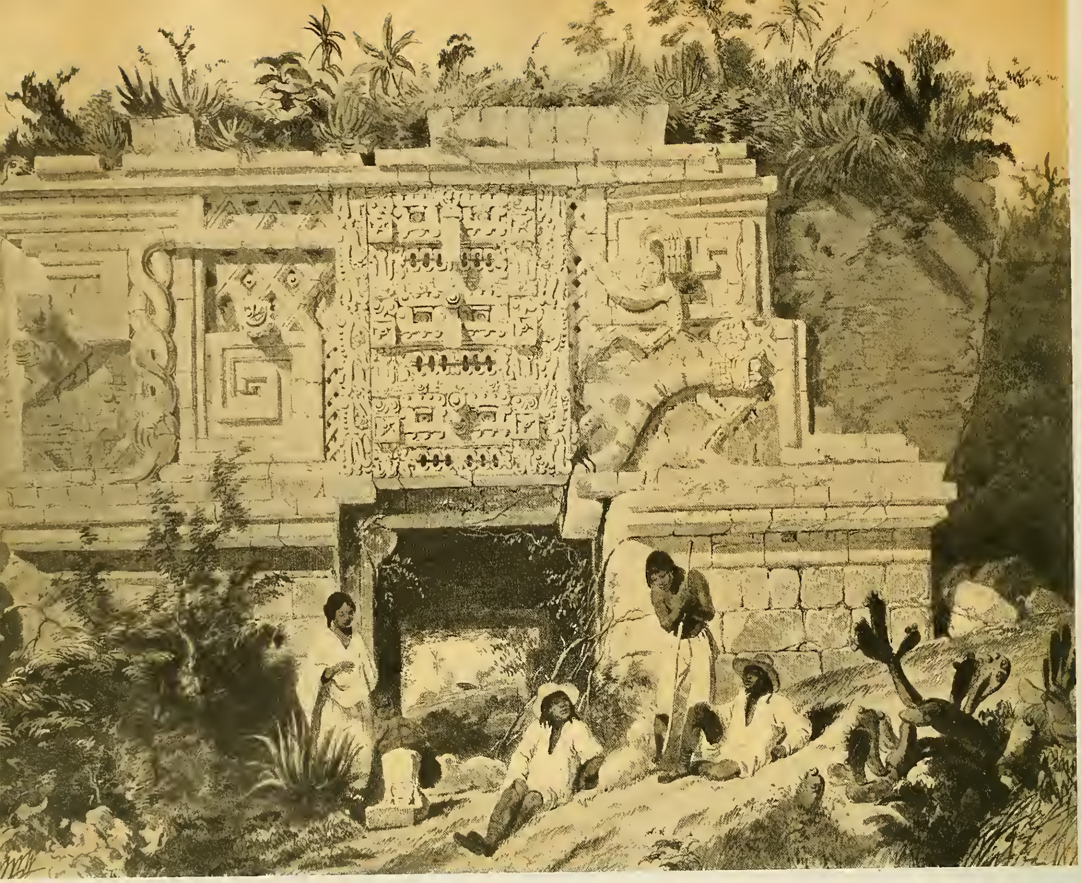
For the next eight years Catherwood, dressed as a Turk, carried his drawing board, his camera lucida, and his surveyor's rods all over the face of Egypt. His superb pencil drawings were some of the first ever made of the Egyptian remains by a trained architect. There he met a number of Englishmen who, like himself, were interested in Egypt. Under the sponsorship of Robert Hay, the titled grandson of the Earl of Tweeddale, Catherwood was asked to join an expedition which made the first systematic studies of the ruins of Egypt. Numbered in that group were names now famous in archaeological history: Wilkinson, Lane, Bonomi, Haliburton (called Burton), and Francis Arundale. Their eight years of explorations are fully told in the 49 folio volumes that Robert Hay presented to the British Museum. Among these hundreds of drawings, sections, and maps is the work of Frederick Catherwood.

After that, Catherwood traveled extensively. He went up the Nile to Nubia, across the desert to Petra, through the ruins of the Roman cities in Transjordania to the Hellenic ruins of Baalbek in the Levant,

Pan American Airways System photo

➤ A MODERN PHOTOGRAPH of the same pyramid, cleared and partially restored, showing the precision with which Catherwood portrayed these monuments over a century ago

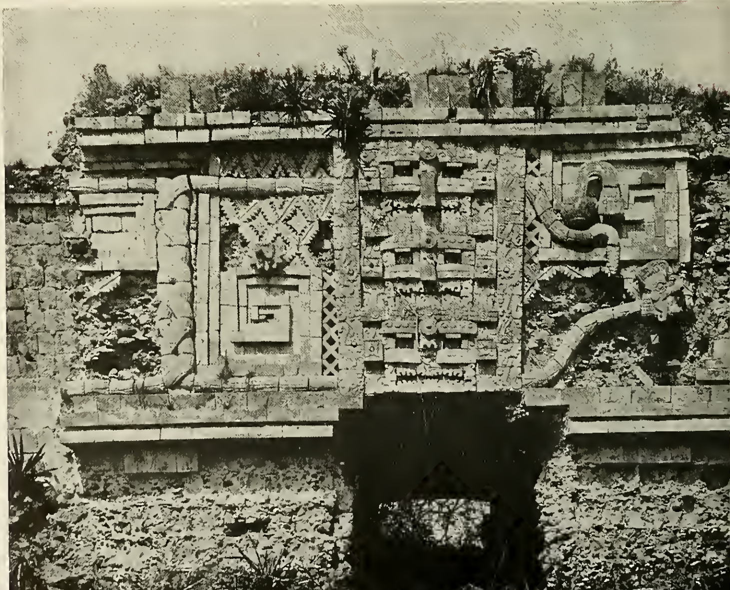
▼ THE NOW FAMOUS PYRAMID, El Castillo, dominating the ruins at Chichen Itza. From 1839 to 1842 Catherwood explored the ancient sites of Yucatán to make the first accurate drawings of them



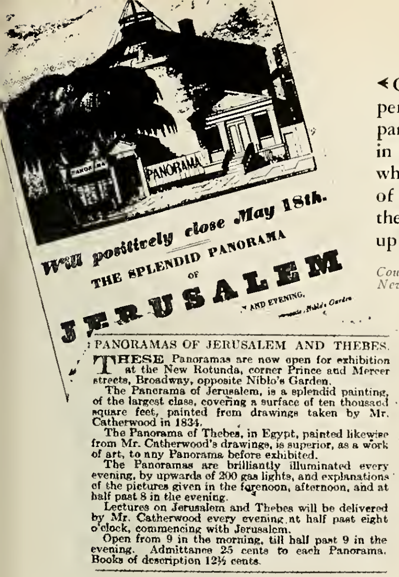
A M N H *photo*

▲ CATHERWOOD'S DRAWING from the inner wall of the Nunnery at Uxmal, Yucatán, is among the most exquisite in his portfolio. Here religious inspiration led the ancient people to embellish the walls of a large enclosure approximately 300 feet square with a wide assortment of mytho-aesthetic motifs

➤ A MODERN PHOTOGRAPH of the same, for comparison



and thence around the rim of the Mediterranean to Tunis, where he settled down among the ruins of Carthage. When he returned to Alexandria in 1832, he was escorted by red-coated janizaries into the presence of the terrible-tempered Mehemet Ali, Pasha of Egypt. It had first been thought that Catherwood was a British agent making military sketches under the pretense of archaeology, but when he exhibited his beautiful drawings of buildings, ancient and modern, the Pasha commissioned him to repair the



PANORAMAS OF JERUSALEM AND THEBES.

THESE Panoramas are now open for exhibition at the New Rotunda, corner Prince and Mercer streets, Broadway, opposite Niblo's Garden.

The Pancrama of Jerusalem, is a splendid painting, of the largest class, covering a surface of ten thousand square feet, painted from drawings taken by Mr. Catherwood in 1834.

The Panorama of Thebes, in Egypt, painted likewise from Mr. Catherwood's drawings, is superior, as a work of art, to any Panorama before exhibited.

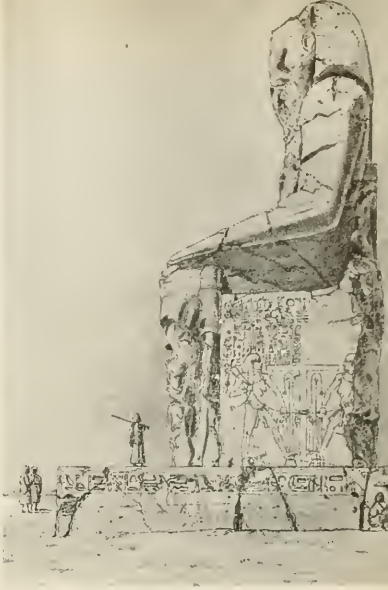
The Panoramas are brilliantly illuminated every evening, by upwards of 200 gas lights, and explanations of the pictures given in the forenoon, afternoon, and at half past 8 in the evening.

Lectures on Jerusalem and Thebes will be delivered by Mr. Catherwood every evening at half past eight o'clock, commencing with Jerusalem.

Open from 9 in the morning, till half past 9 in the evening. Admittance 25 cents to each Panorama. Books of description 12½ cents.

◄ CATHERWOOD enjoyed an era of prosperity when the public flocked to see his panoramas of Egypt and the Holy Land in this Rotunda in New York and elsewhere; panoramas were the "newsreels" of their day. But the Rotunda burned to the ground in 1843, and the murals went up in smoke. Catherwood was ruined

Courtesy of the New York Historical Society, New York City



➤ CATHERWOOD had earlier studied the ancient ruins of Egypt. Dressed as a Turk, the young artist was arrested by the Pasha of Egypt as a military spy but was later authorized to make the first detailed drawings of the Mosque of Omar in Jerusalem. Here we see one of the Colossi of Memnon, on the Nile, drawn by Catherwood in 1832

Courtesy The British Museum

mosques of Cairo. Later he gave Catherwood his personal manifesto, or firman. And so, dressed as an Egyptian officer and with a janizary to keep the ill-washed at arm's length, Catherwood, in perfect safety, toured the Holy Land, entered the famous Mosque of Omar in Jerusalem, and made the first detailed drawings of that Islamic architectural masterpiece.

After ten years spent in traveling through the Near East, Frederick Catherwood returned to London in 1834, his portfolios bulging with drawings. He expected to publish something on his work, particularly on the Mosque of Omar. But Catherwood had an evil demiurge; his elaborate plans for publishing came to nothing. Instead he mortgaged his art and made his drawings into panoramas for Robert Burford's Rotunda in Leicester Square. It was at this exhibition in London that he met John Lloyd Stephens—a meeting that was to have an important effect on his life.

In New York City, Gemini was rising. And so was Catherwood. He was having, for once, excellent fortune; his Panoramas were crowded night and day with the curious, ready to make the walk of his oversize murals. For the first time in his life he knew something that resembled prosperity. He sent his Panoramas "on the road" to Providence, Boston, and Philadelphia, and, under the banner of *Catherwood & Diaper,* he plied his trade as architect.

His friend John Lloyd Stephens was doing well, too. He had published, in the depths of what the Whigs called the Van Buren depression, a two-volume book entitled *Arabia Petraea* (to give its short title), an amusing, delectable account of his travels in Egypt, Arabia, and Palestine. It went through ten editions in a single year. Emboldened by this success, Stephens wrote another book, this one on his travels in Turkey, Greece, and Russia. Now he wanted to enlarge his horizon, and he approached Catherwood with the proposal that they as writer and artist, make a tour of that *terra incognita,* Central America. They would attempt to find the ruins of the ancient stone buildings of which rumors had persistently percolated out of the jungle. For Stephens had read in the out-sized folio published by one Count

➤ THE ONLY KNOWN "PORTRAIT" of Catherwood. The artist is seen here in one of his own drawings (at left, by the tree)

Waldeck* in 1838 of ruins at a site called Palenque.

The rest is history.

In October, 1839, Stephens, with Catherwood in enthusiastic attendance, sailed on the *Mary Ann* to Belize, British Honduras. There in a tropical stench they disembarked to enter through Central America's postern, the never-never land of the Mayas. Revolutions were raging in the interior; everyone was under suspicion, and Catherwood cursed his evil star that he always had to carry on his archaeological researches in revolution. John Lloyd Stephens has detailed how they were arrested, how they were released to discover, or rather re-discover, the ruins of Copan, and how, amidst rain, rubble, and revolution, Catherwood set up his easel to draw in a superb manner the remains of a culture then without name or history. Throughout their travels to Quirigua, Palenque, Chichen Itza, Uxmal, and Tulum, Catherwood continued to draw, despite the malaria that consumed him daily. His were the first accurate drawings of the Maya ruins.

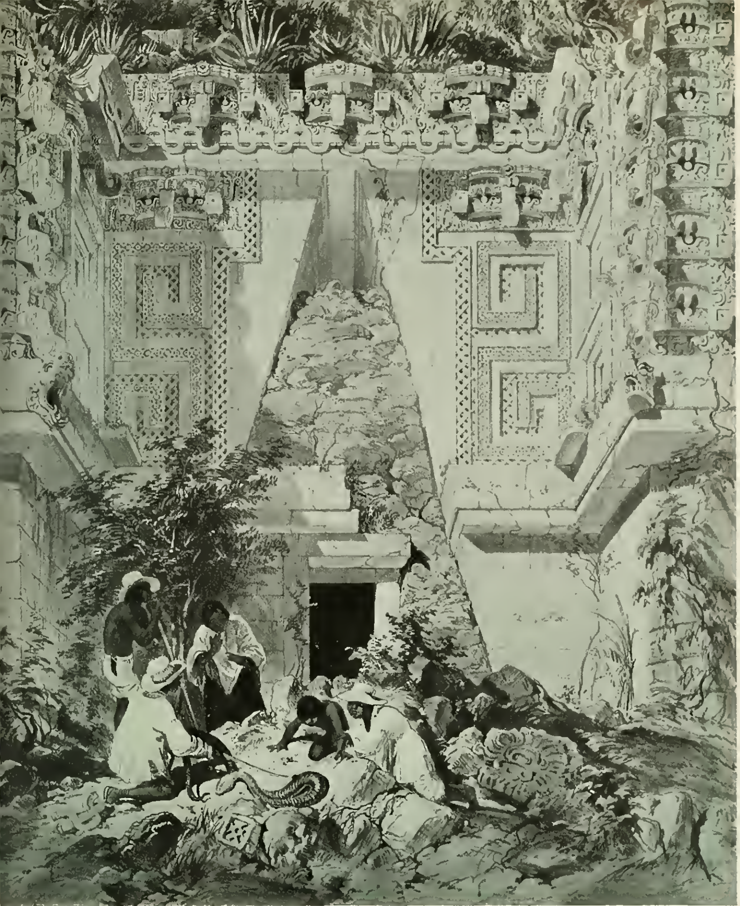
*See "Waldeck," by Victor Wolfgang von Hagen, in NATURAL HISTORY for December, 1946.

One need only to compare his drawings with photographs taken a century later to appreciate how accurate they were. Further, when one takes into consideration that Central America was ravaged by revolutions, that the people of the country had no interest in their buried cities, that the explorers had first to discover the cities and then clear them of vegetation with scant human aid before the designs could be drawn, the project was monumental.

Yet Catherwood was equal to it. He struggled for many days before he was able to capture the "Maya spirit." The aboriginal art forms were beyond his immediate comprehension, for Maya art, like all ancient art in America, had flowered in magnificent isolation. It had had no contact with the evolution of art elsewhere in the world which formed, for thousands of years, the universal base of art as we know it. European and Asiatic art history, as Pál Kelemen has expressed it in his *Medieval Art*, ". . . is like a vast web, stretching from the Roman ramparts of England to the delicately drawn woodcuts of Japan, from the Byzantine icons of the Russians Steppes to the wondrous world of the royal tombs of Egypt . . . Yet, remote as certain points lie from one another, as different as are the styles which they produced, it is clear that details and even whole ideas are incorporated, adapted, and developed inter-regionally. At the time Greek art began to flourish about 500 B.C., there were nearly three thousand years of cultural heritage from which to draw inspiration."

American Indian art lay outside this magic circle of art experience. It was different, unique. And Frederick Catherwood, trying to draw the strange perspective of Maya

▼ LARGELY OVERGROWN with tropical vegetation when Catherwood found them, the ruins of Central America had to be cleared before he could make his celebrated drawings of them



◄ CATHERWOOD'S DRAWING of a portion of the Governor's Palace at Uxmal, Yucatán, considered by some the greatest of Maya buildings. Note the fine corbeled arch, constructed without knowledge of the keystone, also the masked panels and rich decoration. Catherwood's drawings have helped archaeologists interpret some of the details in carvings damaged during the century since he made them

art, with its bold and involved symmetry, had to tax all his powers. It was Catherwood who first gave the world its glimpse of American art—graphic and dramatic. He followed Stephens through trouble-torn Central America, drawing and recording in two prolonged expeditions. During the years from 1839 to 1842, they circled the entire Maya realm, visiting, in all, 44 ruined sites. From the hundreds of water-colors and sepias he made of the ruins, Catherwood selected the views that would best illustrate the books of his friend, John Lloyd Stephens. It was Catherwood who designed the bindings; it was Catherwood who chose the engravers and inspected the finished plates for both of Stephens' publications,* which made American archaeological history. And no less a person than William Hickling Prescott—at that moment writing his celebrated *Conquest of Mexico*—wrote, "Too much praise cannot be given to Mr. Catherwood's drawings . . . they carry with them a perfect assurance of his fidelity. . . ."

After the publication of *Incidents of Travel in Yucatán*, Stephens and Catherwood proposed, in the grand manner of an Audubon, to publish in a huge portfolio a great work on American antiquities, containing 100 or 120 engravings by Catherwood. It was to be issued in four numbers quarterly and to cost one hundred dollars? The text was to be written by Alexander von Humboldt, Albert Gallatin, Sir John Gardner Wilkinson, William H. Prescott, and John Lloyd Stephens.

The mere prospect of so stupendous an undertaking, even a century later, is breath-taking. Catherwood eagerly plunged with unbounded enthusiasm into the re-creation of drawings and burned the midnight gas to make new pictures for the "Great Project."

In the midst of all these preparations, his famous Rotunda caught fire on the night of July 31, 1843, and burned to the ground. Up in smoke went the huge murals of Jerusalem, Baalbek, and Karnak—and Catherwood's income. Up in flames went his hundreds of drawings of the Maya expeditions, his collections of vases and the stones* so laboriously collected in Yucatán. And more tragic for archaeological science, the fire utterly destroyed the carved wooden lintels of the ruins of Kabah and Uxmal, pieces bearing glyphic dates on richly carved sapote wood. Gone in a midnight holocaust was a huge chunk of Catherwood's life. "His private loss," wrote the *New York Herald*, "will be at least $10,000." The "Furies" had been unbound. Misfortune followed him everywhere.

The "Great Project" collapsed, and Catherwood was forced to carry on the work by himself, which he did, publishing 25 of the projected 120 lithographs in London in 1844. Then, in an attempt to recoup his losses, he tried gold mining.

He had found, while in Central America, a piece of ore which, when assayed, showed an unbelievably high gold content. This news reached the ears of the British Chargé d'Affaires, who brought it to the attention of Rafael Carrera, President-in-perpetuity of Guatemala. Carrera was gold starved. He ordered money delivered to Cather-

*Incidents of Travel in Central America, Chiapis and Yucatán, 2 vols., (1841) and Incidents of Travel in Yucatán, 2 vols., (1843).

*Herbert J. Spinden, "The Stephens Sculptures from Yucatán," NATURAL HISTORY, XX (1920), 379-389.

From the original sketch, owned by the author

▲ A PRIMITIVE WOODEN LADDER of about 85 steps that led down to the village water supply at Bolonchen, as depicted by Catherwood in a dramatic view of the well

◂CATHERWOOD'S SCIENTIFIC DRAWING of the sculptured door jam of a small temple at Kabah, Yucatán. It compares well with an actual photograph of the piece itself (at right), which is now on display at the American Museum of Natural History

wood with instructions that he buy the necessary machinery and depart at once for Guatemala. In pursuance of his El Dorado, Catherwood bought the machinery at Pittsburgh, floated it down to New Orleans, loaded it on a steamer, and arranged to follow on the next ship. This was just as well, for a *chubasco* blew up out of nowhere, and the steamer bearing the machinery that was to repair his fortune disappeared at sea.

The New York press was screaming for "The Annexation of Texas" when Catherwood returned from this fiasco. The metropolis was alive with building, so he returned to his old profession of architecture. He did surveying, he designed Gothic houses (most of which never left the drawing board), and, upon hearing that the city fathers planned a fountain for Grammercy Park, he designed a magnificent one in Renaissance style. It was never erected. Next he entered a prize competition for a monument to George Washington. His was a gigantic concept—a heroic bronze statue 75 feet in height, mounted on a stone pedestal in the fashion of the antique. He did not win the competition. He drew, on a visit to Governor's Island, a "View of New York," showing the city as it appeared in 1844. It was a delightful view (aqua-tinted by Henry Papprill) and is now one of the most costly prints of New York City—a collector's item. But Catherwood obtained little from it. Then he tried railroads.

The Crown Colony of British Guiana in South America decided to build a railroad connecting all the sugar plantations of its East Coast, and Catherwood was selected as its superintendent. Through all the eventful years during which the armies of the United States were carving out huge slices of Mexican geography, Catherwood was building, in the miasmas of Guiana, the first South American railway. But he did not recoup his losses. He went to the Isthmus of Panama to help his old explorer in arms, John Lloyd Stephens, build the great Isthmus Railway. There he was struck down by malaria. He sought his health in California and, while there, became involved once again in railways, in which he played a leading part. Then the magnet of travel drew him again, and he left for England.

In London, in 1853, he brought down the curtain once and for all on his archaeological labors; he edited a memorial volume of Stephens' *Incidents of Travel in*

Continued on page 140

From a sketch made by James Smith, a passenger aboard the Arctic. Lith. by N. Currier.

▸"THE LAST GUN." After a brilliant but frustrated career, Frederick Catherwood perished in the first collision of ocean-going steamers. In this famous Currier & Ives print we perceive him beside the cannon in the bow of the vessel, where he had last been seen. So completely had he been forgotten that among the lengthy obituaries only one line was devoted to the once-famous archaeologist and artist: "Mr. Catherwood also is missing"

FIRST SIGNS OF *Spring*

▲ LIFE REAPPEARS in woodland and field, beckoning us to a companionable countryside

March is the open door to the season of rebirth. Capture its essence while spring is young

By HAROLD K. WHITFORD

TO some, spring arrives only when a particular feathered favorite again appears in some treetop or marsh and echoes its cherished notes across the waking landscape. "*Can-kor-ee*" are the welcome notes of the red-winged blackbird, issuing from the still-frozen marshes. The song of the red-wing, which sometimes comes to the New York area as early as late February, is an unquestionable sign of the arrival of the vernal season. The naturalist, in his anxiety to hasten the return of spring, will note any and all early indications, and the red-wing's arrival will be high on the list of every keen observer.

Some nature enthusiasts prefer the appearance of a bit of vegetation to reassure them that the wintry blasts are but a memory. In March, the lowly skunk cabbage, pushing its head of purple, maroon, and green up through the soft, icy marshes, is always welcomed as a spring sign by those eager to "rush the season." They gladly accept this first true blossoming flower as their floral ambassador of springtime.

The more skeptical and exacting, however, may not admit spring's arrival until the appearance of the Trout Lily, the Hepatica, or perhaps the Purple Trillium or Flowering Dogwood. Or, maybe, some will insist on the appearance of Jack-in-the-Pulpit. No matter what plant or animal may be the favorite, spring comes pretty much on time each year. A severe winter may retard the development of some vegetation a few days, but habitues of the fields and forests feel a decided difference during the month of March—a sudden warmth in the afternoon hours. And haven't the days grown noticeably longer for some time now? March—no matter what may be said in verse about its fickleness—is undoubtedly the "awakening month."

Things afield are beginning to stir. The March sun, rising higher in the skies, sends to earth with its stronger rays a day or two of late spring warmth, and this is bound to bring forth the hibernating Mourning Cloak butterfly with its

◀ THE RED-WINGED BLACKBIRD'S CHEERFUL "can-kor-ee" and the welcome pussy willow are an announcement of the vernal season

Photos by Mary Cynthia Dickerson

dark velvet-brown wings, brightly bordered by bands of yellow. What a delight to the lover of the fields and woods is the first sight of this winged beauty in the early spring season.

Woodchucks, after a deep, long winter's sleep, are already about in goodly numbers. Flight robins are returning in large flocks. Bluebirds are more numerous. The Hylas, especially the tiny little spring peepers, are joining in the chorus in cold lakes and ponds, and it won't be long before other tree frogs will be putting in their appearance. The staminate flowers of the familiar pussy willow are sure to blossom during a mild March period, showing their anthers laden with golden yellow pollen.

April is indeed sweet and pungent, but March with its swelling buds and the blossoming of early spring flowers is most assuredly the month that brings the first breath of spring. No one, from the very first day, should disregard one moment of March.

The beauty and the grandeur of the entire spring season and of the whole of summer are now before us. March is the opening door; winter is definitely past. Even if there should be another snow flurry or a full-grown snow storm, winter has lost its teeth. To postpone spring until April would be an unpardonable error.

How can one catch it all—the great pageant of the seasonal unfoldment of life. It comes so suddenly, with its many scenes, and departs so quickly. It steals upon us overnight, gently yet with vivacity and assuredness. Spring, with its stirring beauty and peace, brings also the rebirth of the vision of man. It is a renewing of the spirit within. In spring all the world is reborn.

The sweet, refreshing aroma of the warm, brown earth announces the arrival of the new season. The fields, the woods, the rivers, and

▲ THE MORE EXACTING may not admit that spring has come until the purple trillium makes its appearance

▼ WOOD FROGS also show themselves in the month of March

Photos by Harold K. Whitford

lakes all have a story to tell if one will but venture forth and find it. Capture it while you may, for all too soon will the freshness of the young season have given way to April's stability.

How quietly the early spring procession blends into succeeding stages! With April, the days are clear and dry; objects become sharper and nearer. There seems to be a certain tranquillity in the air and with it a greater understanding of the world about us. We are more awake to the meaning of the spirit of life.

Spring, never flagrant, never flamboyant, never gaudy, but always emerging gracefully and beautifully, comes to all. To some, spring may be a bluebird that comes down from a clear sky; to others, the clear notes of the inimitable phoebe, who seems to be trying to outdo the sweet, full clear notes of the song sparrow in a near-by tree. It may be the first bright yellow coltsfoot blossom thrusting itself into view in damp places along the roadsides or open fields, while abroad in the north-

▲ In March crickets can be found under stones

➤ And the lowly skunk cabbage pushes its hood of purple, maroon, and green up through the soft icy marshes eastern states pickerel and green frogs begin to stir themselves deep in the mud of thawing pools or along muddy embankments. After a long period of suspended animation they come forth to join the spring procession and become a part of its splendor. In March, sharp eyes—those of the trained field observer—will detect such insects as short-horned grasshoppers, crickets, ants, and even mosquitoes. The delicately pinked spring beauty and the white-petaled bloodroot are preparing to blossom in some secluded woodland nook. And though there may still be patches of snow on the ground in the March woods, the common Garter Snake is up and about—and that's a very good sign, too.

The great awakening, the splendor and grandeur of springtime, has already begun. March is the month of its birth. It is upon us; all too soon shall we begin to realize how much of it we lost.

Orion, the outstanding winter constellation, which rose out of the eastern October sky and traveled across the cold, brilliant winter heavens, is low in the southwest. It is March—and springtime again.

Photos by Harold K. Whitford

▲ IT TAKES the flowering dogwood to convince some that spring has come

◄ THE TRAINED OBSERVER will detect the short-horned grasshopper early in the spring

"Of Course Animals Can think"

A laboratory scientist criticizes the anecdotal method of demonstrating the intelligence of animals and advocates sharp discrimination between observation and interpretation

By Frank A. Beach
Professor of Psychology, Yale University

"It is said that in Iceland six to ten mice select a piece of dry cow-dung, pile berries or other food on it, then with united strength drag it to the edge of the stream, launch it, embark and range themselves round the central heap of provisions with their heads joined over it and their tails hanging in the water, perhaps serving as rudders. At first this account was received with some skepticism but it is now established as an important fact in natural history by the testimony of two eye-witnesses of unquestionable veracity, the clergyman of Briamslaek, and Madam Benedictson of Stickeshold, both of whom assured me that they had seen the expedition performed repeatedly."

The foregoing paragraph is a direct quotation from a serious and supposedly authoritative volume entitled *Animal Intelligence*, by the learned Mr. G. J. Romanes, one-time Zoological Secretary of the world-famous Linnean Society of London. If the first story seems a little hard to swallow, try another from the same source.

"Rats carry eggs up and down stairs in a highly ingenious manner. Dr. Carpenter received an eye-witness account of this behavior. Going upstairs the male rat places himself on his forepaws with his head downwards. Raising up his hind legs and catching the egg between them he pushes it up to the female who stands on the step above and secures it with her forepaws till the male jumps up to her; and this process is repeated until the top step is reached. A ship's captain watched rats form a line from his egg basket to their hole, and pass the eggs along in bucket-brigade fashion until the basket was empty."

These entertaining tales exemplify the most common source of "evidence" upon which many popular conceptions of animal intelligence are based. To be sure, any educated adult in this day and age is too sophisticated to credit stories that are as bizarre as the two quoted above, but few people are likely to recognize spontaneously the fundamental weaknesses of the so-called "anecdotal method;" and it is anecdotal evidence that gives rise to hundreds of misconceptions concerning the mental life of animal species other than our own.

Fitting facts to theory

The good Romanes was so opinionated that we can dismiss his contributions in good conscience. Acting in his official capacity as Secretary, and striving to gain support for Darwin's revolutionary ideas concerning the close relationship between man and other living creatures, Romanes solicited evidence *that would prove* that animals were highly intelligent. By seeking only positive results he stacked the cards and prejudiced his case. Furthermore, he often paid good English money for first class examples of animal genius and probably thereby tempted many an otherwise honest correspondent to "remember" the right sort of incidents. Finally, Romanes was completely uncritical of the competence of observers whose reports fitted in with his preconceived notions. Many of his stories came to him second- or third-hand, and the original reporters are variously described as "old experienced trappers," "native gentlemen," medical men, priests, rectors, and now and then even an archbishop.

Disregarding for the moment the many people who must have bilked the poor Secretary, and overlooking those who simply couldn't resist the very human temptation to tell a good story, what about the evidence provided by the remainder? What about that "old, experienced trapper," for instance, assuming that he was a keen observer, well versed in the ways of the wild, and scrupulously honest? Can we accept his reports at face value and use them when we come to pass judgment on the intelligence of animals? We definitely cannot! And this brings me to my reason for writing this article.

In the December issue of Natural History there appeared an article provocatively entitled "Can Animals Think?" Mr. Andrew G. A. Russell, who wrote the article, is described as "a veteran guide who has lived all his life with game, big and small." Reading his story I found myself impressed with Mr. Russell's vast fund of first-hand information about beasts and their ways, and I felt strongly the obvious truthfulness of his accounts. It is exactly for these reasons that his accounts of animal behavior will serve as excellent examples of the anecdotalism which is deplored by scientific students of animal behavior,—students who are just as anxious as Mr. Russell to learn more about animal mentality.

Let's take his anecdotes one by one and examine them carefully. We can start with the story about the skunk. Riding his horse across a flat, Mr. Russell spied a skunk, and in a spirit of curiosity decided to see if he could herd the animal away from the woods and toward his farm. After a leisurely chase, the skunk became winded and settled down under a willow bush, and Mr. Russell dismounted and stood quietly, leaving the next move to the animal. Calmly the skunk began to eat, and by advancing slowly and avoiding any abrupt motions, the man got close enough to scratch the animal under the chin with a twig, a service which evidently was much appreciated.

What signifies intelligence?

Those are all the facts. Mr. Russell says that this incident testifies to the skunk's intelligence because it shows that the animal knew he meant no harm. I say it shows that when the approach was gradual and gentle, the skunk permitted a man to scratch its chin with a twig. Obviously the animal was not particularly frightened, but this alone is no proof of acumen.

Another story has to do with the beaver who outwitted the hired man. Day after day the men tore great holes in the beaver dam in an effort to force the colony to move; and night after night the dam was repaired. Once scarecrows were installed on the dam, and they halted operations for a single night; but the second night "the beavers ignored them and built up the dam." In a burst of inspiration, the hired man inserted a water wheel in a newly made break in the dam. Using tin cans as paddles, he hung a bell above the wheel so that with each revolution the cans struck the bell and raised a racket which, one presumes, could be heard for miles on a still night. On the morning of the second day it was discovered that the bell was silenced, the wheel was motionless, and the dam repaired.

Such are the bare facts. Mr. Russell says that one big beaver (presumably size indicates age, and age sagacity) must have thought the whole problem over very carefully, selected a log of just the right size, and launched it from the bank upstream in such a manner that the current carried it against the water wheel. I say, first of all, that since no one saw what happened we cannot use the incident as evidence one way or the other; but even if events occurred as Mr. Russell supposes, where is the evidence of intelligence at work? It exists only in the imagination of Mr. Russell! It exists only in his gratuitous assumption that the jamming of the water wheel was a cleverly planned act involving foresight on the part of "some big beaver." Now I think this is carrying things a bit too far.

All we need assume is that the beavers became accustomed to the movement and noise of the wheel (just as they previously got used to the sight of the scarecrows) and proceeded to repair the breach in their dam in exactly the same way as they had mended it on preceding occasions. Beavers often release the logs they are carrying a few feet above a break to let the current carry them against the edges of the hole. This could easily have happened in the case in question, and once a log had caught in the wheel and stopped it, the rest of the job was easy.

A third story of Mr. Russell's has to do with a time when he and four other men were climbing in the mountains and sighted a small group of Bighorn rams several hundred yards away. He and the rest of his party were sure that the rams had seen them, but it was decided that the group should proceed as if nothing had happened, and as they passed behind a large boulder two men would stop there while the other three continued along a course which was carrying them farther away from the animals. The plan was executed, but shortly after the decoys filed out from behind the boulder, the sheep bounded away and soon were lost to sight.

Various possible interpretations

Those are the facts and all the facts. Mr. Russell hesitates to say that ordinary sheep can count, but he points out that these particular rams "acted as if they knew that three plus two makes five." I say that there are so many things which *might* have precipitated the flight of the beasts that only a highly prejudiced observer would jump to the one interpretation that reflects most favorably upon the smartness of the Bighorn. Thus, although the men were quite certain the sheep had spotted them earlier, this is not necessarily true, and just possibly the animals may not have noticed them until three walked from behind the boulder. Alternatively we might suggest that the men had been detected while they were two hundred yards away and that their progress had been carefully watched, but that the sheep had not taken alarm since it was apparent that the hunters were moving along a course that did not approach too closely. But when the entire party disappeared temporarily and as suddenly reappeared (minus two members, although that is immaterial), the reappearance created an entirely new situation from the sheeps' point of view and had much the same effect as if the men had not been seen before but had suddenly materialized from behind a too-near boulder. Or perhaps the wind changed suddenly and carried a warning odor to the animals just at the crucial moment. Potential explanations of the type I have tentatively suggested would have to be examined and proved incorrect before we would be justified in accepting the one advanced by Mr. Russell.

Facts and opinions

There were several other anecdotes in "Can Animals Think?", but the three I have cited are sufficient for our purpose. Let's analyze the points of agreement and disagreement between my position and that advocated by Mr. Russell. I have accepted at face value every bit of factual information that he presents, but I have differed with him consistently in the interpretation of those facts. Now here, as plain as the nose on your face, we can see the major weakness of the anecdotal method. *Observation and interpretation are presented as though they were the same thing.* Obviously they are not. Observations are what the man saw, and granting his keeness of perception and the accuracy of his description, we can take the observations without salt. But when he starts to explain why the animal did a particular thing, then we would be wise to assume a critical attitude, for the best-intentioned observer in the world can go far, far astray when he tries to interpret what he has observed.

Hans, the educated horse

A classic example of honest misinterpretation of animal behavior is found in the story of three famous horses, Hans, Muhammed, and Zariff. In 1901 a certain Herr von Osten of Berlin announced to the world that his horse Hans could solve the most difficult mathematical problems and could comprehend and reply to spoken or written questions. Arithmetical problems were written on a large blackboard, and the horse gave the answer by tapping on the ground with his forehoofs, designating units with the right foot and tens with the left. If verbal answers were required, the horse spelled out his reply by tapping a certain number for each letter of the alphabet, which was arranged before him on a large chart.

Scientists who tested Hans found that Herr von Osten's claims regarding performance were not unfounded. To be sure, incorrect replies were often given, but the frequency of correct answers was little short of astounding. However, it was discovered that Hans behaved like any ordinary horse when his master was absent. Under such conditions the animal could not solve the simplest problems and seemed totally unable to spell so much as a single word.

Taking these preliminary findings as a clue, the learned examiners found that Hans was responding to very slight, involuntary cues given by his trainer. The horse had learned to start tapping when any problem was presented and then to watch Herr von Osten carefully for a sign that it was time to stop tapping or to shift to the other foot and tap with it. The master was so anxious for his protege to make a good showing that he was constantly tense as the tapping was in progress and then relaxed slightly when the correct number of taps had been given. Hans had learned. He had learned to start tapping under certain conditions and to stop when his owner changed position slightly or gave some other sign that the job was finished.

It is particularly important to realize that Herr von Osten was no charlatan. He sincerely believed that Hans performed independently and was bitterly disappointed when it turned out that this was not so.

Herr Krall, a friend of Hans' owner, remained unconvinced and repeated the experiment using two Arabian horses, Zariff and Muhammed. Zariff was only a moderately bright scholar, but Muhammed graduated cum laude. In two weeks he learned to add and subtract. From multiplication he passed in three days to the use of fractions; and finally this equine marvel became skilled in the extraction of square and even cube roots. Shortly after he had learned to spell, Muhammed apparently became bored with answering simple questions and began to offer original observations of his own. Herr Krall undoubtedly was overjoyed with this sign of intellectual power, but skeptical scientists who examined Muhammed found reason to suspect that his intelligence had been overrated. In mathematical tests he scored better than chance only if someone present knew the correct answer, indicating that the horse had become skilled in detecting very slight cues given involuntarily by human observers. His spelling was so atrocious that only Herr Krall could identify individual words, and a predilection for novel abbreviations (which Krall regarded as eccentricity indicative of true genius) so confused the unbiased examiners that they protested that no words were being spelled at all.

It was finally decided that Muhammed had learned to start tapping when he was led before the blackboard and to stop tapping in response to tiny movements on the part of the human beings who were watching him. Unfortunately, the tests were not carried far enough to identify with certainty the sort of cues to which the horse was responding, but there was ample evidence against Herr Krall's belief that the animal solved problems by any rational process. For instance, Muhammed frequently started tapping without even glancing at the blackboard to "read" the example he was supposed to be doing. Furthermore, he "learned" all too quickly, exceeding the ability of the most gifted human student. And finally, he gave the answer to very difficult problems as quickly as to simple ones.

In the case of Hans and Muhammed, as in the stories related by Mr. Russell, when observation and interpretation are separated, it becomes clear that the behavior in question can be explained without imputing to lower animals any high development of mental powers.

Law of parsimony

Some readers may ask, "Why choose the interpretation that denies great intelligence to animals?" The point is not to cheat animals of their just due but to arrive at the simplest explanation compatible with the facts. In all branches of science the same rule holds: the simplest interpretation that will account for all of the facts is the one to be preferred. Lloyd Morgan, an English student of animal psychology and a disciple of Darwin, once stated this "law of parsimony" as it applies to investigations of intelligence in the following manner: "In no case may we interpret an action as the outcome of the exercise of a higher mental faculty, if it can be interpreted as the outcome of the exercise of one which stands lower in the psychological scale." Only by adhering to this dictum can we hope to arrive eventually at a valid and accurate understanding of animal intelligence.

Do scientists, then, agree with that famous seventeenth-century philosopher and mathematician,

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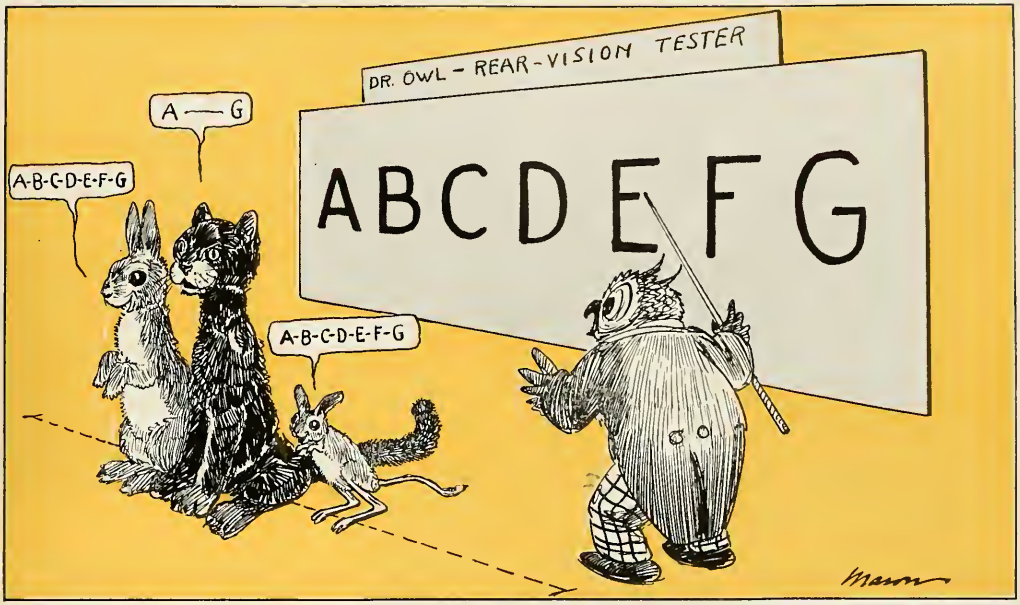
EYES IN THE BACK OF THE HEAD



By John Eric Hill

Drawing by
G. Frederick Mason

As children in school, many of us have had an experience with the teacher's "peripheral sight." When writing on the blackboard with her back partly to the class, she used to locate the passed note or the spitball with unexpected accuracy.

Actually man and the other primates have the eyes set directly forward and have a more restricted field of vision than most mammals. It covers almost half a circle from side to side, and more than 90° up and down. The outermost parts of this quarter sphere are vague in detail, although movements can be perceived clearly. The teacher, of course, could not see directly behind her, but by moving the head a little and looking out of the corner of her eye, she was able to catch most of the misbehavior that went on.

However, if she had been provided with the eyes of a jerboa, a small kangaroo-like rodent living in North Africa and parts of Asia, she could actually have seen what went on directly behind her head. Each of the laterally placed eyes of this little mammal sees more than a half circle, and together they see in every direction, encompassing most of the possible spherical field around the head. The fields actually overlap narrowly in front and behind, and also overhead.

It should not be hard for us to appreciate this overlapping field of vision, for we primates have the most highly developed binocular vision among mammals. Both our eyes see objects within an angle of as much as 140° in front of us. The difference between monocular vision and binocular can be readily experienced by closing one eye when looking through binoculars or a binocular microscope and noticing how flat the objects viewed then appear. Our ability to perceive, to fill in from experience, destroys some of this effect when we merely shut one eye and look at familiar, close-up objects. But if you will fix your gaze on an object only a foot or so away and rapidly open and shut one eye and then the other, you will see how different these images are. When both eyes are fixed on an object, these different images are somehow united in the mind, giving a perception of solidness, depth, and distance. Even up to a distance of about 100 feet our right and left eyes receive slightly different images.

Mammals with a small binocular field, like the large hoofed mammals with eyes directed sideways, try to make as much use of it as they can. You will see them face an object that has attracted their attention so that both eyes can be brought to bear on it. There is no question but that this binocular sight, limited as it is, gives more valuable impressions of the object than monocular sight. Probably the deer or horse perceives solidity and relief and is helped in estimating distance, much as we do. This perception, however, depends more upon the brain and the "mind" than it does on the sense organ.

Among North American mammals the rabbits come nearest to the jerboas in the position of their eyes. Both of these animals have this binocular field *in the rear* and *above* their heads, as well as over a smaller area in front. Thus they can "keep an eye" on an enemy in the air, such as a hawk, or one chasing them from behind, while at the same time they can look for a hole or bush into which they may plunge to escape.

▲ YUCCA-DESERT, showing the predominant plant of this area, ideal nesting site for desert birds and host for the pronuba moth. The tall stalks of the yucca are full of blossoms in June. The photograph was taken in July and shows the fat, green seed pods

Desert Dwellers

Three types of deserts with
Texas, display a wide variet
things we generally associate

By GEORGE M. BRADT

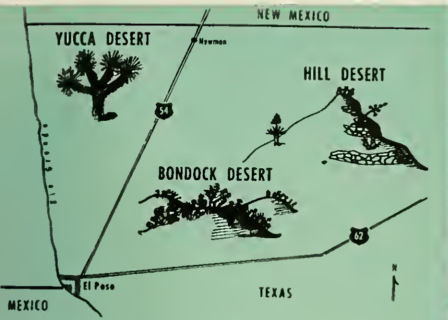
Photographs by the author

DESERTS, to most of us, are far, far away places—inaccessible, inhospitable regions called Gobi, Sahara, Kara-kum—places few of us will ever see. We think of them as illimitable stretches of sand dunes, devoid of all life save an occasional camel, palm tree, or wandering Bedouin, as the case may be. Actually, deserts can be veritable zoological and botanical gardens, and what is more, they can be found right in our own country. In our own great Southwest lie deserts virtually as hot, dry, and mysterious and containing as many interesting living things as any in the world.

Anyone wishing to explore one of these arid, lonely, sun-drenched regions has but to go to El Paso, Tucson, or Yuma. These three cities, as well as many others of the Southwest, are surrounded by true deserts. A trip into them will give insight into climatic conditions similar to those that exist in the extensive wastelands of Africa, Arabia, Asia, and Australia.

For several years my wife and I have tramped the sand flats and rocky hillsides north and east of El Paso, getting a photographic cross-section of the plant and animal life of this fascinating region. Our particular "province" marks the north-

◄ COLLARED LIZARD (*Crotaphytus collaris*): handsome, colorful, and swift inhabitant of the yucca-desert. The jet-black double collar serves to identify this foot-long reptile. It is abundant throughout the western states



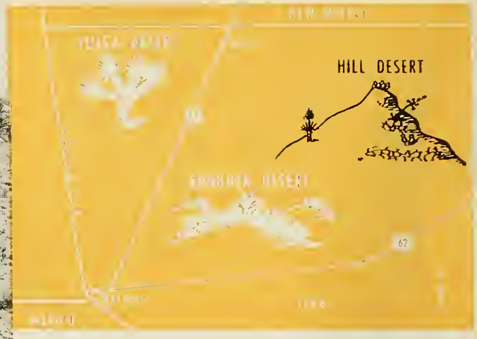
easy reach from El Paso,
of life and illustrate some
ıly with more distant lands

ernmost limit of what botanists call the Chihuahuan Desert, as distinct from floristic zones to the west. While this area has many plants and animals peculiar to it, most of them are similar, at least superficially, to near relatives in other regions.

In exploring our desert we found that it could conveniently and logically be divided into three local types. We refer to them as hill-, yucca-, and bondock-deserts. The yucca-desert comprises an extensive stand of yuccas along the Texas-New Mexico state line near the little town of Newman. The hill-desert is made up of the limestone foothills of the Hueco Mountains about 30 miles east of El Paso. And the bondock-desert is found between the other two. The term "bondock" seems to be a purely local one, used to describe the low mounds that are formed where clumps of mesquite catch and hold the drifting sand. As the imprisoning sand chokes the mesquite, the hardy plant grows higher and higher, until rounded

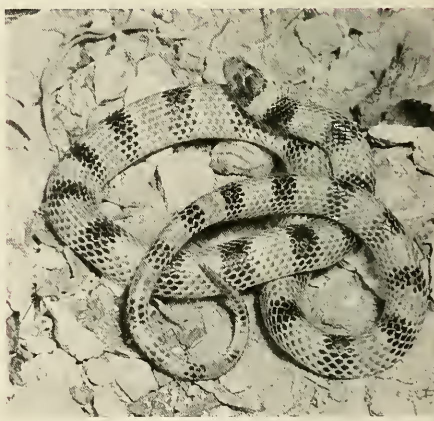
▲ Pronuba moth on yucca blossom. One of the desert's strangest partnerships is that of this white, ghostly moth and the creamy yucca blossom it helps to pollinate. Were it not for each, there would be neither moth nor yucca; for if the moth did not pollinate the yucca, there would be no yucca seed capsules in which she could lay her eggs

➤ Young ground squirrel (*Citellus spilosoma*): This is the common "gopher" of the sand and cactus, often seen sitting up with its tiny paws crossed on its stomach along desert roads and even on the outskirts of towns. It has a high, almost cricket-like whistle



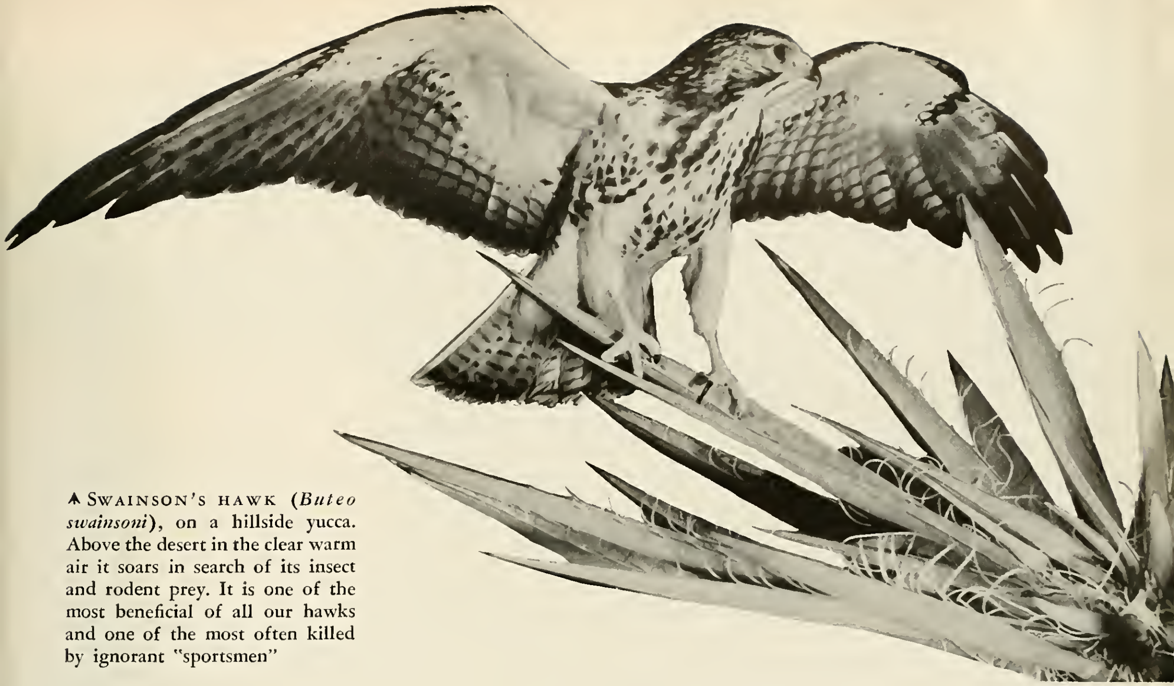
◄ HILL-DESERT: the east slope of our study-hill in July, showing its typical growth of sotol (*foreground*), yucca (*near figure*), low agave (*to right of yucca*), and ocotillo (*against sky*)

◄ POCKET MOUSE (*Perognathus penicillatus*). This dainty, clean, and gentle eater of dry seeds lives near the top of our hill and is a delicate morsel for snake or owl



▲ WESTERN GROUND SNAKE (*Sonora semiannulata*): a foot-long member of the reptile clan of the rocky sotol-agave-yucca hill-desert. It is an eater of insects and a burrower that lives a secretive life

◄ RED SCALY LIZARD (*Sceloporus poinsetti*): another lizard with a collar. This one is from the hill-desert and is a member of the genus of "rough-scaled lizards" abundant in Mexico and southern United States



▲ SWAINSON'S HAWK (*Buteo swainsoni*), on a hillside yucca. Above the desert in the clear warm air it soars in search of its insect and rodent prey. It is one of the most beneficial of all our hawks and one of the most often killed by ignorant "sportsmen"

hills rise fifteen feet or more above the desert floor.

To reach our yucca-desert we travel north from El Paso. The magnificent treelike yuccas, indescribably beautiful in June when tall stalks of glistening white blossoms appear, afford almost the only satisfactory nesting sites for many desert birds. Bird life, indeed, is the outstanding feature of this realm. Among the species using the yuccas for their nidal homes are the roadrunner, raven, cactus wren, white-rumped shrike, Scott's oriole, Arkansas kingbird, and Swainson's and red-tailed hawks. In the soft, sandy ground between the yuccas grow the creosote, ephedra, crucifixion thorn, and mesquite, furnishing cover for the insect, reptile, and mammal residents of the yucca-desert. Three of these creatures are depicted in the photographs: ground squirrel, collared lizard, and pronuba moth.

To study our hill-desert we chose a low foothill lying at the southern end of the Hueco Mountains. Above the near-level flats that stretch eastward from El Paso, our hill rises a steep five hundred feet. It is composed of massive gray limestone, a sedimentary product of the Carboniferous period, full of beautiful marine fossils. On its rocky slopes grow tall sotol, yucca, and ocotillo, low agaves, cactus and Mormon tea, and the ubiquitous creosote bush. During an entire year it receives less than a foot of rainfall. In winter it experiences freezing temperatures, whereas the mid-summer sun heats its surface above 130 degrees Fahrenheit. In its labyrinthine crevices and tiny caves, among its thorny plants, and even in the clear air above, live an amazing group of desert creatures. Our photographs show this hill and five of its principal inhabitants.

➤ PACK RAT (*Neotoma*). His proper name is wood rat, but "pack" or "trade rat" is more appropriate in the desert where there may be little wood but many other things around a cabin to trade or pack away. Bright objects have a way of disappearing where these common rodents abound, but usually, to even things up, a twig or stone is left in exchange

◄THE BONDOCK-DESERT in July. All the way to the mountains stretch the rounded bondocks, formed where the thorny mesquite holds the drifting sand in place. Occasional low yuccas dot the landscape. No shade, no water—just desert

Our bondock-desert, occupying the great plain between the Franklin and Hueco Mountains, more nearly approaches the popular conception of a desert than either of the other areas. The level sands, stretching "boundless and bare" are broken only by the domelike bondocks. Almost the only vegetation is the mesquite. Sandy mounds are honeycombed with intricate systems of tunnels which serve as homes for rats, gophers, snakes, lizards, beetles, badgers, and even owls. Four bondock-dwellers are the kangaroo rat, horned lizard, tarantula, and jack rabbit.

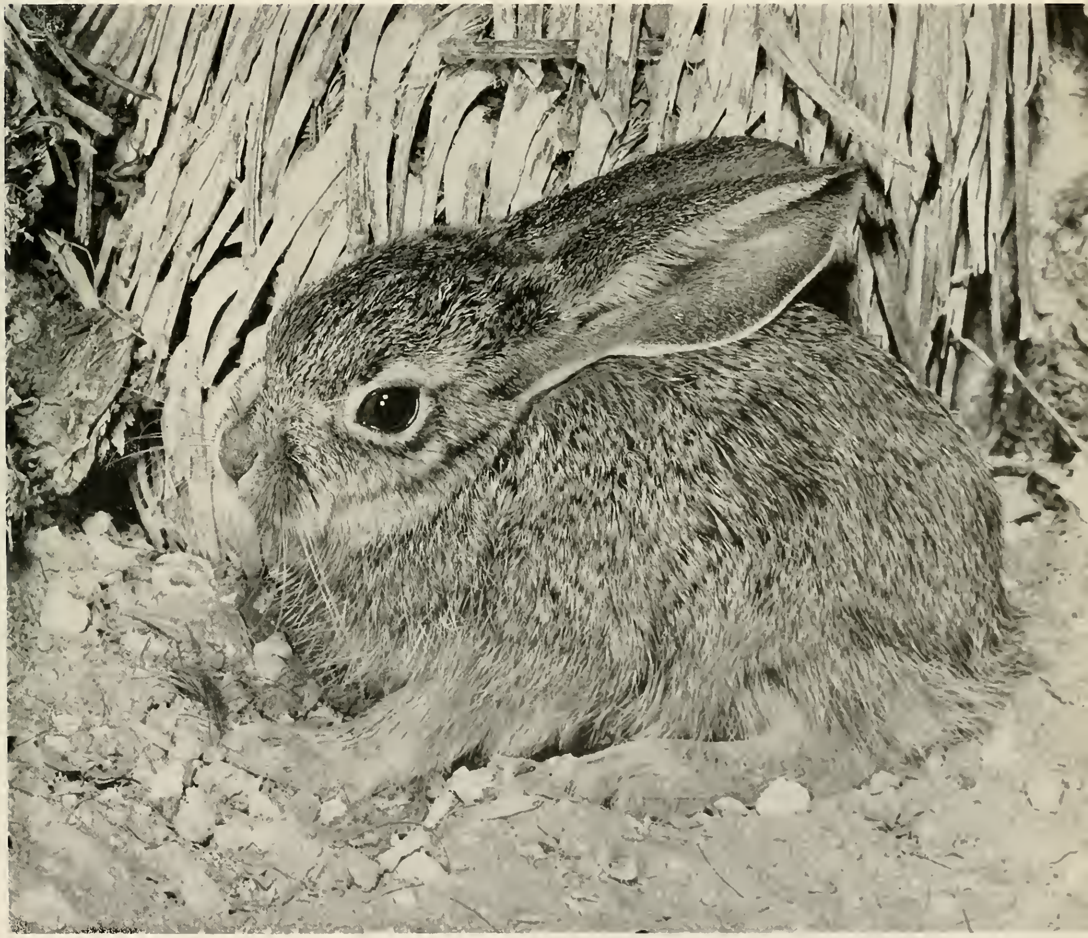
Here is the true desert, hot and dry but full of life and color and drama.

▲TARANTULA. A little water poured into one of the numerous web-covered holes found on the floor of the yucca-desert will usually bring out one of the desert's largest spiders. It is dark brown and covered with long hair, and its bite is reported to be quite painful, though not ordinarily fatal

◄THE KANGAROO RAT (*Dipodomys*) is often seen dashing across the desert roads, caught in the light of the car's headlights. It is one of the most handsome and gentle of the nocturnal rodents

➤ HORNED LIZARD (*Phrynosoma cornutum*). Although it is a colorful and striking creature, the horned lizard is difficult to see on pale sand. It is usually observed only when it makes a dash from one yucca to another

▼ THE JACK RABBIT (*Lepus texianus*) lives among the bondocks and is one of the desert's most conspicuous inhabitants. This one is a baby, but it has the long ears and big feet of the adult rabbit. The jack rabbit is abundant—too abundant—but it is kept in partial check by coyotes, eagles, and horned owls



The Saga of the "EARTH NUT"

The "Irish" potato had many adventures before it reached Ireland during the romantic era of exploration, and it had a profound effect on the economic and social life of the countries it reached in its circuit of the globe

By CLARK WISSLER

Curator Emeritus,
Department of Anthropology,
American Museum of Natural History

WHERE did the "Irish potato" originate? That many people are interested in this question is shown by the letters that come to the American Museum calling for the correct answer. Some people assume that, because it is called "Irish," the plant originated in Ireland. School history books, on the other hand, have stated for a century or more that Sir Walter Raleigh found the Indians of Virginia growing potatoes and carried some to England, whence they reached Ireland. Unfortunately, neither answer is correct.

The Irish potato originated in the Andean highlands of South America. No Indians in North America were growing potatoes when Sir Walter Raleigh arrived, and there is documentary evidence that the potato was first brought to the Virginia colonies from Bermuda in 1621. According to the late Dr. Laufer of the Field Museum of Natural History, an old English book, *The Historye of the Bermudaes,* states that:

"A small ship coming in December last [1621] from the Summer Islands [Bermuda] to Virginia, brought thither from thence these Plants, viz. Vines of all sorts, Orange and Leman trees, Sugar Canes, Cassado Roots (that make bread), Pines [pineapples], Plantans, Potatoes, and sundry other Indian fruits and Plants not formerly seene in Virginia, which began to prosper very well."

This statement is supported by other documentary evidence to indicate that the potato reached Bermuda from England and not from Spanish-American ports.

Historians have shown that the potato was known in England before 1586; that it had been introduced from Europe and thence soon found its way to Ireland. If Sir Walter brought the potato, he obtained it from sources outside of the United States. He may have had some part in taking the potato to Ireland, but the historical record gives no support to the belief that he was the first to bring the plant to England. The error in stating that the potato came from Virginia seems to have originated in a confusion of plants. A historian of the time wrote about a wild tuber eaten by the Indians of the Atlantic coast, vaguely described as resembling a potato but later identified as *Apios tuberosa.* This plant grew wild in central and southern Atlantic colonies where it was eaten by the Indians, though they did not try to cultivate it.

What we know as the common potato is derived from *Solanum tuberosum.* All the species of *Solanum* found in a wild state are peculiar to the New World, but the potato we know, *Solanum tuberosum* is no longer found growing wild. However, many wild species of *Solanum* have been found in South America, Central America, and Mexico; also at least one such species grows in New Mexico, not domesticated but gathered wild and eaten by Indians even in recent years.

When the Spanish explorers reached the western coast of South America, they found potatoes one of the important food crops in the Andean highlands, from Colombia to Chile. In many places where the Indians grew it, the potato seems to have been nearly as important as corn, or maize, and almost everywhere it was a second best. Potatoes could be grown at higher altitudes than maize and so constituted the most important food crop in the high Andes. There is no evidence that they were grown anywhere else, either in other parts of South America, the Antilles, Mexico, Central America, or in any part of the United States or Canada.

In 1538 Pedro Cieza de Leon observed the potato in Colombia and Ecuador, where the Indians called it *pappas.* He describes it as "a kind of earth-nut, which, after it has been boiled, is as tender as a cooked chestnut, but has no more skin than a truffle, and it grows under the earth in the same way."

Later, José de Acosta writes, "These *pappas* they collect and leave in the sun to dry well, and breaking them they make what they call *chunyo* which will keep in that form many days and serves them for bread; and of this *chunyo* there is great commerce in that kingdom with the mines of Potosí. *Pappas* are also eaten fresh, either boiled or roasted; from one of the mildest varieties which also grows in warm situations, they make a certain ragout or *cazuela* which they call *locro*. Indeed, these roots are the only wealth of that land, and when the season is favorable for the crop they [the Indians] are glad; for many years the roots are spoiled and frozen in the ground, so great is the cold and bad climate of that region."

In preparing *chunyo,* potatoes were subjected to freezing as well as drying. The process is described in detail by Padre Bernabé Cobo, who writes as follows: "The tubers are gathered at the beginning of the cold season, in May or June, spread on the ground and exposed for a period of twelve to fifteen days, to the sun during the day and the frost at night. At the end of this time they are somewhat shriveled, but still watery. In order to get rid of the water they are then trampled upon and then left for fifteen or twenty days longer to the action of the sun and frost, at length becoming as light and dry as cork, very dense and hard, and so reduced in bulk that from four or five fanegas of fresh tubers there results only one fanega of *chunyo*."* Cobo adds that *chunyo,* thus prepared, will remain unspoiled for many years and that the Indians of the Collao provinces eat no other kind of bread. A choicer and more highly prized quality was prepared by soaking the tubers in water for about two months, after their preliminary drying. They were then taken out and dried in the sun once more. This quality of *chunyo* which was chalky white within, was called *moray*. From it a kind of flour, finer than wheat flour, was prepared by the Spanish women who used it for starch, biscuit, and sweetmeats of all kinds, like those confections usually made with sugar and almonds.

The high regard in which the potato was held in Inca times is suggested by a prayer addressed to the Creator:

"Thou who givest life to all things, and hast made men that they may live, and eat, and multiply, multiply also the fruits of the earth, the *pappas*, and maize that thou hast made, that men may not suffer from hunger and misery. Preserve the fruits of the earth from frost, and keep us in peace and safety." (Markham)

Many early Spanish writers praised the potato as a food worthy of cultivation in Spain, which attracted the attention of scholars and statesmen in all parts of Europe. John Gerard, the English botanist who published the first scientific description of the plant, seems to have experimented with growing the potato in 1588. The name the botanists of the time favored was *Papas Peruanorum*. The people of Europe, like those of

*Cobo Bernabo, Historia del Nuevo Mundo (1653), 1:361. 1890.

From John Gerard's Herbal

➤ THE CELEBRATED sixteenth-century botanist, John Gerard, chose to be portrayed holding a sprig of the newly discovered potato plant. He published the first scientific description of it, but the Indians of South America had long been acquainted with the potato as a staple crop

China, were still plagued by famine, so educated men gave ear to the new foods cultivated by the Indians of America. Population was tending to increase in spite of wars, so the food margin was narrow. which, with the crudeness of transportation, rendered any local crop-failure a tragedy. Ireland, being relatively overpopulated, was always in danger. The traditional cereals—wheat, rye, etc.—often failed them, but the quick-growing potato proved their salvation. It soon became popular in Scotland also. England, on the other hand, seemed more conservative in adopting the potato than Ireland and Scotland, the tendency being to regard it as a poor man's diet.

As a rule, all people are slow to change their food habits, conjuring up many absurd objections. Thus in England, rumors were circulated that potatoes were dangerous. For one thing, the Bible did not mention them, so the preachers inveighed against their use. Again. it was said that a diet of potatoes induced leprosy. Some looked upon potatoes as dangerous because botanists classed them as relatives of the poisonous nightshades. Herbivorous animals usually refused to eat the growing plant, but hogs would eat the tubers.

In Europe, Italy seems to have led in the use of the potato, but in 1822 one writer declared Ireland and England to be the chief producers. France lagged. In some parts of Germany potatoes became popular about 1700, and later Frederick the Great found it necessary to force his subjects to plant large fields of potatoes as a protection against famine and to guarantee sufficient war supplies.

China was conservative in adopting this new food, but knowledge of potatoes reached Formosa from the Philippines before 1657, and they became known in China about the same time. However, the Chinese and the Japanese were never enthusiastic over them.

It is curious that in Europe, Spain was about the last country to recognize the importance of the potato; yet her own sailors and those of Portugal spread it around the world. Some of the first ships to reach the west coast of South America found potatoes not only a cure for, but a preventive against, the much dreaded scurvy. So it became customary for ships to carry potatoes and to encourage the planting of them at foreign ports where ships were revictualed. Thus, much later, we find Captain Cook trying to teach the New Zealand Maori to grow potatoes in 1773. No doubt other ships' crews tried the same experiment. Thirty-two years later an observer found the Maori so well supplied with potatoes that they were anxious to provide arriving ships with them in exchange for iron. That the Maori have grown them for a long time is also attested by their folk traditions, which state that they always had them. Such errors are not exceptional in folklore. For example, not so long ago a visitor at Zuñi Pueblo, New Mexico, observed some young Indians playing baseball and was told by some old men that the game had been handed down to them from their gods.

TIME-TABLE OF MIGRATION OF POTATO

Home of Potato

1492 Cultivation of the potato widely distributed throughout the mountains and high plateaus of western South America

From Peru to Europe

1560 Potatoes already known in Spain

1586 Potatoes grown experimentally in England before this date; probably introduced from Spain

1590 Probable date of introduction into Ireland. Information fragmentary

1600 Apparently brought into Italy by barefoot Spanish Carmelite monks. Northern Italy probably first European country to promote growth and use of potato

1619 Potatoes were served at the King's table in England

1664 First surviving pamphlet advocating planting of potatoes in England, called "Irish potatoes"

1683 Known to be cultivated regularly in Scotland

From Europe to North America

1613 English introduced potato into Bermuda

1621 Potatoes taken to Virginia from Bermuda

1719 Irish immigrants brought potatoes to New Hampshire

stating that if the white people played baseball, they must have learned it from the Zuñi.

In an earlier article in NATURAL HISTORY we traced the history of corn, or maize, which seems also to have originated in South America. But unlike the potato, the cultivation of maize spread over Middle America, the West Indies, Mexico, and a large part of the United States before 1492. It was quickly adopted in all the colonies and was carried to Europe, ultimately to become one of the world's great cereals.

The potato was cultivated in the Andean highlands for many years before 1492. But its use did not spread outward from the Andean highlands even in South America, and it remained for the Spanish to carry the plant to Europe. From there the English introduced it into North America and the Dutch into northern South America. This roundabout trip to northern South America does not sound so surprising when we recall that all the lowlands of South America and the West Indies possessed a remarkably productive tuber, *manioc,* which required a tropical climate. The fact remains, however, that neither Middle America nor Mexico took to either *manioc* or potatoes, preferring maize instead.

As a modern world food, the potato need make no apologies, especially in Europe and Asia. Russia is by far the greatest producer of potatoes. According to the latest reports, including 23 nations, Russia leads with an annual production of over 2 billion bushels, Germany comes next with 1¾ billion bushels, then Poland with about 1¼ billion. In the United States we consider potatoes a leading food, but our production was less than 400,000,000 bushels, barely one-fifth of the Russian quota. The potato is not a tropical plant, though it is grown in the high altitudes of tropical South America. Modern world production is chiefly in the North Temperate Zone and totals an estimated annual crop of about 8 billion bushels. The highlands of South America now produce only about one-half of one per cent of this. Australia, South Africa, and New Zealand account for about the same amount.

THE INTERNATIONAL MENU

Various words for "potato"

Linnaeus' taxonomic name	*Solanum tuberosum*
Peruvian	*papa*
Chile	*poñi*
Spanish	*turma de tierra*
Italian	*patata,* also *tartuffo*
French	*cartoufle* (1600), later. *pomme de terre*
German	*Kartoffel*
Dutch	*aardappel*
English	*potato, potatoe*
United States	*white potato, Irish potato, murphy*
China	*yang yü* ("foreign taro")
Maori	*taiawa* ("foreigner")

The potato is of such economic importance in the Soviet Union that it has become the country's chief botanical concern, and we need not be surprised to learn that the Soviet Union leads in potato research. Their specialists have exhaustively surveyed the cultivated and wild species in South and North America, listing about 100 species and subspecies. The intensity of their research and experimentation almost equals the study of maize in our own country. They claim

Via Italy to Eastern Europe

1651 King of Prussia ordered planting of potatoes as national duty

1725 Regularly cultivated in Sweden

1744 Frederick the Great enforced planting of potatoes on large scale. Shortly thereafter, Russia began to cultivate them

To the Orient

1650 Philippine Islands, Formosa, and China had potatoes before this date

1690 Introduced into Indio by English

1773 Captain Cook introduced potatoes into New Zealand

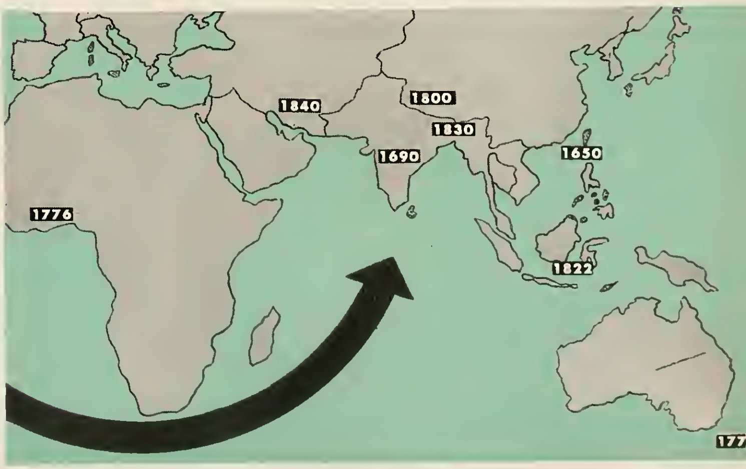
1776 Potato growing begun in Lower Guinea, Africa

1800 Potatoes appeared in Tibet. But Chinese and rice-eating peoples in general never showed much enthusiasm for potatoes

1822 Potatoes were generally known in the East Indies, but have never been a popular food

1830 Potatoes were introduced into Assam

1840 They appeared in Persia



From Frederic Lewis

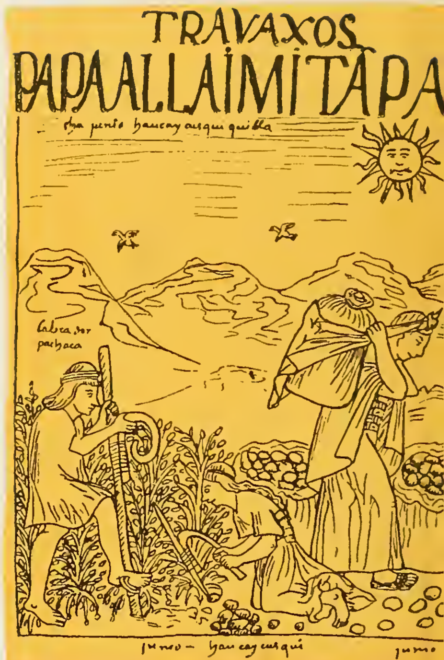
▲ THE POTATO in the machine age: a two-row potato digger in operation near Porterville, California

➤ Yearly Potato Production

Clusius 1601, Rariorum plantarum historia

▲ A WOOD-CUT of the potato plant and tubers dating from 1601, when Europe was beginning to awaken to the vast potentialities of the plant

▼ EARLY INDIANS of the Andean highlands harvesting potatoes, as depicted in an old Peruvian document from the time of the Spanish conquest



From Poma and Guaman

▼ POTTERY VESSELS made in the form of potatoes by South American Indians of the Andes, among whom the potato was often more important than grain

Courtesy of Chicago Natural History Museum

▲ POTATO PLANT showing branch and blossoms, 1588

that the domestic potato came from the Chilocean Indians of Chile, and that the Chilocean variety was introduced into Europe. They conclude that most of the varieties grown in Peru, Bolivia, and Ecuador are not well adapted to European conditions. On this basis, it would seem that the Spanish explorers made a careful choice when they carried the potato to Europe.

But in some recent publications, South African botanists question this interpretation. They call attention to the fact that the earliest descriptions of the potato came from Ecuador and Peru at a time when most of the Spanish shipping was from that part of the South American coast, thence to Panama and, after portage across the isthmus, to Spain. It was almost a century later that ships began to visit Chilean ports on trans-Pacific voyages and to make trips to Spain via Cape Horn. These ships had learned the value of potatoes as ships' stores and hence stimulated the production of potatoes in and about these ports. They state also that the early potatoes in Europe were obviously fitted by nature to seasons of short days such as are relatively constant throughout the year in tropical latitudes. The early recommendations for the growing of potatoes in Europe were that they be planted in August and harvested in November, the time when the days and nights are nearly equal. The other alternative was to plant in the spring, but that was not especially recommended. We have noted that the early center of potato cultivation was the high altitudes of the tropical Andes. For reasons of this sort, these critics are disposed to differ with the Soviet conclusions and to choose Ecuador and Peru as the most likely area where the aboriginal potato was first domesticated and the region from which it was

▼ MODERN WORKERS in a potato field harvesting certified seed potatoes, which will later be transported to the grading shed

Three Lions photo

diffused and taken to Europe. At present we lack good archaeological data as to when the potato first appeared in the pre-Spanish Andes.

The Russian botanists are inclined to believe that a long interval was necessary for the domestication of the potato, greater than most American archaeologists are willing to grant. They regard the pre-Inca people as the great distributors of agriculture in the Andes. Good representations of the potato have been noted on pre-Spanish Peruvian pottery, but none of these are necessarily of great antiquity. However, recent studies of maize also suggest a long pre-Inca period of development.

For some time after 1580 in Europe and America the words "*patata*" and "*patatus*" referred only to the sweet potato; hence in interpreting early European literature care must be exercised to be sure which is designated. In 1782, however, when Thomas Jefferson, writing about Virginia, stated that "We cultivate also potatoes, both long and the round," we take it to mean both sweet potatoes and Irish potatoes.

The sweet potato (*Ipomoea batatas*) is a different kind of plant, whose origin is still uncertain and controversial. A less satisfactory story of its migrations could be written but perhaps a more intriguing one because of the gaps that remain for scientists to fill in. The claim is often made that the sweet potato was known in the East Indies, the Pacific islands, and South America before Europeans discovered any of these lands. But many botanists regard the sweet potato as native to the Americas. Many writers who believe that this plant was widely distributed in early times assume that it was carried across the Pacific to America before Columbus arrived. Even many who accept America as its ancestral home believe that it probably migrated to the Pacific islands before white man reached America, yet in general we have no satisfactory evidence of contact between America and these Pacific islands before the time of Columbus.

By Ebner, from Safford in J. of Heredity, 1925

▲ FREDERICK WILLIAM, The Great Elector (1620-1688), with his consort, inspecting potatoes planted by his order in the Berlin Lustgarten. His grandson, Frederick the Great, forced his subjects to grow potatoes to guarantee sufficient war supplies

The Story of FORMICA

Formica was an ant by birth, a female by sex, and a forager by occupation. A victim of determinism, she lived a binding life in a stratified society, and when she died, she would go the way of all slaves

By Roy L. Abbott
Iowa State Teachers College

THE blazing August sun beat hard on the dry grass and weeds of the fence row, but Formica, the big black and red ant whom men called "rubicunda" because of her color, gave it no heed. She was out on a foraging trip, and at the moment, along with a dozen or so eager honeybees and testy looking bald-faced hornets, she was greedily filling her crop with watermelon juice from a long, red rind tossed there an hour before by a passing boy. Bonanzas like that weren't met with every day.

Finally, sated with juice and with her rounded abdomen so distended by the thin liquid as to show light colored rings marking its stretched intersegmental membranes, she started homeward, wobbling with unaccustomed awkwardness on her six slim legs.

Home, to Formica, was a huge, underground nest or formicary some 30 yards down the fence row—a place of many interconnecting chambers and galleries, all excavated by the patient labor of a busy horde of workers and slaves, members of the same commune, a citadel covered and concealed by a great pile of twigs and dead leaves.

During her first year, Formica would never have ventured to hunt so far afield as she was today. Indeed, on her first hunts, she had on several occasions become hopelessly lost only a few yards from the nest, only to be hunted out and carried home at evening by some more experienced sister. Even old, much traveled ants sometimes lost their way when ranging far, and so never returned. But in spite of the trackless jungle through which she was moving, the big ant appeared to know just where she was going; her detours were seemingly endless, but she kept moving in the general direction of home and presently hit upon one of the many twisted trails that radiated from the great citadel under the wild grapevine.

Along the faint path on which Formica now found herself, many of her kind were moving to and fro. From time to time, one of the outgoing ants would approach her eagerly, tapping her lightly or caressing her with its antennae, imploring her by this action (if men rightly understand the language of ants) to share with it some of her provender. She never failed to comply with these requests, for an ant appears to have almost no sense of personal property and is ever ready to share the contents of her "social stomach," as it may be called. Thus, in one sense, a whole ant colony may be said to have but a single stomach. So many supplicants approached her that by the time she reached the nest her stomach was almost empty, and she could walk normally again.

Tired and dirty from her long journey, Formica stopped inside one of the main galleries of the nest and began what to an ant is one of the most important tasks of its life—that of making its toilet. For, although it spends most of its life close to the soil, it abhors dirt and is one of the cleanest creatures in the world. Dirt and molds and bacteria must be kept off at all costs.

But Formica had barely begun her toilet before one of her sisters rushed up to help her. This self-appointed nursemaid, in fact, practically took over the entire performance, beginning at Formica's face, passing from there to her thorax, next to her abdomen, and then to each leg in turn, thus all along one side, after which she began on the other side, starting at the rear and ending at the head. During this shampooing act, largely performed by the nurse ant's tongue, Formica showed by her complete muscular relaxation her intense enjoyment of the process, behaving much after the manner of a house dog that is having its neck scratched.

Refreshed by her bath, she slept soundly for two or three hours, seemingly oblivious, save for the slight jerking of her antennae, to all the hurly-burly around her. On awaking, she spread her jaws in a remarkable simulation of a yawn, stretched her legs, and set off on a slow prowl through the formicary, stopping every now and then to cross her antennae in friendly fashion with those of one of her numerous sisters, who were hurrying through the galleries and chambers as if in hopeless confusion. They knew well what they were doing, however. Some were carrying eggs, some larvae, some pupae. It was their task to sort and pile these various stages into separate heaps according to age and condition, something after the manner in which a school of human youngsters is divided into classes.

But Formica gave scant attention to these heaps or "classes" of embryonic young and their attendants. Snobbery, as such, probably does not exist among ants, but she had long since served her turn at these

Drawing by Shirley Lapp

menial tasks. Now she was a mature, experienced worker, a forager tried and true. Nursing and housework were jobs for young ants!

Anyone seeing Formica racing along madly with seemingly inexhaustible energy on one of her foraging trips, particularly one unfamiliar with the ways of ants, would have found it difficult to believe that this shiny, pulsing, armored being had once been a creature identical with these hairy, soft-bodied, legless, and crooked-necked larvae now heaped at her feet. Yet, only two years before, and in one of the chambers of this very nest, the germ of her had been pushed forth from her queen mother's body as the merest speck of thin yolk covered by a delicate, transparent shell. At its appearance this egg had been grabbed by an eager nursemaid, to be tended and licked and cared for through all the stages it would show before becoming an ant. Indeed, that egg which was to transform eventually into Formica required some twenty days to hatch. Twenty-four more were needed to pass that hungry, heavy feeding grub or larval stage, and yet seventeen more before she was to issue from her silken case as a so-called callow or new-born ant. As a matter of fact, she was actually assisted into the world by a delicate bit of mid-wifery on the part of her older sisters, for they had used their jaws to slit the cocoon—that external womb of silk in which she had swathed herself at pupation. After that they had not only carefully pulled off a sort of shirt that still enveloped her, but had cleaned and washed and tended her, amazingly after the manner in which human beings care for their new-born.

Why had the egg that had produced Formica made her a worker instead of a queen? And why had she no wings such as her mother had possessed at first? She had developed from a fertilized egg just as her mother had. Men do not know the answer to these questions, although they suspect that it may be partly a matter of nutrition. Certainly Formica didn't know the answers, even though she possessed a brain larger in proportion to her bulk than any other insect and stood at the very summit among all invertebrates in her ability to mold her behavior to the effects of outside stimuli. She had the faculty of memory, too—yes, even a strong associative memory, as was well proved by the large number of alien friendships she had made as a young ant with the host of slaves and hangers-on about the nest and by the many complicated physical behavior patterns she had learned. All of which, however, is not to say that she could call up memories or images when she wished. Perhaps she never voluntarily recalled what had gone before or speculated on what was to come; memory or recall, for her, was probably always the result of direct sensory stimulation.

But Formica's brain, like that of a man, had seemingly developed in its power to put two and two together, so to speak, at the expense of her sense organs. She could hear only badly or not at all (although she could feel vibrations in the soil), and her eyes were feeble things as compared to those of, say, a dragonfly or a wasp. Two senses, however, she did possess, and those in full measure: the senses of smell and touch. These were strangely combined in one set of organs, her antennae, organs that might be thought of as everted noses or, more accurately perhaps, as amazingly delicate fingers or touch perceiving machines, intimately interbuilt with those for the perception of odors. For her antennae enabled her not only to perceive odors at a distance as men do, but, unbelievably, to feel them directly, which men cannot do. Thus, she had both perception and memory of what might be called odor-form; she could know and recall smells as being long or short, round or square, hard or soft, as well as knowing them to be pleasant or unpleasant. She didn't need to see the size or shape of an object or an acquaintance; she smelled and felt these qualities as concrete things.

But amazingly endowed and capable as she was, Formica had had no part in the founding of the great colony of which she was a unit. No worker ant ever founds a colony. That, in its first phase at least, is the sole task of a queen.

Strangely enough, however, Formica's mother, although beautiful and impressive in her brilliant livery of red and black, had seemingly been unable to found a colony in what we would call a conventional manner—that is, by digging her own nest, laying eggs, and hatching a brood of workers. Instead, she had first sought adoption in the colony from which she had just been reared. Rebuffed in this attempt, she resorted to violence. Seeking out a young colony of closely related ants (a form which she and her kind usually kept as slaves), she promptly murdered both its queen and workers and then took the undeveloped young as booty. It was too much trouble to feed the larvae, so she ate them. The pupae she tended to maturity. On hatching, these foolish slaves never recognized their foster mother as an imposter, but treated her as they would have treated their own brood queen. Her eggs, of course, tended by these alien slaves, developed into workers of her own breed. Thus was the rubicunda colony born.

Formica, of course, knew nothing of all this; she was only a worker, a child of fate. Indeed, had she chanced to have been a

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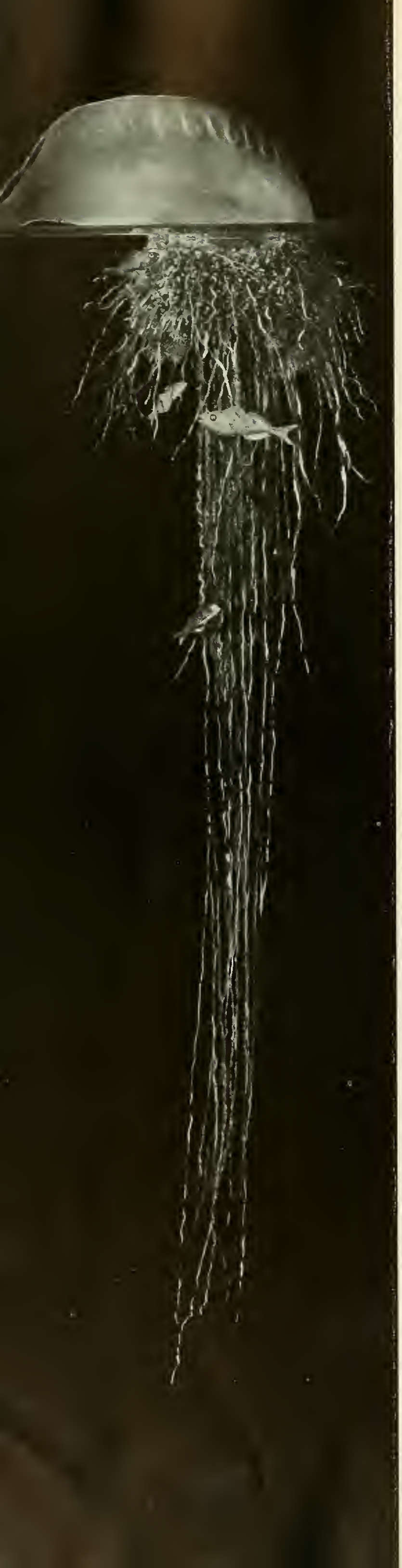

BEWARE The Portuguese Man-of-War

Though beautiful in color and form, this curious colonial jellyfish will inflict critical injury if you encounter it while swimming

By JOSEPH BERNSTEIN

ONE July day a few years ago, two American servicemen stationed in Puerto Rico—a 20-year-old soldier and 27-year-old ensign—went swimming in the ocean. Shortly afterward both of them were carried into the dispensary of the U. S. Naval Hospital.

The appearance of the soldier, according to the attending physicians, "was as though he were recovering from an epileptic convulsion." With eyes staring wildly, and unable to give a coherent account of what had happened, he was propped up on his elbows on the examining table, breathing with such difficulty that each outgoing breath came as a cough. Across his back and left shoulder was an angry, red rash, and the skin of the rest of his body was flushed.

The ensign had a rash on his wrist and abdomen which, he complained, burned severely, and he was perspiring profusely. "There's a load on my chest," he mumbled. "I have to lift my shoulders to breathe." His muscles had contracted to such rock-like rigidity that he could not button his shoes or raise his arms at the shoulder.

◂ THE PORTUGUESE MAN-OF-WAR is buoyed on the surface of the sea by a translucent blue float and sometimes sinks and rises again. Great numbers are sometimes seen together, traveling with the wind and current. A certain little fish can swim safely among the tentacles, but a bather is instantly stung by thousands of poisonous nettle cells
A.M.N.H. photo

Both men had been stung by the jellyfish called the Portuguese man-of-war.

Those who have made voyages far out at sea have often seen numbers of the beautiful blue floats of these jellyfish buoyantly bobbing on top of the roughest waves. At a distance from the shores of Devon and Cornwall, in England, enormous throngs of them have occasionally been seen, forming tremendously long lines and schools. Glowing a brilliant azure blue in bright sunlight, and with crests of a delicate pink hue, they make a strikingly pretty and deceptively innocent sight.

But if you ever come near a Portuguese man-of-war, you had better give it a wide berth and admire it from a generously safe distance. For contrary to persistent popular belief, it is one of the most dangerous organisms known. Its sting is not only excruciatingly painful but has often been fatal, and native pearl and sponge divers in tropical waters dread it more than the man-eating shark. Only a thick-skinned whale or shark can tangle with the largest of these jellyfish and escape without severe injury.

To the superficial observer the Portuguese man-of-war looks like a single animal, but in reality it is an amazingly complex colony of great numbers of individuals highly specialized for different functions such as flotation, reproduction, feeding, feeling, and fighting. Colonial jellyfishes of this sort are known as Siphonophores. For all practical purposes the individual members of this organization are so essential for the preservation of the entire colony that they may be considered as organs of a single body.

The float-organism is a bag often a foot long filled with gas that serves to keep the colony at the surface of the water. By contraction it can expell the gas through a pore and submerge. Later the bag will fill up again through the secretion of gas, thus buoying the colony to the surface. Stretching down from the float, and spreading out in all directions in the water in search of prey, is a mass of threads or tentacles that sometimes reach a length of 50 feet.

Woe betide the hapless creature that gets too near one of these harmless-looking tentacles.

The slightest contact with the batteries of sensitive, triggerlike hairs on these deadly streamers releases thousands of small barbs which sting the animal to death. Slowly the long, snaky tentacles cling tightly around the victim and draw it into contact with the sticky mouths of an array of squirming siphons. As soon as the fish touches these mouths, which are gluey and equipped with nettle cells, it sticks fast. The lips of the mouths are spread out around the fish, so that by the time the victim is dead, it is inclosed in a tight bag. Here it is digested and taken into the stomachs of the attached siphons. Nowhere in the animal kingdom except among the jellyfishes and their allies is there anything like this amazing trigger-mechanism for capturing prey.

The barb is really an inverted tube coiled up like a spring in a box that is covered by a lid. When the trigger-hair on the box is stimulated by contact and chemical effect, the lid springs open and the tube shoots out with lightning rapidity, inverting itself like the finger of a glove. As this happens, viciously-sharp spines on the tube's inner surface unfold to the outside. These barbs can be used only once. After the threads are discharged, the jellyfish discards them and grows new ones.

One of the strangest things of all is that a small species of fish lives in association with the Portuguese man-of-war and is actually protected by it. These fish swim freely in large numbers among the murderous tentacles, brushing safely against them without being stung. They amply repay such generous protection, for their role in this bizarre partnership seems to be to lure unsuspecting, larger fish within the range of the tentacles.

The Portuguese man-of-war, although widely distributed, is most frequently found in the open sea in the warmer regions of the world. It apparently has little control of its own movements and generally drifts about helplessly at the whim of winds and currents, with the float acting as a sail. It is rather common from Florida northward, where it is carried by the Gulf Stream and southerly winds and storms. Frequently it drifts as far north as the Middle Atlantic and New England states, where it may be cast up and stranded on the beach.

A warning to bathers who may see these gorgeously-hued jellyfish on the beach: Even after the Portuguese man-of-war has been dead for several days, the tentacles are still capable of inflicting severe stings.

When they are out of their tropical environment, their sting seems to be not quite so deadly, though still extremely painful and capable of causing severe illness. Thus Commander A. H. Allen, of the U. S. Naval Medical Corps, reported a case of a woman attacked by three jellyfish which may have been of this kind while swimming in York River, Virginia. She survived but suffered from the effects for several weeks.

Other persons who have been attacked in tropical waters have not been quite so fortunate. A strong, healthy, nineteen-year-old Filipino was working waist-deep in water in a Philippine Island mangrove swamp, gathering firewood. He was clad only in short, cotton drawers. Suddenly he screamed out that something had bitten his leg. One of his fellow workers rushed to him through the 60 yards of water separating them and reached him just as he was about to collapse and in time to prevent his submersion. Gasping and livid, and unable to speak, he was dead by the time he was placed on a raft. Solemnly they brought the dead youth to Dr. H. W. Wade, Chief Pathologist of the near-by Culion Leper Colony of the Philippine Health Service.

"No wound was found," reported Dr. Wade, "except a purplish livid discoloration practically encircling the right leg at the knee." Likewise there was no mark suggestive of snake bite or any other abnormality. None of the boy's companions had seen what had bitten him. Dr. Wade therefore reached the diagnosis that a fairly large, long-tentacled jellyfish had stung him. In all probability the creature was a Portuguese man-of-war. The chief danger to life is not in being stung to death by a jellyfish, according to Dr. Wade, "but the possibility of being overcome before reaching shore and so drowning."

Still another case of fatal jellyfish stinging was reported many years ago by Dr. E. H. H. Old in the *Philippine Journal of Science*. Here the victim was a 14-year-old boy who died "in hysteria" several hours after the sting.

What is the nature of the venomous substance in the stinging cells? Experiments have shown that small animals are promptly killed by eating dried Portuguese man-of-war tentacles. It has been suggested that the poisonous substance is a protein or a mixture of proteins, producing the toxic symptoms through a sharply aggravated allergic reaction. But this theory has been disputed because it would require that the person showing the severe symptoms of an attack be previously sensitized to this type of jellyfish poison. Experience has shown that people who have never

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Gull Antics

By Hugo H. Schroder

Photographs by the author

GOOD news travels fast—even in the bird world, it seems. Years ago, when I came to Orlando, Florida, only small numbers of ring-billed gulls could be seen on lakes in the city during winter months—straggling birds rather than regular visitors. But when these stragglers discovered that people were handing out food to their liking—bread, crackers, and other things—, there was a noticeable increase in the daily gull population.

Prior to this, hundreds of wild ducks (mainly scaups and ring-necked ducks) had been coming regularly to Lake Eola, in Orlando. Daily rations of shelled corn, plus complete protection from the guns of the hunters, had made this like a paradise for wintering ducks. Large numbers of coots had also come to share the lake with the ducks.

So long as only grain was being fed to these waterfowl, the gulls were not tempted. But when people began to find pleasure in feeding bread and other things to the feathered visitors, the gulls promptly put Orlando's lakes on their daily schedule. The ducks and coots made these lakes their headquarters continuously during their stay, but the gulls departed every evening for a larger lake and returned early each morning to take advantage of the handouts.

Each autumn saw a larger gull population, and now there are hundreds of gulls on Lake Eola every day from November until they travel northward to their nesting grounds. The gulls congregate on all the other city lakes wherever they learn that food is available, and they visit the school grounds at lunch time to pick up offerings from the school children. Gulls may be seen on the wing during the day in all sections of the city.

The gulls quickly learned to catch bread thrown into the air and became so adept that they seldom missed if the food was within their diving range. Their aerial acrobatics were wonderful to watch. Sometimes if the bird missed on the first try, it would make a rapid dive to pick up the food before it hit the water.

These remarkable maneuvers intrigued me, so I secured the co-

◄RING-BILLED GULL with wings elevated on the forward stroke as it tries to get into position for catching food thrown into the air. Note the spread of the tail as the bird is in an almost vertical position

▲THIS RING-BILLED GULL is determined to catch the bit of bread; the bill is ready to clamp over the food

➤THE BIRD HAS JUST CAUGHT the morsel of food. Note position of wings, tail, and feet

operation of some folks in feeding the birds while I trained my camera on the rapidly moving gulls as they raced after food in the air. Numerous films were exposed, and almost every exposure captured a different flight position. The movement was rapid, because even when the exposures were made with the highest speeds of the Graflex and Speed Graphic cameras, one or both wings were badly blurred on many of the pictures.

Examining the resulting photographs was most interesting, for they presented a great variety of flight positions, which the human eye could not discern because of the rapidity with which the gulls moved their wings.

MR. CATHERWOOD ALSO IS MISSING *Continued from page 111*

Central America. . . . He lectured briefly on his travels to help fill his pockets for his return trip to California. One of the young men in his audiences never forgot that tropic-scarred face, for when this young man, Wilkie Collins (author of *The Moonstone*), wrote *The Woman in White*, Catherwood became the model for Walter Hartwright, the drawing master of that lurid Victorian drama, who left for "Central America in the 1840's to make pictures for an archaeological expedition."

Henceforth the picture of Frederick Catherwood grows dim. In September, 1854, he boarded the S. S. *Arctic* bound for America. It was his last odyssey. After an eventless voyage across the Atlantic the *Arctic* was engulfed in an opaque fog off Cape Race, Newfoundland. A vessel appeared out of the fog and plowed full-speed into the hull of the *Arctic*. It was the first mid-ocean collision of steam-driven vessels. The crew escaped in the first life boats; the other boats were capsized in launching. There was nothing left for the passengers to do except die heroically.

Some survivors remembered seeing Frederick Catherwood beside the gun on the bow of the boat. In the famous Currier and Ives print, "The Last Gun," reproduced in this article, we see him on the listing ship pulling the layard on the deck cannon. This amazing archaeologist-adventurer who had been the intimate of the great men of his epoch, who had advanced archaeological history on two continents, and whose name had been linked for 20 years with the growing-up period of America, then disappeared in the "froth and foam" of history. So completely had he vanished from New Yorkers' memories that the re-write man on the *Herald* could think of nothing more to write than:

"Mr. Catherwood also is missing."

From the book *Frederick Catherwood, Arch't*, by Victor Wolfgang von Hagen, to be published in the fall by the Oxford University Press.

LETTERS *Continued from page 97*

placed it in the basement bathroom, which can be kept cold but not freezing.

After several days, he now remains in the same position, can open his eyes and turn his head slightly, but otherwise he remains motionless. . . . Our encyclopedia says woodchucks can be easily tamed and generally wake in March. . . . I do not like animals in cages and would like to release him at the proper time, but I do not know at what temperatures a sleeping chuck would freeze.

Therefore, any information or suggestions you can give me will be greatly appreciated. Incidentally, if it should be a female, do woodchucks give birth to their young during hibernation?

Before closing, I should like to tell you that three generations of my family are ardently devoted to your magazine, and each issue goes the rounds of a number of other families.

Barbara Graham Green.
Dayton, Ohio

The following information was sent to Mrs. Green by Dr. John Eric Hill of the American Museum's Department of Mammals:

"The woodchuck you found is very interesting. Hibernation is not absolute, there being several intermediate stages, and I would suspect that this woodchuck is only partly hibernating. As long as the temperature remains quite cold (a few degrees above freezing), he will remain inactive, but darkness and quiet add to the depth of his sleep.

"If you have an outside shed where you could put him in a slatted box, it might be a little safer, though a woodchuck is not very 'formidable.' He might chew the woodwork a little indoors.

"I think you would have to keep him in a cage for a while to really tame him. Feeding him, getting him used to your presence, getting over any fears you yourself may have, all are important in taming an animal. Do you know Robert Snediger's *Wild Pets?* It has a lot of hints.

"Woodchucks do not give birth to young during hibernation. After emerging in the spring they mate. Gestation is about four weeks, the young being born in April or early May."

Whooping Crane

Sirs:

I was very much interested in the article on the Whooping Crane in your November, 1946, issue.

The paragraph relative to the statement made by Ernest Thompson Seton brought back to my memory something on which I have first-hand information. The incident took place in 1899.

A friend of mine living near Topeka, Kansas, shot a Whooping Crane, but as the crane was stunned and also had a broken wing and leg, the boy started to carry the bird home. Soon the crane evidenced more life, and the boy placed it on the ground so that he could take a firmer hold. The crane immediately stood on one leg and made a vicious drive for the boy's eyes.

Finally arriving home, the boy placed the crane in an eight-foot wire enclosure. Every time anyone came near the enclosure, the crane would strike for the eyes. Even if hands were placed on the fence and the eyes were near, the crane would attempt to reach the eyes rather than the hands.

Col. Lloyd L. Stanley, (Ret'd).
San Luis Obispo, Calif.

Striking for the eyes may be due to the "shine" rather than a knowledge of their vulnerability. Cranes are known to be pugnacious on occasion, as when defending themselves or their nests. It is less likely that they would start a fight without provocation. The bird in Col. Stanley's incident was wounded and hence likely to fight as best it could.

John T. Zimmer,
Department of Birds.
American Museum of Natural History
New York, N. Y.

Bullfrog in the Snow

Sirs:

Have you any explanations to offer for the actions of a bullfrog which, according to a local newspaper notice, had climbed over snowbanks and been caught in a rabbit snare? Why would a bullfrog be out in the snow in January?

Lindsay, Ontario D. S. Maclennan.

The following information is offered by Charles M. Bogert, Chairman and

Cocoon to the *N*TH *POWER*

When you think of cocoons, you think of something the size of your finger—unless you happen to have been to the land where jumbos like this one are produced

By James P. Chapin

Associate Curator of Birds, The American Museum of Natural History

Photograph by James P. Chapin

▲ A Cocoon the size of a football might be expected to produce a moth the size of a rooster. But this is a "communal cocoon" and may yield as many as 300 or 400 moths

THIS silken pouch may have contained 300 or 400 individual cocoons, for it was spun by a great number of African "processionary" caterpillars, so sociable that they enclose themselves in one large envelope when about to pupate.

The largest of such "nests" may weigh as much as a pound, and for many years efforts have been directed toward the utilization of this "wild silk." Strong, but not lustrous, the threads can be utilized for some fabrics, for sewing-silk, and for the insulation of cables. But since this silk has been spun by a number of individual caterpillars, it is not possible to reel it from the cocoon, and the thread differs from that of true silkworms by having "knots" at rather regular intervals.

During World War II, when there was such a vital need for rubber, quinine, minerals, and other materials that could be produced in Africa, attention was given in West Africa to the gathering of this wild silk. It was said to be needed in England for the making of parachutes.

The nest shown here was one of those that were brought in 1942 to the Forestry Officer, Mr. W. B. Collins, at Juaso in the Ashanti Forest of the Gold Coast. The caterpillars that made it were probably the young of the moth named *Anaphe venata*, this being the only form of *Anaphe* reported from the Gold Coast as late as 1930, though there are four other related species, widely distributed in tropical Africa and Madagascar. The adult moths are dull and whitish, with a few brown or blackish bars on the wings. The wingspread is a little more than a couple of inches.

It is not likely that *Anaphe* nests will retain any great commercial value in times of peace, for cultivation of the domestic silkworm has been undertaken with great success in recent years in the northeastern corner of the Belgian Congo.

Curator of The American Museum's Department of Amphibians and Reptiles:

Occasionally both amphibians and reptiles are caught off base, so to speak, when there is a drop in temperature. It does not happen often, but these animals are sometimes found on the snow, even though they are dependent upon sources outside the body for their internal heat. Invariably they are in a lethargic condition and presumably incapable of surviving.

Why such animals have failed to reach a safe refuge for hibernation is a matter for conjecture. They may have been heavily parasitized and thus were "sick" individuals with insufficient vitality to seek a suitable place. Or an accident, such as falling into a natural trap of some sort, may have prevented them from doing so. Or, again, they may have been routed from their winter sanctum through the activities of some other animal.

We know little about the mechanism that leads a frog or a snake to seek shelter at the appropriate time. Conceivably there may be occasional failures in the sensory apparatus involved. The animal misses his cue, perhaps through an inherited defect. If so, he is unlikely to survive to transmit it to future generations.

Toads from temperate climates that have been tested live for prolonged periods at 30° F., even though they fail to survive body temperatures of 28° F. We do know, moreover, that some cold-blooded creatures are able to function efficiently at much lower temperatures than others. Witness the energetic movements of a high-mountain trout hooked even when there is ice on the surface of the water. Any reptile at the temperature of the water in a tarn near timberline would be almost completely immobilized by the cold. A few frogs and salamanders are better adapted for cold environments, and they would be considerably better off under such conditions.

Some aquatic salamanders are active in ice-covered ponds throughout the rigorous winters of upstate New York, and the tadpoles of the bullfrog in the northern portion of its range must be able to cope with similar conditions for at least one winter. But adult frogs must seek soil or mud where temperatures never drop much below freezing. The frog in question possibly made two mistakes,—being caught abroad on the snowbank and being caught in the rabbit snare. Either one might have been fatal.

° ° °

SIRS:

Today was a great day indeed for me. Just imagine: within ten hours I received three copies of NATURAL HISTORY, that wonderful and highly-prized magazine which I had been missing for four long years. I shall not try to describe to you my pleasure and the joy of my boys in looking once again, after such a long time, at the wonderful pictures.

I have many reasons to love NATURAL HISTORY. Having been a student in the United States some 20 years ago, I have always been anxious to keep contacts with a country to which I am so much indebted and from which I brought back such heaps of happy souvenirs. Moreover, being a nature lover and a bird student, I find in your pages a rich substance and an everlasting interest. This is why I am blessing the return to more or less normal conditions, which at last allows me to renew my membership in the American Museum. From now on we shall all be looking forward, month after month, to the arrival of the three-barred Magazine, which brings us, in every single copy, so much knowledge together with so much pleasure.

(DR.) CHARLES CHESSEX.
Lausanne, Switzerland

Errata

SIRS:

I was pleased with my Coca article in the February issue of NATURAL HISTORY but was sorry to see that my name is now William. . . . W. H. HODGE.
Massachusetts State College,
Amherst, Mass.

Deep apologies, Dr. WALTER HENRICKS HODGE, for an error that is as inexplicable as it is inexcusable. Henceforth we shall see that it is WALTER HENRICKS HODGE.—ED.

The Chinese ginger jar illustrated on page 41 of the January issue should have been credited to the Walker Art Center, through whose courtesy the photograph was available. The credit line was inadvertently shifted to Mabel Irene Huggins' photograph of a pewter teapot opposite.

Governor-General of Canada Honored by the Museum

Field Marshall Viscount Alexander of Tunis, the Governor-General of Canada, was presented with an honorary life membership by the American Museum of Natural History, at a reception held in his honor at the Museum on February 8.

The honor was bestowed upon the Governor-General in recognition of his service in the cause of democracy while serving as Field Marshall during the past war and also in recognition of the long friendship that has existed between this country and Canada. The presentation was made by Mr. F. Trubee Davison, the Museum's President, and was attended by various other members of the Board of Trustees and Administrative Staff. Viscount Alexander took occasion to make a tour of the Museum.

GEMS BACK

The legendary "Star of India," largest star sapphire in the world, and the equally famous "DeLong Ruby," said to be the largest and finest star ruby known, are among the treasures that have recently been brought from the wartime secret vaults and placed again on display at The American Museum of Natural History.

Besides these and many other interesting gems, visitors can again see the Aztec gold jewelry, the royal Hawaiian robe of feathers, and other irreplaceable exhibits that were put in safe keeping during the war.

THE STORY OF FORMICA

Continued from page 135

worker ant of the kind known as leaf-cutting or parasol ants, her business in life might have been that of cutting and carrying bits of leaves to the home den. Or she might have been only a tiny creature whose humble job it was to remain at home to cultivate and pull weeds from the fungus gardens kept by these strange leaf-cutters. Or, belonging to another tribe, say, to the "harvester ants," she might have been a soldier ant with a head as large as the rest of her body and with huge jaws for the purpose of cracking the hard shells of seeds. Had she been born a soldier of the tribe of gall-nesting ants, she might have been a creature with a prodigious head shaped like a bottle stopper, with no purpose in life save to act as an animated plug to a nest entrance. For ants, unlike people, have long ago learned to put their giants and pigmies into useful niches in the body politics—yes, actually to produce them for the filling of such niches.

Being a worker, Formica was, herself, one of those beings whose specialized bodies constitute the commune or social insect society. Nutricially unsexed, so to speak, she held much the same relationship to her queen as the human eunuchs of the palace once held to the king and his harem. She would never try to kill the queen, usurp any authority, or try to found a new colony by leading off with a band of disgruntled followers. For as a worker, two things alone dominated her life: an intense loyalty to her clan and an equally intense desire to carry on with her job as a forager for that clan.

At birth, she had a potential life span of perhaps four to six years. Two of these life-units had already passed. When she became too old for the strenuous job of hunter, she would retire to the security of the nest to live out her last days in quiet. She might even for a time take on part of the function of the queen—that is, become an egg-layer and the mother of many young males. At her death, there would be no funeral, but her body would be calmly carried outside of the nest and placed on the communal rubbish heap. And that would be a natural and fitting conclusion to the story of Formica.

Photos by Gladys Diesing

▲ ASPENS on the shore of Navajo Lake, a short distance from the road to Cedar Breaks National Monument

BEWARE THE PORTUGUESE MAN-OF-WAR *Continued from page 137*

seen or been near a jellyfish have frequently suffered severely from the tentacles of a Portuguese man-of-war.

For a long time the standard treatment for jellyfish poisoning was injection of morphine, which generally alleviated the symptoms but was not too successful in effecting speedy recovery. But Dr. M. A. Stuart, of the U. S. Naval Medical Corps, who attended the two servicemen attacked in Puerto Rico, thought that their symptoms looked strangely familiar. Back in the United States he had observed several cases of black widow spider bite. The symptoms were strikingly similar. He had achieved excellent results in treating black widow spider bite with intravenous injections of a solution of calcium gluconate. The standard morphine treatment was tried on the soldier, who felt improvement but did not become entirely well. Dr. Wade decided to try an experiment. Would the calcium gluconate medication be successful on jellyfish victims?

When this treatment was tried on the ensign, the results, according to Dr. Stuart, were "instantaneous and dramatic." Immediately the patient felt relief from his cramps and oppression in the chest. The local burning was also relieved, and he was now able to lift both arms. He soon was well enough to return to camp.

It is too soon to say that this result means that the venom present in two such dissimilar and unrelated organisms as the black widow spider and the Portuguese man-of-war is basically the same. Further research may eventually supply the answer.

Traditionally we have used the expression "spineless jellyfish" as a contemptuous epithet for flaccid weakness. But perhaps some day you may be swimming in the ocean, and you may come upon a "spineless jellyfish" under a gay, blue float. Treat it with enormous respect. Better yet, start swimming in the opposite direction.

OF COURSE ANIMALS CAN THINK *Continued from page 118*

René Descartes, who stated flatly that all animals are flesh-and-blood machines that react automatically to various stimuli in their environments and are totally incapable of learning, remembering, or reasoning? No, the present-day students of animal behavior are thoroughly satisfied that lower animals can and do learn and remember a surprising amount of things. Furthermore, some species show good evidence of being able to reason,—a type of mental activity which is considerably more complicated than learning by practice. Scientists are satisfied that this is so, because the results of their tests with animals have convinced them.

These tests, by the way, reveal some rather curious errors in popular thought. People often credit the most stupid species with great intelligence while failing to recognize animal genius where it does exist. For example, the horse makes a miserable showing in intelligence tests that any self-respecting pig can pass with ease.

Certainly animals can think, but it can never be proved by the anecdotal method. The story of how intelligence and reasoning ability are measured in animals would make an article in itself, but the moral of *this* tale is: "Don't put your faith in anecdotes."

Professor Beach will offer in a coming issue of NATURAL HISTORY another article on various specific experiments that have been performed to evaluate the intelligence of animals.—ED.

MONEY ISN'T EVERYTHING—

(OR IS IT?)

BY GROUCHO MARX

WHAT do you want to save up a lot of money for? You'll never need the stuff.

Why, just think of all the wonderful, wonderful things you can do *without* money. Things like—well, things like—

On second thought, you'd better keep on saving, chum. Otherwise you're licked.

For instance, how are you ever going to build that Little Dream House, without a trunk full of moolah? You think the carpenters are going to work free? Or the plumbers? Or the architects? Not those lads. They've been around. They're no dopes.

And how are you going to send that kid of yours to college, without the folding stuff? Maybe you

think he can work his way through by playing the flute. If so, you're crazy. (Only three students have ever worked their way through college by playing the flute. And they had to stop eating for four years.)

And how are you going to do that world-traveling you've always wanted to do? Maybe you think you can stoke your way across, or scrub decks. Well, that's no good. I've tried it. It interferes with shipboard romances.

So—all seriousness aside—you'd better keep on saving, pal.

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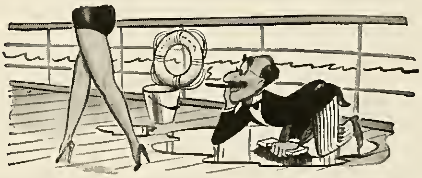

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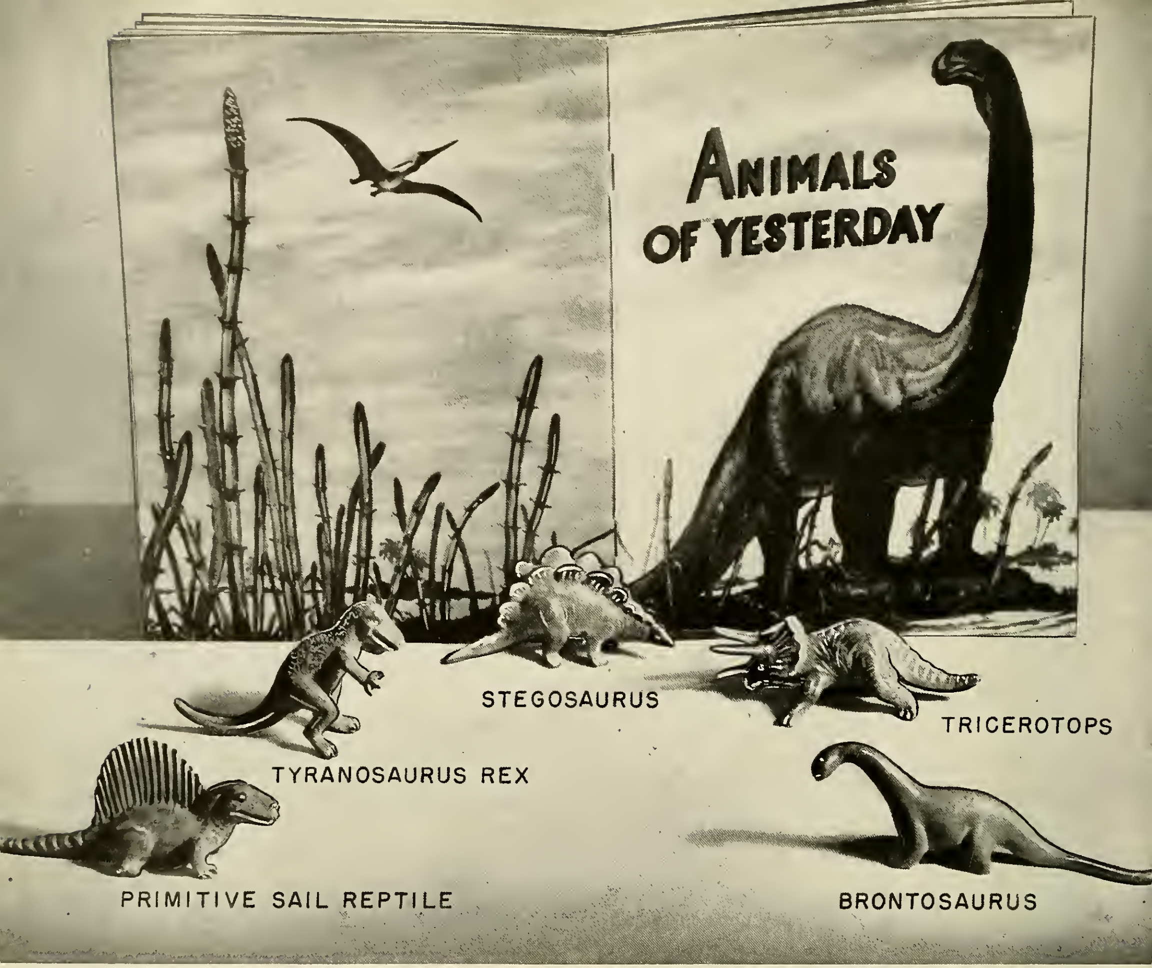

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Animals in the Laboratory and in the Wild

SIRS:

I have read with the greatest interest the article Dr. Frank Beach wrote in reply to mine on the behavior of animals in the wild. Although I do not agree entirely with Dr. Beach in many ways, I am extremely interested in his point of view, as his realm of science is one with which I have had little contact. The mere fact that he has taken sufficient interest in my article to so thoroughly tear it to pieces is flattering.

I am fully aware that the observations of a field observer leave much room for criticism, but I still think that reliably reported anecdotes can and do illustrate animal intelligence. Dr. Beach must not forget that any observations I have made were not based on just the single incidents mentioned in my article but on years of experience and study. One does not learn all there is to know about a microbe by looking at it once through a microscope; nor does one know the characteristics of a beaver or a mountain sheep by a single observation. I wrote my article with the idea of letting the reader make his own observations, and with the hope that the sum total of these conclusions should be of some value even to such an eminent scientist as Dr. Beach. Many scientists make the mistake of believing science to be absolutely infallible. This may be a fact when they are dealing with concrete things, but when it comes to analyzing such things as the mental processes of wild game they are leaning a good bit on theory themselves and should go gently when they describe the observations of a naturalist as imagination.

One of the great weaknesses of the scientific analysis of animal intelligence is the fact that the subjects are confined to so few species. Unless scientists take their laboratories afield and are able to study the animal in something like its natural habitat, such animals as the mountain sheep are utterly beyond research. If a sheep were caged in a laboratory, I have no doubt that he would be everlastingly damned as a dunce for the simple reason that he was out of his element.

Dr. Beach clearly illustrates another weakness of the scientific methods of research in regard to animal mentality when he says, "For example, the horse makes a miserable showing in intelligence tests that any self-respecting pig can pass with ease." He also says this illustrates "some rather curious errors in popular thought." Actually it illustrates a rather curious error in scientific research, for anyone who has worked for any length of time with these animals will agree that it is sacrilege to mention the two species thus in the same breath. We wonder if it ever occurred to the good doctor to question his methods.

Since I was a small boy I have worked and trained horses in the western cattle country, and I have also had considerable experience with pigs. It may be possible to teach pigs some simple things, like when to come to breakfast, lunch, etc., but their ability to learn lessons of the same grade as those taught to a horse is chiefly noticeable by its absence.

By way of illustrating the intelligence of horses and many other animals both wild and domestic I could go on for chapters, but I will refrain from taking any more of your time. Anyway I have grave doubts if they would do much to convince Dr. Beach.

So I will just say in closing that I think we both have something and that if we could combine our observations, we might go a lot farther in evaluating animal intelligence.

ANDREW G. A. RUSSELL.

P.S.—One wonders what opinions would be reached about the human race if some Martian scientist were suddenly to descend to earth and put our human animal under close study and observation. After looking over our efforts to wipe each other out with atomic bombs and what-have-you, I wouldn't be surprised if we were classified with Dr. Beach's horses!

A. R.

Twin Butte, Alberta, Canada

° ° °

Beaver

SIRS:

I observed last summer a beaver's work in felling an eleven-inch poplar tree. The tree was on the edge of a lake, so that standing room was afforded on only one side. The place where the beaver was cutting came to a point, leaving about four inches uncut, so the tree did not fall. Then with mud, stones, and sticks he built a platform in the water to stand on and finish the cutting.

I think Arthur Radclyffe Dugmore, in his book on beavers, tells about hearing similar stories, but he took these with a grain of salt. So I thought the readers of NATURAL HISTORY might like to hear of an actual case.

J. M. HOLLISTER.

Schenectady, N. Y.

° ° °

Man in Whale

SIRS:

I read in one of the popular magazines an apparently sincere account of a man who was swallowed by a whale in 1891 and lived to tell the tale. The "well authenticated facts" were said to have been found while "browsing through some old records." I would like one of your experts to comment on this, if possible.

The event is narrated as having taken place when the Whaler, *Star of the East,* was cruising off the Falkland Islands. A huge cachalot whale—"the toothed sperm whale of southern waters"—surfaced, and a whaleboat was dispatched in pursuit. In the struggle the whaleboat was smashed to pieces, and it was found that a young seaman named James Bartley was missing. The whale was killed and brought alongside. The next morning the flensers had been busy for two hours when they noticed a strange, undulating movement in the whale's stomach. They slit it open and found James Bartley doubled up inside, unconscious.

It is stated that he required four weeks to recover sufficiently to tell his tale. He had found himself engulfed and sliding down a slippery channel, the walls of which quivered at his touch. The great heat of the whale's stomach "drained all his strength"; then he remembered no more until he awoke aboard the ship. The whale's digestive juices had permanently bleached Bartley's face, hands, neck, and arms as white as snow. The opinion was expressed that a strange combination of circumstances had given him his million-to-one chance of survival: (1) The whale's "serrated teeth" had missed his body, (2) the man had lost consciousness and remained quiet, and (3) the whale had soon been killed, which lowered its body temperature.

How about all this?

WILLIAM KASTNER.

St. Louis, Mo.

The following comments are offered by Dr. Robert Cushman Murphy, who has gone out with the whalers from New Bedford, as well as with the Norwegian whalers in Antarctic waters, and is one of the few scientists to have studied the old-time Yankee whaling methods at firsthand:

With reference to this inquiry from

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NATURAL HISTORY

The Magazine of the American Museum of Natural History

FREDERICK TRUBEE DAVISON, President — ALBERT E. PARR, Director

VOLUME LVI—No. 4 — **APRIL, 1947**

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THE COVER THIS MONTH

The lovely passion flower excited the imagination of Spanish explorers in the New World; they believed this plant and its blossoms had been "designed by the great Creator that it might, in due time, assist in the conversion of the heathen among whom it grows." They saw symbols of Christ and his sufferings in the make-up of the flower, its leaves, and tendrils.

These early explorers referred to the South American species. Our native passion flower, *Passiflora incarnata*, although quite similar in appearance, is commonly known as a maypop. In some regions it is so abundant that it sometimes becomes a weed pest.

In Florida, where this photograph was made, it is found in wastelands and along roadways and railways. Passion flowers grow from Virginia and Missouri southwards. Regardless of its tendency to take over wherever it becomes common, one always admires the beautiful color and intricate make-up of this interesting wildling.

HUGO H. SCHRODER.

PUBLICATION OFFICE: American Museum of Natural History, Seventy-ninth St. at Central Park West, New York 24, N. Y.

EDITOR: Edward M. Weyer, Jr., Ph.D.
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ART AND PRODUCTION: Robert E. Williamson.
Sarah Lasersohn, *Assistant in Art and Production.*

Magazine subscriptions, Membership applications, and Advertising inquiries should be sent to Charles J. O'Connor.

NATURAL HISTORY is published monthly (except July and August) at New York 24, N. Y. by the American Museum of Natural History, Seventy-ninth Street and Central Park West. Subscription price $4.00 a year, single copies fifty cents. Subscriptions to Canada, Newfoundland, and all foreign countries $4.50. Entered as second class matter March 9, 1936, at the Post Office at New York, under the Act of August 24, 1912. Manuscripts and illustrations submitted to the Editorial Office will be handled with care, but the publisher cannot assume responsibility for their safety.

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DROUGHT: ITS CAUSES AND EFFECTS
- - - - - by Ivan Ray Tannehill

Princeton University Press, $3.00, 264 pp., 118 figs., 5 tables

FAMINE, pestilence, and war have, since ancient times, been considered the three principal scourges of mankind. Drought is the cause of famine, and its effects are often significant in the spread of pestilence; and it has been known to result in war. All would define a drought as a prolonged period of deficient rainfall; yet, a precise definition is impossible. What would be called a drought in Ohio would be considered a period of unusually heavy precipitation in Utah or Nevada.

These factors are pointed out in the present interesting study by Mr. Tannehill, Chief of the United States Weather Bureau's Division of Synoptic Reports and Forecasts. It presents a fully documented account of droughts in this country and analyzes known data from many points of view. The results seem to accord with the author's thesis "that the dominating influence in broad-scale drought development is the Pacific Ocean, a fact which has not been recognized before."

When one considers that a large proportion of the moisture that falls on the United States, especially in the region east of the Rocky Mountains, comes from winds off the Atlantic and the Gulf of Mexico, this is a striking conclusion. But Mr. Tannehill has marshaled his data to present a convincing argument. A survey of sunspot cycles shows that these, too, are of primary importance, and it appears that it is the effect of sunspots on the total solar radiation that determines the atmospheric pressures and surface water temperatures of the Pacific area, and that these, in turn, have a significant bearing on the amount of rainfall in all parts of our country.

Well-written and excellently illustrated, the work is a true contribution to scientific knowledge, as well as to the field of non-technical literature—, and it is as fascinating as a detective story.

H. E. VOKES.

GREAT ADVENTURES AND EXPLORATIONS
- Edited by Vilhjalmur Stefansson

With the collaboration of Olive Rathbun Wilcox

The Dial Press, $5.00, 788 pages, 18 maps

THE editor of any anthology has two major problems. First, he must decide which authors to include; second, he must decide which of each author's writings he should select. Explorers, sea captains, and other adventurers have not been conspicuously modest or sparing when it comes to writing. This coupled with the fact that the compiler does not limit himself temporally or spatially must have made the task of selection here a profound one. The results of Stefansson's labors are excellent. The selection is good, the contributions are the important ones, and the writing, for the most part, is excellent prose.

The individual selections are woven into a well-integrated story through the media of the author's interpolations. These add the real value to the story. Dr. Stefansson shows the results of his long and notable career as an explorer. The way each contribution is summarized and exposed to the strong light of modern knowledge is a tribute to his effort to be impartial and honest in his criticism.

Those who know or who have read Stefansson will chuckle when they read some of his comments concerning the problem of food, in particular those extolling the virtues of meat.

The eighteen chapters of this work, each with a useful map, deal chronologically with the story of exploration from Pythias (330 B.C.) to Amundsen (A.D. 1911). The inspirational value of the book is considerable. One thrills at the tales of brave men who faced hardship and peril. Here we find a parade of epics, including two outstanding ones of the twentieth century. Of these two adventures Stefansson writes, "Peary's is the world's greatest success story of men against the elements; Scott's is the noblest."

There is a quality to reading firsthand stories of these great adventurers that makes this anthology far better than a history of exploration. In addition, there is the added perspective of the comments of a tried and accomplished explorer. This book is one that the relatively few bona fide explorers and the great host of armchair explorers will want to own and read.

JOHN R. SAUNDERS.

INDIANS BEFORE COLUMBUS
- - by Paul S. Martin, George I. Quimby, and Donald Collier

The University of Chicago Press, $6.00, 582 pp., 122 illustrations

WRITTEN expressly for the interested layman and the beginning student, this up-to-date compendium deals with the physique and activity of the American Indians north of Mexico from the time of their arrival on this continent, perhaps 20,000 years ago, up to the coming of Columbus and the first explorers of the early sixteenth century. That it represents a tremendous literary task is demonstrated not only by the bibliography but also by the triple authorship and the acknowledgments to several skilled assistants.

Covering as it does a vast expanse both in time and space, as well as an enormous variety of facts, the authors have simplified their presentation by commendable subdivision. Part I sketches the general background, defines archaeology, describes its methods, and disposes of certain deep-rooted fallacies connected with the subject. Part II gives a descriptive account of Indian arts and industries, such as the methods of working stone, bone, shell, and copper, as well as the making of pottery and textiles, and ends with a discussion of trade and commerce. Part III summarizes the latest and most exciting finds of the last 20 years bearing on the question of antiquity. Parts IV to VIII, covering 413 pages, are devoted to condensed descriptive accounts of our distinguishable culture complexes and the areas they occupy. This is done by first recognizing four major regions, namely, the Southwest, Eastern North America, the Pacific Slope, and the Far North, each part being furnished with a general introduction. These "regions" are further subdivided into 18 culture areas, most of which begin with a special introduction and end with a brief summary. The named cultures—about 140, all told—are briefly characterized under such headings as area occupied, physical type, village, livelihood; tools, utensils, and weapons; pottery, basketry, and textiles; pipes and ornaments; games, burials, etc., each according to the wealth or poverty of the information available. Interspersed throughout, somewhat unevenly, are a series of well selected illustrations—photographic and line-cut—as well as a number of chronological tables. In fact, contrary to previous manuals, this work places special emphasis on tentative chronologies. Part VIII, the conclusion, besides a brief text, gives a valuable over-all chronological chart.

This handsome book begins with a glossary, furnishes a 21-page bibliography, confined mostly to the latest field reports, and ends with a 35-page index.

On the whole, while such a skeletonized version of archaeology cannot be all that one could wish in every respect, it is a much needed, enviable achievement. By condensing the index, bibliography, etc., and by using some of the ample margins, a great deal more good meat could doubtless in the future be added to what are now, here and there, almost bare bones. But even as it is, the book should be of great service and inspiration to anyone interested in the general subject and also to local specialists.

N. C. Nelson.

The Cherokee Nation
- - - - - by Marion L. Starkey

Alfred A. Knopf, $3.50, 355 pp., 25 illust.

THE tragic story of the Cherokee Removal is much the same as that of the removal of the other four of the Five Civilized Tribes of the Southeast, for they all followed the same pattern and all knew The Trail of Tears.

The Cherokee Indians clung tenaciously to their freedom and to their beloved mountains of the Great Smokies as well as to their rich lands that extended into the states of Georgia, Alabama, and Tennessee. The Cherokee had made great progress, particularly under the guidance of their devoted Chief John Ross, who had conceived the idea of making the Cherokee Nation one of the states in the Union. They had a written constitution, an elected executive or Chief, a Council, and a body of laws which they faithfully enforced.

But the whites of Georgia coveted the rich lands, which they thought and said were far too good for any savage Indians, and stirred up the issue of Indian Removal. Jackson, by whose side these very Indians had fought and helped to greatness, treated them shamelessly and allowed Georgia to have its way. John Marshall, Daniel Webster, Henry Clay, and others in high places in the North tried to stem the tide of this injustice but to no avail. Even General Wool and General Scott, when sent to remove these contented, industrious people, became pro-Cherokee and tried in every way to right this dreadful wrong but in vain. The missionaries, for the most part, took the trip west with the Indians and continued to devote their lives to them.

There is a beautiful chapter on the genius, Sequoia, giving him high praise for his remarkable accomplishment—the Cherokee alphabet or syllabary. *The Phoenix*, the Cherokee newspaper which used this syllabary, was truly an amazing achievement. This paper was published weekly with a very few brief lapses for more than six years. In 1835 the Georgia Guard seized the press and type. When Oklahoma became a state, the Cherokee were disappointed that it was not named in his honor. However, the name Oklahoma meaning Red People, a Choctaw Indian word, is certainly appropriate for this state of Indians. Sequoia was honored, however, by having the California Big Tree and the Coast Redwood named for him.

Another fascinating chapter telling of the Great Ball Play is illustrated with paintings by Catlin. These paintings were made when Catlin traveled in the Choctaw country and saw a Great Ball Play there. Some 25 photographic illustrations add to the interest of the book.

Miss Starkey has evidently done an immense amount of research, which is well documented in a bibliographical appendix. She has told this sad story with moving simplicity and beauty which would warm the hearts of old Chief Ross and The Ridge, too, could they but know.

Te Ata.

Around the Garden
- - - - - by Dorothy H. Jenkins

M. Barrows and Co., $2.50, 206 pp.

THE year's round of garden duties, published ordinarily in our Sunday newspapers, has now been brought together between one set of covers. Miss Jenkins, besides being Garden Editor for the *New York Times*, is the author of *Annual Flowers* and a member of the editorial board of the magazine, *The Home Garden*. She has organized her present book by the expedient of devoting a chapter to each month of the year and separating each chapter into first, second, third, and fourth weeks. A fifth week is provided for May and October, somewhat as we toss in an extra day each Leap Year, to compensate in part for the missing days.

In the course of the 50 weeks of her year the author, using marginal headings in bold-faced type, reminds us of the multifarious tasks that dog the steps of the gardener. During the third week of March (to cull a week at random), she admonishes the horticulturist to finish pruning grapes and fruit trees, start seeds of verbena, ageratum, and phlox, dig the parsnips, paint arbors and garden furniture, visit the flower show, care for the peach tree, and start early spraying. In case time still hangs heavily, she offers such thoughts as raising Lenten roses, having an apple tree in the garden, and growing a crop of the mosslike baby's tears, *Helxine soleirolii.*

This flexible plan permits her a wide choice of subjects, but it involves some repetition. The menace of thrips to gladioli is touched upon repeatedly, and we are advised more than once to provide ourselves with bulbs of madonna lilies. Certain "musts," such as pruning, spraying, and fertilizing, appear in their proper places. Fortunately those prosaic matters are usually sandwiched between more stimulating reading.

Several tips appealed to the reviewer as unusual. Begonia leaves that are to be rooted on sand can be fastened down by laying small sheets of glass on them. Cut flowers of appropriate species of plums are placed in water close to orchard plum trees, so that bees can go from the one kind to the other and cross-fertilize the orchard plum flowers. Fruit trees are sprayed with non-poisonous liquid to prevent attack by Japanese beetles.

Though Miss Jenkins has covered a huge number of subjects, there's one she missed: I looked hopefully but in vain for a new way to repel moles!

The illustrations by Joseph Schultz include diagrams such as that on bulb protection (page 137) and also whimsical sketches relating to garden matters (pages 90, 96, etc.). There is a 17-page index.

G. H. H. Tate.

Handbook of the trees of the northern states and Canada

- - - - by Romeyn B. Hough

The Macmillan Company, $5.50, 470 pp., 478 photographs

Most tree books have individuality and represent the primary interests of the authors. This is well, for present-day difficulties in interpreting the tree species of northeastern United States—for example, oaks, ashes, hawthorns, birches, willows, and lindens—are so great that no one book can serve as a guide for the enterprising amateur. There are many tree books yet to come, each one able to bring us closer to an actual understanding of the species making up our forests.

This book is a reprint of the 1907 edition on somewhat thinner paper. It is, therefore, less bulky. The plates naturally do not have the crispness of the original edition, a situation most apparent in the photographs of tree trunks. Nevertheless, it is still among the most satisfactory tree books for the area extending southward to northern Georgia.

The author includes a full-page plate of each species, showing leaves, fruits, and twigs photographed on a one-inch grid background which allows one to see actual dimensions without printed encumbrances explaining size-reduction. On the opposite page there is a photograph of the trunk of the living tree, sometimes with the lower branches, together with a description, a map, and occasionally photomicrographs of wood sections. A descriptive key to genera and species covers about 40 pages.

Distribution maps today are fearfully and wonderfully generalized, and one of the great contributions the amateur can make is to gather accurate information on the distribution of our trees at the margins of their range. This is one of the reviewer's special interests. For example, what are the northeastern limits of the sweet gum (*Liquidambar*), the tulip tree (*Liriodendron*), and the river birch (*Betula nigra*); and what are the southwestern limits of the hemlock, the white pine, etc.?

Incidentally, while you are getting the correct pronunciation for the trees, you may as well know that the name of the author, Romeyn Hough, is pronounced "Huff," whereas his home town, Lowville, N. Y., rhymes with "How."

H. K. Svenson.

Mammals of eastern Asia

- - - - - - - - - by G. H. H. Tate

The Macmillan Co., $4.00, 366 pp., 79 figs.

Mammals of Eastern Asia was written to complete the coverage on the mammals of the Pacific war area and the adjacent shores. The preceding book, *Mammals of the Pacific World*, dealt with the Pacific Islands, and both of these volumes are part of the "Pacific World Series," designed to give information to men in service and to their relatives and friends whose attention had been drawn to an area previously known only as place names on a map.

Dr. Tate has prepared an excellent text on the mammals of the Asiatic mainland, restricting his area to that which figured most prominently in military operations and from which a large part of the mammal fauna reached the Pacific islands lying on the Asiatic continental shelf. This region is the home of a great many mammals, and, in consequence, the amount of text given to each has had to be brief to stay within the confines of a single volume. But the author has shown good judgment in his selection of subject matter.

He gives the systematic basis for the identification of species insofar as this is possible without setting forth a mass of data usable only by a museum man, and he brightens many of the accounts with brief comments on life history, geographic distribution, the reason for the common name, etc. His introductory chapters give the reader valuable background data such as the characteristics that distinguish a mammal from other animals, and the topographic and environmental factors that operate in the area under consideration. There are occasional passages touching upon the pre-history of the recent mammals and the movements that have influenced their present-day distribution.

The book closes with a glossary, an index of common names, and one of scientific names. The line drawings and maps are good and very useful.

This is the first book to give such a full, systematic account of the mammals of the area. Because so many species are cited, no one mammal can hold the limelight long, but the brief introduction will certainly help to acquaint the reader with the many species. This volume should prove the Baedekker for the mammals of Eastern Asia.

H. E. Anthony.

Animal drawing and painting

- - - - - - by W. J. Wilwerding

Watson-Guptill, Inc., $6.00, 160 pp., 150 illust.

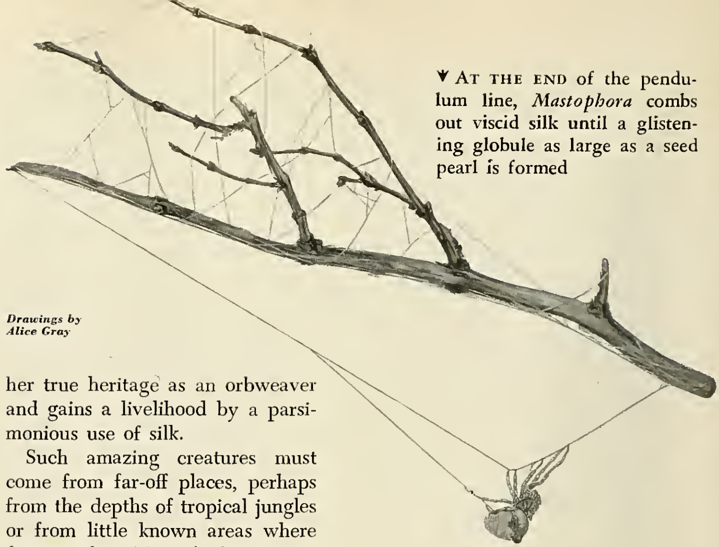
This very neatly printed and bound 9 x 12 book deserves much praise. and the praise should go not only to the publishers for its fine appearance but also to the author for the very excellent job he has done in presenting a difficult subject. Mr. Wilwerding, a finished and outstanding artist with a very considerable background of experience, is particularly well qualified to discuss this field of art.

This reviewer considers *Animal Drawing and Painting* one of the best treatises on this subject, and he cannot recommend it too highly to those who aspire to follow this branch of creative art. It is also a valuable book for the advanced student and the professional artist. Even though the latter may know many of the

Continued on page 192

By Willis J. Gertsch*

Associate Curator,
Department of Insects and Spiders,
American Museum of Natural History



Drawings by Alice Gray

▼ At the end of the pendulum line, *Mastophora* combs out viscid silk until a glistening globule as large as a seed pearl is formed

IN all societies there are usually certain noncomformists who persist in a determination not to follow the communal line of least resistance. Usually such heresy is productive of nothing that can survive, but also from such heretics may come the geniuses who originate new methods and establish new lines. Among the orbweaver spiders we find a group that has broken so completely with the past that its members do not spin orbwebs at all but have substituted an entirely different method of capturing insects. Instead of relying on the static but dependable round web, they spin a line, weight it with a sticky drop of liquid silk, and hurl it at their prey, much as the gaucho throws his bolas or the angler casts his line.

No pounding hoofs or shrill cries attend the throwing of the viscid ball by *Mastophora*, the Bolas Spider, whose successful effort is marked at most by a frenzied beating of soft wings. Very quickly the fluttering ceases, and no record of the means of capture is evident when we see her with her bulky prey. Long before the South American Indian learned to throw his bolas of round stones tied to ropes of braided rawhide, the Bolas Spider was an accomplished boleadora. But she has kept her secret so well that few Americans know of her existence. With the license of an inventor, she keeps her line attached to the single bola and hurls it as a sort of lasso. The viscid ball is the noose that holds the unwilling prey until she enswathes it in bonds of silk.

Spiders have devised many ingenious methods for stopping and ensnaring flying insects. Most of these are based on a copious production of silk and the use of this strong, elastic material for expansive webs. Perhaps the one best known and most pleasing to the eye is the round web or orbweb, composed mostly of radiating and spiral threads. *Mastophora* belies her true heritage as an orbweaver and gains a livelihood by a parsimonious use of silk.

Such amazing creatures must come from far-off places, perhaps from the depths of tropical jungles or from little known areas where few men live. Not so! These exotic spiders are found over most of the United States and are within reach of anyone with the inclination to find them and the time to observe their activities. Indeed, some of them seem to prefer the formal vegetation of our city parks and live in the shrubs and trees along the walks and riding lanes. Close relatives of the Bolas Spiders live in Australia, where their incredible habit of angling for prey has gained them the name of Angler Spiders. One of these heretics from Africa, *Cladomelea*, varies the fishing procedure by spinning its line around like a whirligig.

All are fat spiders of above average size, whose bodies are ornamented in a most grotesque manner. The carapace is bedecked with sharp, branched crests or horns and set with many small, rounded projections, whereas the voluminous abdomen is lined and wrinkled and surmounted with rounded humps. These bizarre specializations, reminiscent of such ornamention in the dinosaurs and many other groups of animals, are not known to play an important part in the life of the spiders. Indeed, there is little indication from the general appearance of these creatures that they do anything exciting. The spinelessness of the first pair of legs, and their greater length as compared with the other pairs, probably contribute to a better handling of the pendulum fishing line and thus may be said to be specialized for that purpose.

Fall is the best time to search for the Bolas Spiders, which, though not uncommon throughout their range, rarely come to our notice. Their failure to spin an expansive web, as do most of their relatives, increases the difficulty of discovering them. One factor that also contributes to their apparent rareness is their habit of living in bushes and trees, often at considerable heights. Usually we are attracted first to the conspicuous egg sacs and see near them one of these curious spiders. Once we have her, we can carry her home and install her in a convenient spot; or, better still, watch her in her own hunting grounds.

The site is usually an outer

* Dr. Willis J. Gertsch, a staff member of the American Museum for fifteen years, can claim allegiance to several states and institutions. Born at Montpelier, Idaho, where he lived until eighteen, he was graduated from the University of Utah and later received his doctorate at the University of Minnesota. During his undergraduate days at Utah, he acquired, under the guidance of Dr. R. V. Chamberlin, a lasting interest in the spiders and their relatives. As Associate Curator of the Museum's Department of Entomology, he has been a member of field parties to Panama and many points in North America. It is his belief that spiders do more amazing things than any comparable group of animals.—Ed.

branch several feet above the ground in plain sight, and the spider may be exposed or only partially hidden from view during the day. Mementos of her previous activities are numerous silken lines, which soon form a thin coating over the twig and the leaves. Hanging to the lines or hidden among the near-by leaves may be one or more egg sacs, beautifully and durably made, and representing many hours of tireless spinning.

During the daylight hours, *Mastophora* clings to the twig or leaf, completely immobile, perhaps deriving some sort of protection from this simulation of an inanimate object. A confirmed introvert, she can be said to resemble a bud, a nut, a snail, or, with considerable faithfulness, a bit of bird dung. Indeed, her resemblance to bird lime makes one of her common names, the bird-dropping spider, quite appropriate. If we take her in our fingers, she shows only a momentary evidence of life and then quickly resumes her inanimate role. We roll her around in our cupped hands like a nut or marble, and she does not even respond when we accidentally drop her to the ground. Finally, we place her back on her perch and find, an hour or more later, that she has seemingly not moved an inch during our absence. Few spiders are so completely inscrutable.

The Bolas Spider in Action

But *Mastophora* is a creature of evening and night, and as we watch her later in the performance of her marvelous routine, we forgive the early listlessness she showed. The disappearance of the last rays of the belated twilight is the signal for action, for soon after that she takes up her position for the evening's sport.

With her plump body swinging from the ends of numerous legs, she moves to one end of the branch and affixes her thread to the lower side by pressing her spinnerets against the bark. Grasping this thread with one of her hind legs and holding it away from the branch, she crawls along for several inches and finally pastes the line firmly at the other end. The result is a loosely hung line. She often moves about on it and strengthens it with an additional dragline thread. This strong trapeze line is strung far enough below the branch to allow a clear space for her fishing.

Moving to the center of the trapeze line, *Mastophora* now touches her spinnerets and pulls out a new thread, which lies clear of the other and is drawn out to a length of about two inches. Still keeping it attached to her spinnerets and held taut, she now combs out on the line quantities of viscid silk by means of her hind legs. Each leg alternates in combing out the liquid until a shining globule as large as a seed pearl is formed.

The spider now pulls out a greater length of line, allowing the weighted portion to drop part of the distance to its natural point of equilibrium, and then turns and severs the line just below the globule with the claws of one of her hind legs. The freed line swings back and forth like a pendulum, but the spider turns quickly and approaches it, searching and groping with a front leg until she is able to grasp it. Quickly she swings her massive body and takes up the position shown in the illustration on page 153, grasping the trapeze line by the hind legs of one side and adjusting the fishing line between her palpi and one of her long front legs. Poised and ready now is the boleadora, and she waits for the approach of any suitable victim, with the patience that characterizes this spider.

▼ HANGING to the trapeze line by the legs of one side, she adjusts the casting line between her palpi and her long front leg, and is then ready to hurl the viscid ball at her prey

Spiders THAT *Lasso* THEIR PREY

Few scientists have ever observed it, but if you know what to look for, you may witness this most extraordinary performance

➤ *Mastophora,* the inscrutable Bolas Spider, sits quietly on a leaf and simulates a bud, a nut, a snail, or even a bird dropping

➤ The voluminous, wrinkled abdomen presents in rear view the face of some strange gargoyle

Also roused to activity at this time of night are many nocturnal insects, which soon fly along their accustomed lanes, dipping down close to the foliage and fluttering in and out among the branches. A large-bodied moth, with wings spreading nearly two inches and with great eyes shining red in the last rays of reflected light, dips down toward the hunting grounds of the waiting spider. As the insect approaches, *Mastophora* gives every evidence of knowing of the nearness of a prospective victim. She moves her body and adjusts her line as if in tense expectancy. At just the right moment, when the moth comes within the reach of the line, the spider swings it rapidly forward in the direction of the flyer. The viscid ball strikes on the underside of a forewing and brings the winged creature to an abrupt stop, its tether an unyielding line which will stretch half its length before it will part.

Fluttering furiously at the end of the lasso, the moth makes every effort to free itself from the sticky globule, but the spider is quickly on hand to deal out the final coup by biting the victim on some part of its body. Resistance ends quickly with the venomous bite, and the paralyzed moth is rotated and trussed up like a mummy with sheets of silk. To the victor belong the spoils, and *Mastophora* now sets to work feeding on the body juices of her catch. This bountiful food supply will keep the spider busy for some time. After having satiated her appetite, she cuts loose the shrunken remnant from the trapeze line and drops it to the ground below. Later in the night a second capture may be made, but *Mastophora's* needs for food are usually well met by a single sizable victim.

Poor Hunting

It must not be concluded that the life of this spider is quite as simple as the incident portrayed might indicate. *Mastophora* may wait in vain for a flying creature to come near enough for capture. In many instances, her aim may not be as accurate as pictured, or the prospective victim may be too large to be held even by the strong band of silk. But patience is one thing at which spiders excel, and *Mastophora* is no exception. Should no victim reward her after half an hour of sitting with her line ready for casting, she winds the globule and line into a ball and eats it. Quickly she spins another line, prepares another sticky bead, and resumes her vigil.

How wonderfully complex is the pattern of instinctive activities that makes up the fishing habit of *Mastophora!* Although endowed with glands that produce silk in copious quantities, the spider now bases her whole economy on a blob of sticky silk dangling at the end of a short line. And still not content with a niggardly use of this vital material, she eats the viscid globule if it is not put to use against her prey. One would like to think that the stickiness of the viscid globule is impaired by exposure to the air, and that a wise spider is renewing it, but we know this is not the case. This action is often seen with great surprise by casual observers, but it is characteristic of the orbweavers as a group. Perhaps it is inspired by the fact that they must so often roll up the lines of their tattered webs and build them up again.

Mastophora's lifeline is a silken dragline thread of great elasticity and of a tensile strength said to be second only to fused quartz fibers. The trapeze line, the pendulum thread, the viscid globule, and the instincts of the hungry spider combine to give us one of the most sensational of all devices for the capture of prey.

In September, 1903, there appeared in the *Scientific American* an article entitled "A Bolas-Throwing Spider," in which are given full details of the angling habit as practiced by *Mastophora cornigera,* one of the Bolas Spiders. We owe the first description of this moving drama to the patience and keen observation of Mr. Charles E. Hutchinson of Glendale, California. Nearly twenty years later, in 1922, the similar habits of the Australian Angler Spider, *Dicrostichus magnificus,* were described by Mr. Heber A. Longman, who knew nothing of Hutchinson's early paper. American spider specialists have, likewise, either forgotten or were completely unaware of the existence of this fine description of one of our most interesting spiders.

Dicrostichus *Angles for Moths*

The Australian spiders of this group have been studied rather carefully by various workers, but the fundamental investigations are to be credited to Mr. Heber A. Longman of Brisbane. He noted the complete absence of a web of viscid silk and watched the remarkable method by which the Magnificent Angler Spider, *Dicrostichus magnificus,* caught one of the common Noctuid moths. His description deviates little from what we know of *Mastophora.* "From its slender bridge it would spin a filament, usually about one and a half inches in length, which was suspended downwards; on the end of this was a globule of very viscid matter, a little larger than the head of an ordinary pin, occasionally with several smaller globules above. This filament was held out by one of the front legs, the miniature apparatus bearing a quaint resemblance to a fisherman's rod and line. On the approach of a moth, the spider whirls the filament and globule with surprising speed, and this is undoubtedly the way in which it secures its prey. The moths are unquestionably attracted to an effective extent by the spider, whether by scent or by its color we cannot say. We certainly could not distinguish the slightest odor. But the fact remains that night after night one or two moths would flutter up and be caught. Other moths near by seemed to be indifferent, but two were often secured in the space of an hour, one of which would be packed away on the line to be sucked later. The spectacle of the moth fluttering up to the spider, sometimes two or even three times before it was caught, is one of the most interesting little processes which the writer has ever witnessed in natural history. The supposed desire of the moth for the star is a poet's fancy, but the attraction of the moth to the *Dicrostichus,* although mysterious, can be seen by any patient watcher."

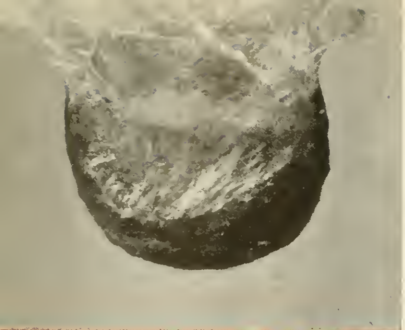
Cladomelea *and Her Whirligig*

We have saved mention of the *Cladomelea* from Africa until the end of this section, because the habits of this species are a further innovation. *Cladomelea* spins the same horizontal threads as do the other species and attaches the usual perpendicular line with a viscid globule at its end. Instead of holding the weighted line with the long front legs as do her cousins, *Cladomelea* grasps it by the third or shortest leg and uses her other legs to secure herself to the trapeze lines. Mr. Conrad Akerman of

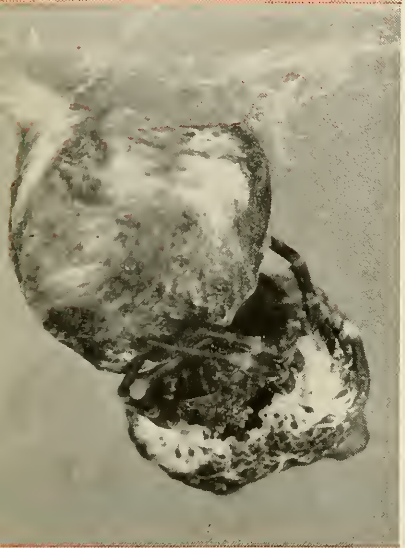
Photos by George Elwood Jenks

◂ WHEN DISTURBED, the shy creature folds her legs snugly against her body and plays dead

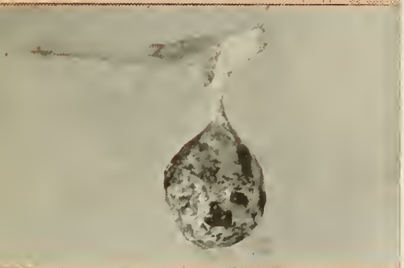
▾ NO PROBLEM for the photographer, she sits completely immobile and maintains her pose for hours



▲ A PROVIDENT MOTHER, she lays her pearly white eggs in a tough silken cradle . . .



▲ . . . then strengthens and variegates the sac with different colored silks drawn from the glands in her abdomen



▲ THE TOP of the egg sac is drawn out into a long tough stem, and . . .

Pietermaritzburg, South Africa, tells us that "This spider does not wait for the appearance of her prey and then hurl the droplet at it as with *Dicrostichus magnificus,* but whirls it rapidly on the end of its thread with a rotary motion in a horizontal plane. She keeps up this movement for about fifteen minutes without a pause, then draws up the thread and swallows the viscid droplet. After resting a few minutes she repeats the performance, spinning another line with a terminal globule and rotating it again for about fifteen minutes. Should any insect come within the radius of the circling droplet it would be struck with considerable force, and so, I imagine, would be captured by sticking to the viscid matter; the spider could then seize it or enshroud it in silk. The droplet is always rotated in a clear place and never struck any of the stationary objects in its vicinity."

Thus we note that already *Cladomelea* has introduced a refinement to the fishing line in the design of a whirligig. Or perhaps the converse is true—the measured, less wasteful practice of *Mastophora* may represent the real advancement in technique.

The Angling Habit

The habit of angling for prey must be a very old one, inasmuch as it is shared by spiders in such widely separated areas as Africa, Australia, and America. Just when it arose and what inspired it belong at present only within the realm of speculation; the solution must await fuller data on this group and on related spiders. The place of origin of this new method is tied up with the origin of the group itself, and of that we know nothing. Nor are enough of the spiders known to give us some clue, in their structure or in the instincts of the young, to the probable beginnings of the group.

We are inclined to be dogmatic in our belief that these spiders were once nearly typical orbweavers, but just how long ago this was we can only surmise. It seems reasonable to suppose that the angling habit arose within the web itself and that the orbweb was discarded only after the habit was perfected. The repudiation of the orbweb must have occurred some time after the new process was devised, for dependence on the orb must have been fairly complete at the time the new habit was forming. We can visualize the parent spider of the group on her orb in the process of subduing a fluttering insect and see her force out great sheets or drops of viscid silk to entangle it. We have only to place one of these globules on the end of a short line to have the fishing line of *Mastophora.* The instinctive actions that gradually refined the technique and guided the spider to the normal position for holding the line must have been acquired very slowly, perhaps only after long periods of time. Once the new method proved a success, the orbweb became superfluous and was finally lost altogether in its normal form. Perhaps in the trapeze lines of the Bolas Spider we have a vestige of the once mighty orbweb.

In a recent letter Mr. Hutchinson informed me that the angling habit

Photos by George Elwood Jenks

▲ . . . the pendant treasure is securely tied to her leafy domicile by lines of silk

◂ CLOSELY PACKED in their tough, waterproof nest, the spiderlings usually pass the winter, emerging in the spring

▾ WHEN THE MALES emerge they are easily identified by their bulbous palpi, and are fully adult (*lower center*)

▾ ONLY THE broods hatched in the fall see their mother, who dies before winter. Some of her babies are fully adult males—insignificant atoms when compared with the buxom females

is fully developed in young females one-fourth grown. However, the activities of young spiderlings just beginning to capture their prey still remains a mystery. We know that young spiderlings have little need for food soon after emerging, but efforts to maintain and study them have so far been unsuccessful. Perhaps in the early habits of some of the other species or some other orbweaver heretic we may discover a hint or definite recapitulation of the ancient practices of these atypical round-web spinners.

What Attracts the Moth?

In all of the descriptions of the angling habit there have been speculations as to the role of the moth in the drama. Some principle of attraction seems to impel the victim to fly toward the spider, indeed to return repeatedly if it does not become entangled the first time. Hutchinson, who studied *Mastophora* very thoroughly and has continued his interest in the spider to the present time, found the method of capture a most successful one and was inclined to believe that an agreeable odor was emitted either by the spider or the silken line. The dearth of suitable moth prey in the vicinity and the consistent success of the spider contributed to this inference. Longman's conclusions were similar, and they are largely contained in our quotation from his splendid paper.

It seems reasonable to suppose that the attraction must be the chemical one of odor or a visual one. The moth is probably well supplied with receptors for space perception, for we know that many moths are attracted to baits and other odoriferous objects.

On the other hand, it is more probable that visual stimuli could be responsible for sending the moth into the jaws of the spider. The compound eye of the moth is a wonderful organ, specialized for nocturnal use and no doubt responsive to even small quantities of light stimulus. The glistening globule of viscid silk or, perhaps, the pale body of the spider itself, might be sufficiently illuminated by light rays, either not evident to man's diurnal eye or outside his visual range, to cross the responsive threshold in the eye of the moth.

However, there is no real evidence that either of the above alternatives even approximates the truth. The true explanation may well be that the whole business is only a fortuitous one, largely dependent on the random flying activities of the moth. Mere chance would bring one or more within the reach of the spider almost every night, and if not, the creature could go without food for days or weeks without being profoundly affected. Although this solution would be at variance with the reasonable impressions of two eminent investigators, its simplicity has much in its favor.

But let us return to *Mastophora* who hangs on her trapeze line and awaits the approach of her prey. With what senses does she detect the presence of the flying insect and know just when to hurl the viscid globule? Her eight small eyes are of little use to her, and at night they probably convey no visual impressions at all. At the expense of better eyesight, her progenitors developed an expansive web and substituted touch-vision to keep them informed of activity in any part of it. Her relatives respond to the presence of prey by rushing to the spot and are informed of its nature by the vibratory disturbance. Although reduced in size, the web on which *Mastophora* hangs in midair is still adequate as a sounding board. She feels the vibrations heralding the arrival of the moth and orients herself accordingly.

The Egg Sacs

The egg sacs of the Bolas Spiders are hardly less spectacular than the spiders themselves. As is the case with many spiders, the process of laying the eggs and encasing them in a distinctive sac is a long and exhausting ritual. Even so, several egg sacs may be spun by the same female at intervals of about a week apart. In *Mastophora* the sacs are essentially equal in size to the spider herself and are hung near the site of the angling grounds, sometimes in the sun but more often partly protected by leaves. The sacs are hard objects that resemble nuts or other plant fruits. The distinctive features of the sacs are the long stem, which is drawn off the rounded base and attached to twigs or leaves, and the globular base, which is variegated with light and dark kinds of silk. In one of our species the base is broadly attached to a twig, and the stem is free. In another the sac is somewhat bell-shaped and embellished with lateral extensions, the whole resembling a small, dried apple.

The Emergence

The female usually dies in the late fall and rarely lives to see her progeny emerge from the egg sac, an event which ordinarily occurs in the spring. The emergence of the spiderlings from the cocoon is an occasion of great moment in the life of the species and a thrilling sight to one who is lucky enough to be on hand to watch it. A small opening near the base of the stem, perhaps the result of concerted action on the part of the creatures inside, is barely large enough to allow each tiny spiderling to wriggle through. As soon as one has emerged, another appears at the small opening, and then another, until they are out in considerable numbers and beginning to string their silken lines on neighboring objects. The instinct to move upward asserts itself strongly, and soon many of the spiderlings are scattered far from the egg sac and many of them are being wafted into the air on their silken lines. Within a few hours the whole family of perhaps 150 spiderlings may be far dispersed from the site of the empty egg sac. Inasmuch as some female bolas spin as many as five egg sacs, the possible progeny from a single spider may be as many as 700 spiderlings. The rarity of adult spiders of this group indicates that the mortality must be exceedingly high among their newly emerged spiderlings.

The Males

Up to now, all of our attention has been focused upon the female Bolas Spider and her egg sacs. What about her mate? The answer is found in a closer perusal of the spiderlings wriggling out of the small aperture in the cocoon before us. Some of the creatures are much redder than the others and have the tiny palpi armed with bulbous enlargements, which signalize the male spider. Closer inspection shows that these palpi are fully developed and indicates that these pygmies, averaging about one-sixteenth inch in length, are the mates of the Bolas Spider, which herself frequently attains a body length ten times as great. These adult males crawl out of the sac in company with baby sisters of equal size, which will not become full-grown and sexually mature for several months.

After studying the contents of various egg sacs in different stages of development, we are able to reconstruct the probable happenings within the egg sac. Several days or weeks after the eggs are laid, their pearly white shells break and allow the still embryonic spiders greater freedom for further development. The first true molt brings to light the creature we know so well as a spiderling, a small replica of the adult, which is able to spin and to eat. The males at this stage are precocious and have the palpi enlarged, but they are still not fully developed, being comparable in appearance to the penultimate stage of most male

Continued on page 189

U. S. Forest Service

◄THE SASSAFRAS TREE has three kinds of leaves—oval, mitten-shaped, and trident-shaped — hence the scientific name *Sassafras variifolium*

Sassafras SHAPED HISTORY

By
BETTY WILSON HIGINBOTHAM

A sixteenth century penicillin and sulfanilamide rolled into one, this Indian cure-all attracted expeditions to America's colonial shores and financed navigators and colonizers

THE unexalted sassafras tree has probably had more to do with the making of early American history than any other plant. It has served as a decoy that attracted expeditions to explore our coastline, it financed navigators and colonizers, and it became the first American cartel.

Sassafras was unknown to Europeans when Columbus made his discovery, since it grows only in the eastern half of North America, mostly in the United States. About twenty years after Columbus, however, Ponce de León and his compatriots came searching for the Fountain of Youth in Florida. Even as they searched they grew hourly older, and the flesh, for which they so eagerly sought eternal youth, became subject to the aches and ills that presage age and death. In a desperate effort to escape these ailments the Spaniards may have seized upon sassafras as a substitute that would do until the potent fount could be found. Their search for eternal youth developed into nothing but a historic joke. But sassafras became a subject for dissertations and an ingredient of beverages for the next five centuries.

For men searching for eternal youth, a plant that banishes all ills without delaying the marks of the years is a very poor second indeed. And yet it was something to have a cure-all, as sassafras was considered, and its discovery caused quite a stir in disease-ridden Europe. It is not hard to imagine the reception such a panacea must have received when we think that to the people of that day it was a sort of combination sulfanilamide-penicillin-streptomycin to which they looked for complete relief from their ailments. The publicity accorded sassafras was comparable to that of our own most recent remedies.

Old prescriptions

The much-quoted John Gerard, in his herbal published in 1597, says: "The wood heerof cut into small peeces and boiled in water, to the colour of claret wine, and drunk for certain daies togither, helpeth the dropsie, remooveth oppilation or stopping of the liver, cureth quotidian and tertian agues, and long fevers.

"The roote of Sassafras hath power to comfort the liver, and to dissolve oppilations, to comfort the weake and feeble stomacke, to cause a good appetite, to consume windiness, the chiefest cause of cruditie and indigestion, stay vomiting, and make sweete a stinking breath.

"It provoketh urine, remooveth the impediments that do cause barrennes, and maketh women apt to conceave."

A list of the diseases that sassafras has been reported to cure

reads like a handbook of human illnesses. Here are a few of them: ulcers, skin trouble, mumps, bronchitis, pneumonia, fever, wens, inflamed eyes, dysentery, catarrh, gout, dropsy, rheumatism, and syphilis.

It is no wonder that there developed a tremendous market for such a product, and when it was said that the same remedy that "cured" syphilis also cured the ague and the plague, the demand for sassafras knew no bounds. Everywhere people were buying—at exorbitant prices—the marvelous new drug.

Discovery by Europeans

Sassafras had been used by the Indians before the coming of the white man. Sixteenth- and seventeenth-century records credit the Spanish in Florida with introducing the plant to Europeans. Mostly it is claimed that the tiny colony of French Huguenots in Florida in 1565 first gained a knowledge of sassafras from the Indians. Before these French were put to death by the Spaniards they are said to have passed their information on to their assassinators, and hence to the world.

There is indirect evidence, however, that sassafras was known even earlier in Europe. Nearly a century before the Pilgrims landed at Plymouth Rock, a Frenchman in Canada, Jacques Cartier, the discoverer of the St. Lawrence River, was having serious trouble combating scurvy, which was ravaging his men. Finally an Indian pointed out a tree that could cure them, and reportedly it did. Cartier was astonished and delighted; the journal

◄ **Sir Walter Raleigh probably had more to do with the early commerce in sassafras than any other celebrity. But it is doubtful whether he ever saw the living plant**

Culver Service photo

of his experiences says, ". . . this is thought to be the sassafras tree." It wasn't. But the fact that someone had heard of sassafras in 1536 (unless later translators or editors took liberties with the work) almost necessarily indicates that Ponce de León or one of his successors in the search for the Fountain of Youth knew of it and had spread the word.

To get down to historical facts of which we have definite knowledge, one Captain M. Arthur Barlowe was cruising along our coast in 1584-85, 35 years before the Pilgrim Fathers landed. In his account of "The first voyage made to the coasts of America" for Walter Raleigh, he mentions finding sassafras on Roanoke Island and tells of its use as a beverage by the Indians.

Again in 1585, Ralph Lane, who led a colony for Raleigh to Roanoke Island, noted "great woods of sassafras" around Chesapeake Bay. Being plagued with starvation, his experiences with sassafras were not as happy as those of other men. There came a time when his party had to subsist upon a pottage containing nothing but sassafras leaves, ". . . the like whereof for a meate was never used before as I thinke."

Many endorsers

Another chronicler of this group, Thomas Harriot, took a different view of the tree. He wrote of sassafras, ". . . a kinde of wood of most pleasant and sweete smel, and of most rare virtues in physic for the cure of many diseases."

Men were by now thoroughly sassafras-minded, and all of the early explorers and colonists apparently kept their eyes peeled—if not most of the trees—searching for sassafras.

Of all the great men who have had a hand in the history of America's most fantastic plant none has contributed more than Sir Walter Raleigh, although it is doubtful that he ever saw the living plant.

Raleigh considered that he had a firm control of the sassafras trade. His grant gave him full rights over the territory and produce of Virginia, extending from the vague boundaries of the Spanish in Florida to the French in Canada.

With sassafras bringing 20 shillings a pound (about four dollars at the present rate), Raleigh had a lucrative business in this article, which was becoming a necessity in every Elizabethan medicine cabinet. As astute a businessman as any market manipulator, he was curious when the price of sassafras began to fall. He found, to his consternation, that his monopoly had been infringed upon.

In those days, and for long afterward, exploration was often far from profitable. There were no geographic societies to finance expeditions. Royalty was rarely willing to expend money on a hazardous and doubtful outcome; its support lay in its willingness to grant permission to some intrepid soul to get backing where he might and to reap his reward from any commerce that might come from the trip. Such a policy necessarily meant that exploration was carried on as much with an eye to picking up profitable commodities as to actual discovery. Aside from gold and slaves, there were a few more profitable commodities than sassafras. It was not to be expected that men could long respect Raleigh's rights to all the sassafras.

The monopoly threatened

One fine day, then, when Raleigh was prowling about a port of England looking for the cause of the sudden drop in the sassafras market, and doubtless aware of just what to look for, he came upon a boat newly returned from America laden with sassafras—but not consigned to him. He is reported to have done what any monopolist would do: he complained that this would "cloy the market" and confiscated the cargo. Sassafras therefore may be considered the first American (U. S.) cartel.

The cargo that had fallen into Raleigh's pocket had been brought back by an "exploring" expedition

➤ AFTER playing a tempestuous role as the first cartel in early American history, sassafras today enjoys a quiet reputation as a cherished springtime beverage

AMNH photo

◂ SASSAFRAS retains an honored reputation as an important ingredient of the famous Southern dish, gumbo filé

AMNH photo

led by Bartholomew Gosnold (who named Cape Cod) and Bartholowmew Gilbert. The record of their experiences, as written by one M. John Brereton, forms our earliest book in English on New England. The Earl of Southampton, who was the patron of Shakespeare, was also a patron of sassafras in that he helped finance this expedition, which made the first settlement in New England, though not a permanent one. Settling at Cuttyhunk, Massachusetts, in 1602, they found ". . . Sassafras trees plentie all the Iland over, a tree of high price and profit . . ." They were helped in the reaping of this profitable commodity by the Indians, for Brereton says, ". . . sixe or seven of them [the Indians] remained with us behinde, bearing us company every day into the woods, and helpt us to cut and carie our Sassafras . . ." While Archer, another narrator of this voyage, relates that "The powder of Sassafrage in twelve houres cured one of our Company that had taken a great surfett by eating the bellies of Dogfish, a very delicious meate."

Martin Pring

Martin Pring, however, recognizing Raleigh's rights, joined forces with him and gained his consent to search for sassafras in 1603. Pring was openly frank about his purpose. Although the journal of his voyage says in the title that it set out "at the charge of the chiefest Merchants . . . for the discoverie of the North part of Virginia," we are left in no doubt about their instruction, for the narrator says, "But meeting with no Sassafras, we left these places . . . where going upon the Mayne we found people, with whom we had no long conversation, because here also we could find no Sassafras." Or, "Here we had sufficient quantities of Sassafras." And even, to make sure that none suspected that this was a trivial mission, he explains, "As for Trees the Country yeeldeth Sassafras a plant of sovereigne vertue for the French Poxe, and as some of late have learnedly written good against the Plage and many other Maladies; . . ." And finally, about a month after sighting islands off the New England coast, of which

➤ THE VOLATILE OIL of sassafras is peculiar in that it is heavier than water. It is used to scent medicines and for other purposes

AMNH photo

➤ A GIANT SASSAFRAS TREE near Alvon, West Virginia

U. S. Forest Service

he is regarded as an early explorer, ". . . we had laded our small Barke called the *Discoverer*, with as much Sassafras as we thought sufficient, and sent her home into England before, to give some speedie contentment to the Adventurers." What a lot of contentment that shipload of sassafras must have brought the "chiefest Merchants" and "Adventurers" if it sold at anything like four dollars a pound!

Leading the life of Raleigh, however, was not all puddle-cloaking and contentment. His interest in sassafras was not merely an economic one. He was genuinely intrigued by medicine in general and while in prison spent much of his time concocting doses. Indeed, as he examined the axe that a few seconds later was to end his life, he remarked, "This is a sharp medicine but a sure cure for all diseases."

By 1610 the following appeared in a Public Record Office: "Instructions for such things as are to be sent from Virginia, 1610. (1) Small Sassafras Rootes to be drawen in the winter and dryed and none to be medled with in the somer and yt is worth 50£ [pounds sterling] and better, p. Tonne . . ."

A civic duty

In 1611 Sir Thomas Dale, newly arrived deputy governor of the young Virginia colony at Jamestown, put an end to the popular diversion of bowling in the streets and ordered the men to dig sassafras roots and cut cedar to support the colony (or was it the company?), and by this means they carried on until they found tobacco to be a more profitable crop.

Other men whose names are written large in American history paused in passing to mention sassafras. Among these were Champlain, Captain John Smith, Winthrop, and William Penn.

By this time, however, there were other inducements besides sassafras to bring men to America. As Thoreau has said of the earlier explorers, or rather sassafras-seekers, ". . . thereafter they began to come thick and fast, until long after sassafras had lost its reputation."

Sassafras has never entirely lost its reputation, however. People in rural districts still pin considerable faith on this tree or shrub. Sassafras tea "thins the blood," according to many an old-timer, and thin blood, apparently, is desirable. Others say that it "cools" the blood, or it "puri-

fies" the blood; but always it is as closely associated with springtime as sulphur and molasses, so we must wonder whether it is not an antidote for spring fever.

Is it from nostalgia for the old springtime dose or from genuine appreciation of its flavor that many city people are enthusiastic about sassafras tea? Few people who have not known it in their youth find it pleasant to the taste. But those who have drunk of it in their younger days find a comfort and an epicurean delight in a cup of the hot, red-tinged sassafras tea.

A springtime ritual

The tea is boiled or steeped from the inner bark of the roots until it is nearly wine colored, then sweetened to the taste. It is packaged and marketed commercially on a small scale, and many markets are provided with small bundles of the roots or root bark in the springtime by near-by farmers.

Peter Kalm, in his *Travels into North America,* relates that the English used to enjoy drinking sassafras until they recalled its use as a remedy for venereal disease, whereupon they "left off, lest those that used it should be looked upon as infected with that disease." The British beverage was sold on street corners and called saloop.

Dr. Francis Porcher, a southern physician who during the Civil War was called upon to find local substitutes for the many wartime scarcities during that period, wrote a book on methods by which the blockaded Confederates could make use of their own native plants. He naturally found sassafras a source of several necessities. As a Confederate Army surgeon, he often prescribed sassafras tea as a remedy, while urging its use on the side as a beverage. He includes in his book a recipe for a "cheap and wholesome beer for the use of soldiers," made of sassafras. As a beverage, sassafras has progressed from the Indians to the British and to the Rebels, and it is now used by up-to-date Americans as an ingredient of root beer.

Today sassafras is still a marketable product. Its roots are dug by hand and by powerful machines; its leaves are gathered, and its branches clipped. But the many overly optimistic prescriptions of the Europeans have been discredited in the modern uses of sassafras.

Sassafras pith

Indians are supposed to have revealed to the white man that the pith of sassafras wood yielded a mucilage that was excellent for irritations of the eye. This use for sassafras is still recognized in some quarters today.

If sassafras tea "thins the blood" it is not due to the oil content. The volatile oil of sassafras is unique in that it is heavier than water. The oil is extracted commercially and is still used, chiefly to scent other medicines or to disguise their flavor. It is sometimes taken for certain ailments but should be prescribed with care, for too large doses have been reported toxic. It is especially used in liniments, perhaps because of its odor, perhaps because it is good for rheumatism, or perhaps just because it has been used for rheumatism for several hundred years.

The fragrance of sassafras is noticeable in the leaves, twigs, wood, and roots. It was once called cinnamon wood because of this spicy odor (although the resemblance is doubtful), and the early Spanish had hopes of making it a substitute for cinnamon in addition to its other uses. Perhaps here was a use we ourselves overlooked in our recent cinnamon scarcity during the war. Because of this fragrance it has been used to perfume some products. Homemade soap was sometimes scented with sassafras. The wood was also used for dyeing materials before good commercial dyes came on the market.

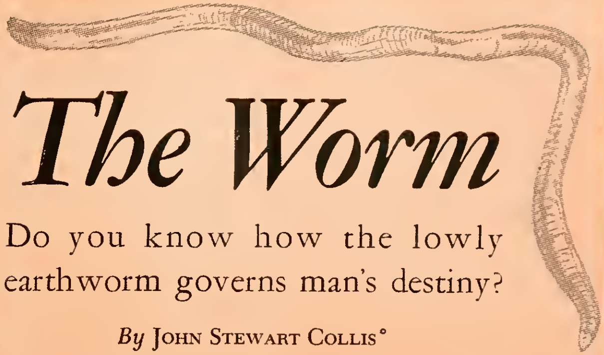
Nature has set sassafras apart from most other plants by providing it with not one but three different kinds of leaves: simple oval leaves, mitten-shaped leaves, and roughly trident-shaped leaves. Modern scientists recognize this variable leaf form by calling the plant *Sassafras variifolium.*

In the South, the French found it completely to their taste and gave it the French name of *filé.* Today where French influence has been felt in the South, bottles of filé stand on the tables ready for use in the famous gumbo filé. Made of shrimp or other sea food base, the gumbo is not complete without its condiment made of powdered sassafras leaves. The powder is an unpalatable looking greenish-gray color and imparts its color to the gumbo.

Filé is usually added for the extra flavor after the pot of gumbo has been lifted from the fire, else it will become thick and gelatinous. But there are those who contend that it must be added *before* the pot is removed in order to give the gumbo the thick consistency which they claim is the filé's proper function.

No fountain of youth

To the rest of the world sassafras may have been, at various times, a panacea, a dye, a drink, a perfume, or a condiment, but to some, sassafras is no more than a tenacious weed. The chore of "grubbing out" a field of sassafras is no light one, and while many an early expedition came to this country hoping to found a fortune on sassafras—and some succeeded—, our modern farmer is usually dedicated to destroying it with never an idea of its fabulous history or multitude of uses. To him it has become the antithesis of the Fountain of Youth, for a day spent in grubbing out sassafras makes one feel older by the hour.



The Worm

Do you know how the lowly earthworm governs man's destiny?

By John Stewart Collis[*]

EYELESS, legless, faceless, earless, and voiceless, the Earthworm is not much to look at—a mere squirming piece of flesh. Yet, with its powerful muscles, its two stomachs (one inside and one outside), and its false teeth, it is able to carry out remarkable works. Its task is to eat the earth.

The earthworm feeds upon the earth for the organic matter it contains rather than for the dirt itself. As the soil is digested, the worm extracts from it decaying leaves and other vegetation, insect eggs and larvae, spores of cryptogamic plants, and micrococci. The second reason why it swallows earth is in order to make its underground passage, its burrow, a process by which the earthworm casts the material upward into delicate little towers. This continuous mining has prodigious results.

Charles Darwin estimated that 50,000 worms often inhabit an acre of ground, and subsequent counts have put the figure at a million or more in rich soil. Since each worm ejects from twelve to twenty ounces of castings annually, 20 or 30 tons of earth are frequently thrown up every year on an acre. Hence, stones lying about on an uncultivated field will sink at the rate of two inches a year, so that in 30 years you can gallop a horse over once-stony ground without its hoofs striking a single stone. Sometimes there are so many worms at work that a narrow stone path across a lawn will sink so quickly that a gardener cannot control it. Some of the slabs of Stonehenge have already dropped considerably, although it will take some time before the rest of the ruins disappear from sight.

The worm is a friend to archaeologists, who owe to it the preservation of many ancient objects. Coins, gold ornaments, and stone implements are buried through the action of earthworms and stored for future inspection. Not so long ago, a neglected field near Shrewsbury was ploughed up, and arrowheads used in the battle of Shrewsbury were uncovered. War-time ploughing-up has, likewise, revealed many new objects; a bomb which fell near my neighbor's house blew a Roman knife into his bedroom window. But that is only the minor museum work of worms. Villas, abbeys, pavements, walls, and even towns have been preserved by them. All of the following had, according to established authority, been lowered into the earth by the action of earthworms: the remains of a large Roman villa at Chedworth, with coins dated A.D. 350; the tessellated pavement of Beaulieu Abbey; eighteen chambers of a Roman house at Brading on the Isle of Wight, with coins dated A.D. 337; the walls, tesserae, pottery, and coins of Roman emperors from A.D. 133 to 361, dug up at Abinger; and the town of Silchester, with a wall eighteen feet high and a mile and a half long.

Another by-product of the labors of the earthworm is the lowering of hills and the widening of valleys. Wherever there is a tumulus, an embankment, a hill, or a slope that is not made of gravel or pure sand, worm castings will be thrown up, and the action of rain and wind will, in time, roll the little towers of earth to the bottom, so that the mound is lowered. Small effects have vast results in the calendar of nature, and the eye that could keep watch across the centuries might see the Sussex Downs and the Dorset slopes vanishing because of the movement of worms.

Their general work is more ambitious. They create soil. Everyone knows that rock is solid soil. When it becomes broken up and mixed with vegetable ash, it is called clay. Worms, by means of acids and salts which they generate digestively, carry out steady decomposition of rocks. They go further. They wear down the small particles of rock, which other agencies can do little to diminish, by grinding them in their gizzards with beads of glass and angular fragments of brick or tile which they employ as millstones or artificial teeth in order to crush the earth. At the same time, they add to the organic matter in the soil by drawing astonishing quantities of half-decayed leaves into their burrows to a depth of two or three inches. These leaves are moistened, torn into shreds, partially digested, and intimately mingled with earth, thus giving vegetable mould its uniform dark tint.

It is pleasant to reflect, when we look out upon an expanse of land with a fine superficial mould, that it has all been swallowed by worms, that it has all passed, and will again

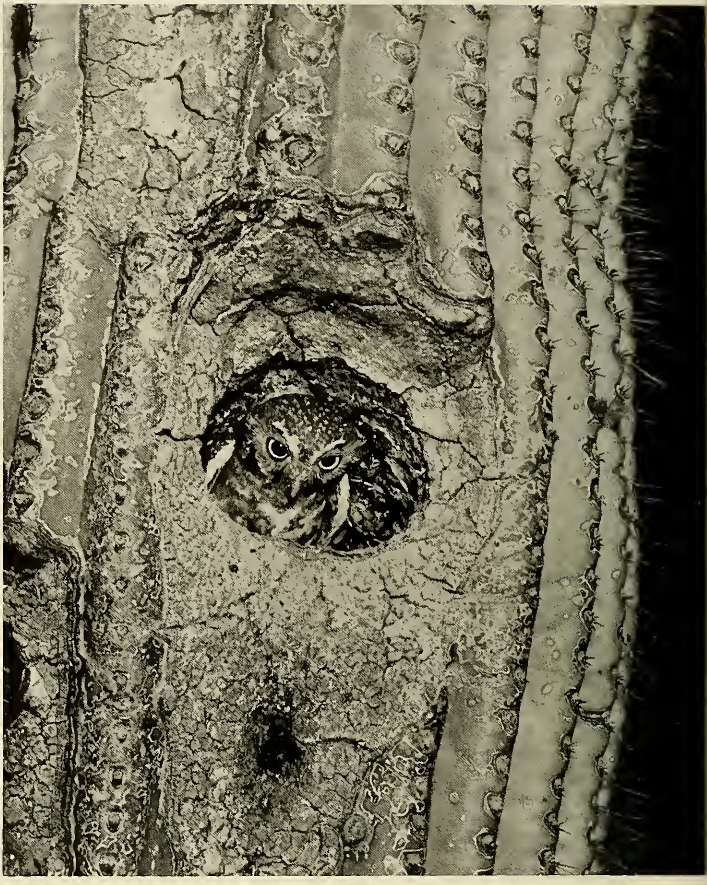
[*] The author of this article, who lives in London, modestly disclaims that he is a naturalist or even an agriculturist, but readers may well know of him already. His latest book is *While Following the Plough*.—Ed.

pass, through the bodies of worms. For during the course of this journey, the finer particles are sifted from the coarser; the whole is mixed with vegetable debris and saturated with intestinal secretions, so that the ground is prepared as by a gardener for the growth of fibrous-rooted plants and seedlings of all sorts. The soil is turned over and over; it is in perpetual motion.

Thus the worms plough, and thus they harrow. They also drain the land. Their burrows, which often penetrate to a depth of five or six feet, provide a vast drainage system. These tunnels also make way for the penetration of air, and they greatly facilitate the downward passage of moderate roots. They go further: they nourish these roots with the humus that lines the burrows like a cemented tunnel.

It is possible that some people are uninstructed concerning this monarch among animals. I have seen golfers unabashed at the spectacle of thousands of dead earthworms, poisoned on the fairways for their convenience. Some people know nothing of the worm except that it "will turn" under certain unspecified circumstances. Others, when they have cut one in half, honestly feel they have performed an act of creation, making two creatures proceed where there had been only one.

There are no songs to the earthworm's name. True, the poet who bent the most concentrated gaze on the tiger and saw that in it the fire of light burned brightest, was also he who, looking down into the damp, dark earth, perceived the worm and said, "Art thou a worm? Image of weakness, art thou but a worm? I see thee like an infant wrapped in the lily's leaf." Even he may not have known that the worm is more powerful than the tiger, that by its vast operations in ploughing, harrowing, leveling, draining, airing, manuring, and even in creating soil, it adds to the wealth of nations and governs the destiny of man; that, given the time and conditions, the worm could remove a mountain and cause a city to vanish from the face of the earth.



▲ At home in a cactus

The *Elf* Owl

The little Elf Owl, portrayed here through the skillful photography of Karl Maslowski, is the smallest member of its family. It is found in the desert country of the southwestern United States and northern Mexico. It favors the giant cactus, in whose protection it frequently spends the daytime and in whose hollowed interior it makes its home, usually in a deserted woodpecker nest. Three to five rounded, white eggs form the usual complement. These nests, although secure from most adverse conditions, are sometimes said to be flooded by heavy rains, with disastrous results.

This owl is strictly nocturnal, unlike its little woodland relative, the Pygmy Owl, which is almost as tiny. Although it may capture an occasional small mammal, its principal food consists of beetles, moths,

▲ An advocate of squatter's rights

ants, and grasshoppers. Its note is variously described as a wooden churr or rattle and sometimes as a repetitive *cha-cha, cha-cha,* sung in different keys.

The bird in the photograph is Whitney's Elf Owl, one of the two forms known from the United States. A third is confined to southern Baja California.

➤ Not a giant peanut but the nest of an Elf Owl. Woodpeckers excavate cavities in the pulpy saguaro cactus, and the plant exudes wound-callus which lines the interior. When dry, it becomes as hard as wood. The cactus may die and rot to the ground, but the nest shell still survives. Many other birds besides Elf Owls use these cavities as nests. This one was cut open fully a year after it had fallen to the base of a saguaro

Photographs by Karl H. Maslowski

Forest OF STANDING STONES

In the southeast corner of Arizona lies a fantastic area of massive rocks, sculptured by the tireless hand of geological time,—a wild terrain that evaded exploration by the white man for over 400 years

By William H. Carr, with Photographs by George K. Geyer

FAR up in the rugged mountains of southeastern Arizona there is a strange region where unnumbered thousands of towering rocks form one of the most unbelievable forests in the world. It is a forest of stone, where individual rocks are so tall that actual trees, growing lustily in the gaps between them, are dwarfed like blades of grass among boulders. Huge, balanced stones, weighing hundreds of tons, perch precariously on comparatively delicate bases. Formations with thin stems and grotesque, bulbous tops point skyward and crown the summits of steep cliffs like enormous, misshapen teeth. Inconceivable spires, pinnacles, and columns of solid rock reach upward for heights of 80 feet and more, covering the mountains in serried ranks, crowding the narrow canyons, and continuing on to fill the horizon until the eye is bewildered and the mind confused by the magnitude of the scene.

This fantastic area comprises the little known but outstanding Chiricahua (Cheer-ee-cow-ah) National Monument, some 70 miles north of Arizona's border city of Douglas. Near by is the storied Apache Pass where, 80 years ago, the strong-willed War Chief, Geronimo, made frequent and bloody sorties against adventurous settlers and United States Troops, when the country was literally a howling wilderness. Here the stubborn Apaches fought and raided back and forth across

◄ Carved through the centuries, this huge Winged Victory seems to defy the force of gravity. The wind that helped to carve it has not been able to overthrow it

► Unleash the imagination, and the strange formations resemble petrified faces and forms. Questions from curious visitors are numerous. Here Custodian Claire Cooke explains the process of weathering

▲ THERE IS limitless variation in the contours of the perched stones; no two of the massive structures are alike. This rugged boulder reaches to a height of 22 feet at the edge of a deep canyon

▼ THE WIDE SKYLINE is inconceivably exotic. Thousands upon thousands of weathered rocks rise upward to create the sort of landscape one might expect to find on the moon

the tortuous mountains to defend and keep the territory that had been theirs for so many centuries. First allotted to the Forest Service and then to the National Park System, the Chiricahuas stand today as one of the most spectacular regions of sculptured rocks on earth.

Early Western days

Before exploring this country, both on horse and on foot, I had the good fortune to meet one of the land's earliest white residents, 93-year-old Mrs. Emma Sophia Erickson. This fine woman possessed a wealth of information, good humor, and a becoming modesty when speaking of her own considerable achievements. She had lived near the canyons of mystic rocks for more than half a century, and her memory of incidents connected with the mountains was as clear as the blue of her eyes. She fairly sparkled with interest whenever she mentioned the weird rocks and their legends. Yes, indeed, she had seen many of the stones long ago, when she accompanied her children on excursions to investigate sealed caves where Indians had concealed their booty. In those days the mountain lion and the bear roamed, with few to molest them.

Mrs. Erickson said that hardly anyone ever went up into the canyons when she was a young woman.

She remarked that the country was too wild, adding, "Anyway, the men in those days never walked when they could help it. The only time they would use their own feet was when they walked toward a horse. Why, a man would travel on foot for ten miles just to ride a horse for five! No, they just didn't get up into the rocks, because the ground was too rough and steep for horses, and the game trails were too difficult to follow."

A no man's land

In Mrs. Erickson's early days, when the Indians were still a constant threat, it seemed that only an occasional Apache would dash off into the wilderness of rocks to escape pursuit or to consummate some secret business of a sort unknown to any settler. Only in recent years have white men ventured in any thoroughgoing fashion along the twisted trails that wind among the upright stones. Prospectors, cowboys, and hunters first viewed the region, but few left records of their exploits, content as they were to force their way into the more easily accessible sections in search of mineral wealth, strayed cattle, or game.

There can be no doubt that the Indians knew the land of the standing rocks. Indian pottery and stone implements have been found throughout the area. Just what the true natives thought of this mysterious place will probably never be known. One can easily picture the first Americans as they walked silently among the overpowering rocks and rested in the shade cast by some irregular column on the warm edge of an exposed canyon wall. Doubtless, many a stone pillar served as a hiding place for some primitive hunter as he crouched in wait for an unsuspecting animal to come within range of his arrow.

Mrs. Erickson expressed considerable sympathy for the original inhabitants of the uplands. She felt that they had been abused, misled, and cheated by the white men, especially by adventurers who perpetually roamed the land and refused to settle down to legitimate work and a peaceful life. She said that she liked the Apaches, even in the days of bloodshed, and respected them as the real people they were. She told of a particular day when her husband was away from home, and she was busy in her adobe house with her three children. A breathless neighbor rushed over to warn her that the Apaches were raiding down from the hills and had just killed a near-by settler and his wife, had burned their dwelling, and had stolen cattle and horses. The excited friend insisted that Mrs. Erickson take the children and run for another house where defense was possible.

▲ THE FOREST OF STONE is the result of weathering by water, wind, and frost. Individual surfaces are rough and angular, and small sections will sometimes scale off when touched

A friend of the Indians

When I asked the snowy-haired pioneer woman whether she had accepted the offer of rescue, she said, "Certainly not! I always was a friend of the Indians, fed them when they were hungry, which was often, and showed them that I never regarded them as enemies. They never bothered me. Leave the house? I should say not! There

➤ THE INKY-BLACK INTERIOR of Key-Hole Cave superimposes the silhouette of its jagged frame against the sunlight. Numerous caves provide cool shelter and rest from the summer heat

were plenty of raids while I was there, but the Apaches never troubled me or anyone else who befriended them. No, sir, I never took to the hills!"

New trails in the wilderness

Questioned further about the inaccessibility of the mountains that overshadowed her home, Mrs. Erickson and a group of neighbors and relatives who were with her reiterated that the section had not been described by any explorer until about 30 years ago. These statements were borne out by National Park scientists who had surveyed the land and investigated its history. They agreed that the terrain was too difficult for any but the most hardy until the Government built horse trails into the region. It was in 1924 that Washington moved to create a National Monument in the mountains to protect the rocks and other scenic features from commercial exploitation or danger of destruction. The Monument is named for the Chiricahua Indians who inhabited the mountains at one time. The entire range surrounding the Monument is also named for the same tribe. The serrated peaks and broad, swelling slopes rise precipitously from the deserts of Arizona and New Mexico like tremendous green islands in a sea of gray and brown.

As the lowland country became more settled and fences went up, increasing numbers of hunters wandered farther and farther into the vastness of rocks and emerged to talk about the strange sights. Photographers visited the region, and various promotion schemes eventually attracted wide attention. Many came from long distances to view the rocks, and in the middle 30's the Park Service moved in hundreds of men under the Civilian Conservation Corps, and trail and road work was initiated in earnest to open the region for the benefit of all who wished to see it. The former C. C. C. camp in Bonita Canyon at the Monument's entrance has been very cleverly rebuilt and serves as a guest ranch to accommodate visitors.

Mrs. Erickson's son-in-law, Ed Riggs, had done considerable exploring afoot and had given names to certain rock formations. Like other early travelers in the mountains, he climbed the canyons, parted the bushes, and looked upon the landscape with amazement. Every opening in the hills revealed new details, and there seemed no end to them. From the canyon floors to the highest mountains the fascinating formations went on and on. Bears and mountain lions still roamed through the region and were seen in the early morning and late evening hours. The interior section was a game paradise, thanks to its inaccessibility.

The C. C. C. men built a splendid series of horse and foot trails through the most remarkable sections of the mountains. There are fourteen miles of these trails—solid, substantial, and well planned routes that are a monument to the young men who labored to construct them. Afoot or on horseback, the guest can now journey in perfect comfort and safety where the early adventurers suffered many hardships. There is an excellent road

➤ CROOKED TRAILS, often passing among tilted formations, reveal startling new vistas at every turn. This trail winds beneath an inverted V-shaped archway and continues in darkness for 300 feet

◂THE CHIRICAHUA PATHS are some of the most spectacular horse trails in America. They twist erratically, and on many "switchbacks" the rider can almost see himself coming!

system, too, by which one may drive to lookouts and view the area without getting out of the car, though it is doubtful that many visitors will ever be content to sit still in the midst of so many natural marvels.

The highlights

My expert guide in the region was the Custodian of the Monument, Claire Cooke. Boy and man, he had worked first for the Forest Service and then for the National Park Service. Like all good outdoorsmen, his enthusiasm was contagious, and one could not fail to be carried along by his warm and ever-growing interest in the terrain under his supervision.

Cooke says that the "Wonderland of Rocks" reminds him of a huge subterranean cavern with hundreds of thousands of stalagmites growing upward from the ground and with the "roof" taken off. This is not a surprising description, considering that the man who gave it had previously been stationed at the Carlsbad Caverns National Monument in New Mexico, the largest underground caves in the world. However, the origin of the jutting rocks of Chiricahua is quite different, and the only roof is the brilliant blue sky.

Cooke is still exploring the territory. On his very brief "time off," he gathers groups of interested visitors and seeks new fields to examine. So far, he has not had the good fortune that attended one of Mrs. Erickson's expeditions, when she removed the rocks that concealed the entrance to a cave and discovered a well preserved Indian water jar and a small bronze mission bell. Doubtless, the relics were stolen from one of the very early cathedrals built by the Spanish padres, who were first to see the Southwest and who suffered attacks at the hands of marauding Indians.

Cooke is an expert horseman, having been born on a Wyoming ranch. This is a valuable asset to anyone who attempts to guide people through the region. On our first day we saddled up and rode to a section known as the "Heart of Rocks." This is an outstandingly spectacular part of the Monument. It is an area 7000 feet high where some of the most fantastic formations are to be found. Incidentally, we also came upon one of the little green rattlesnakes, native to mountains. It proved to be sluggish and non-aggressive. To Cooke's chagrin it did not even rattle.

In delicate balance

In the "Heart of Rocks" there is a tremendous, balanced boulder, some 30 feet in height and in width, that tapers toward the bottom until the section that actually rests upon its stony pedestal is not more than five feet across. This delicately balanced mass would certainly dive earthward with a tremendous crash if even the slightest earthquake were to shake the countryside. Cooke did his best to climb to the top of the pedestal to provide a comparative figure in the photograph we wanted. But try as he would, he could not quite reach the spot. He is an excellent climber, but, like all true mountaineers, he knows his own limitations and does not attempt the impossible once he has carefully studied the possibilities. He had been telling me of a particularly massive, strangely sculptured formation, known as the "Mushroom Rock," balanced

Continued on page 186

A New Memorial Exhibit at the Hayden Planetarium

Weather Science ON DISPLAY

WEATHER has been a topic of conversation for a long time. Mark Twain is credited with having said "Everybody talks about the weather, but nobody does anything about it." This was probably true up until World War II, when something was done about it.

During the past five years the science of weather predicting has made vast strides. We have read so much about meteorology and aerology that the various types of cloud forms and such terms as Cold Fronts, and Warm Fronts, Cyclonic Disturbances, and the movement of air masses, mean more than just abstract scientific terms to the average layman. He has begun to realize that these things have something to do with whether the sun will shine tomorrow, whether it will be foggy, or whether there will be rain.

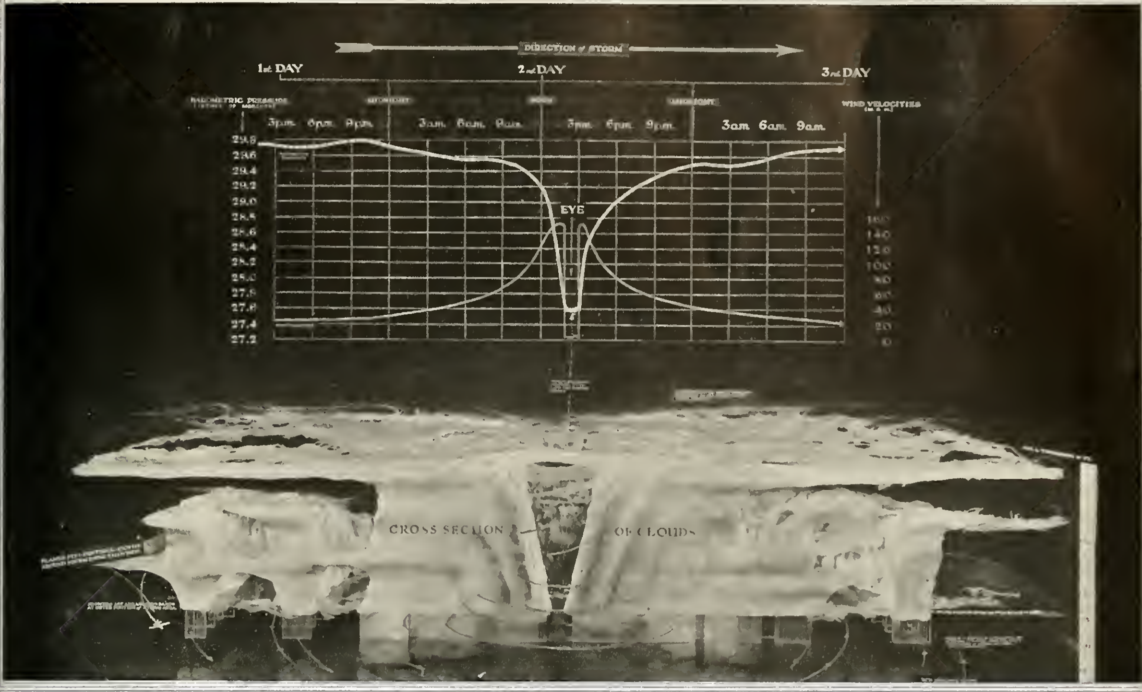
The American Museum of Natural History and the Hayden Planetarium, recognizing the importance of the science of meteorology and the public thirst for knowledge regarding it, have established, through the co-operation of Mr. William P. Willetts, a memorial exhibit located on the second floor of the Hayden Planetarium. It is in memory of Lt. (j.g.) Joseph Prentice Willetts, who with twelve members of his crew, was killed while on active duty in the Naval Air Service on August 18, 1943. An endowment fund has been provided by his family so that a suitable memorial on meteorology can be maintained as evidenced by the models which constitute the present exhibit.

As weather conditions were probably responsible for the accident, this memorial was presented to the American Museum of Natural History to provide primary education in the field of weather, in the hope that this knowledge will save the lives of future airmen.

The formal presentation of the Memorial was made on Dec. 18, 1946, by William P. Willetts, acting in behalf of his family. The Memorial was accepted by President F. Trubee Davison for the Trustees of the Museum, and Gordon A. Atwater for the Hayden Planetarium. The Dedication Address was made by Rear-Admiral E. O. McDonnell, U.S.N.R.

The exhibit in its present form embraces seven graphic models illustrating important weather phenomena, surrounding a "theme shaft" which depicts in cross-section the atmospheric envelope of the earth. Moving lights and various other devices help to convey a graphic impression of weather dynamics.

Although meteorology is an old science, aerology is a comparatively new study. People have become "aircraft-minded" without actually becoming "air-minded." Because the sea of atmosphere in which we live is invisible, many of us treat it as a void and are no more conscious of it than a fish is of his own fluid environment. We are not so much earth-animals as we are atmospheric-animals, inseparably bound to this medium. We are "deep-sea animals" living on the very



THE TROPICAL HURRICANE

Model designed by Eric Sloane

ocean-bottom of the atmosphere.

We can leave the earth at will and live comfortably for quite a while; but we cannot leave the atmosphere for a second. Without oxygen, we and all other creatures would immediately cease to live, and the earth would become lifeless like the moon. Without the pressure of the air upon us, we would "burst" outward, as a fish does when brought up from the ocean's depths.

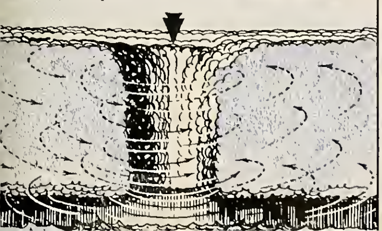
The pressure of the air results from its weight. If air is thrown away from the earth, gravity pulls it back. It clings to the solid earth and even penetrates into its depths. Higher up, where there is less air pressing down from above, the pressure is less. One half of all the atmosphere, in fact, is compressed within the lower 18,000 feet—a film that would be no thicker in comparison than the varnish on a desk-size globe.

The pressure also varies locally over the surface of the earth at all times, owing to the heating action of the sun, which is the prime cause of all weather. The sun produces more heat in some places than in others, and some kinds of surfaces heat up more quickly than others. This uneven heating sets up currents and unequal pressures. Some air is always rising and some falling, some advancing and some retreating.

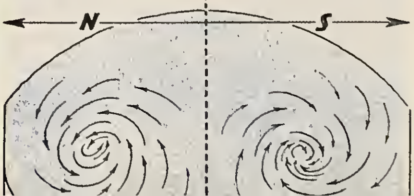
When extremes of air pressure are produced, violent weather results, such as in the tropical cyclone depicted above.

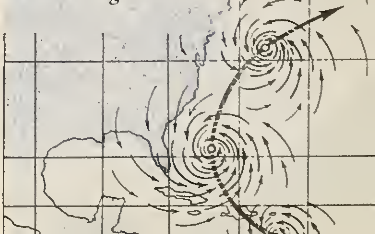
In the tropical cyclone, winds of 100 miles an hour or more circle a central core or "eye," in which the pressure is extremely low. The heavy dotted line in the graph above shows how the pressure dips sharply toward the center of the storm. The lighter curve shows how wind velocity rises as you travel toward the center, and then drops abruptly in the "eye," where the sky is only partly overcast. Rain showers fall in bands around the outer edge of the storm area. Clear weather persists above the cirrostratus clouds, capping the storm area at about 40,000 feet.

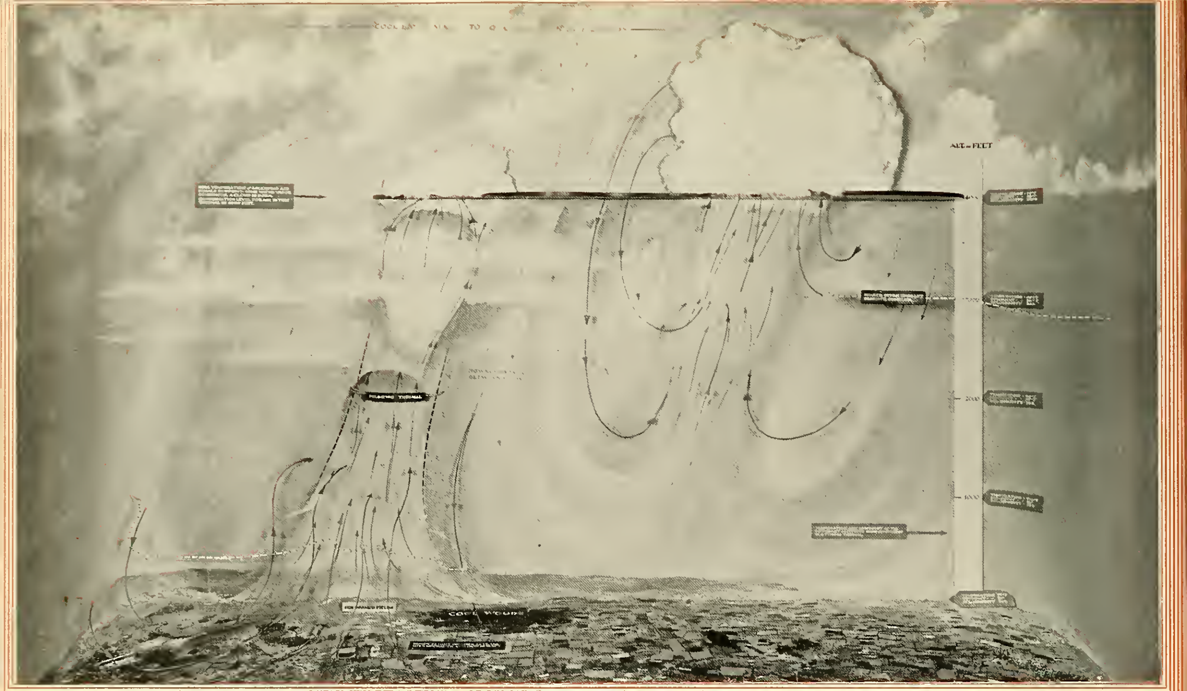
▼ THE CALM "EYE" of the cyclone is usually only about 10 to 20 miles across



▼ THE CYCLONE revolves counterclockwise in the northern hemisphere, clockwise in the southern. The entire hurricane generally moves at about 10 to 20 miles an hour, like a man carrying a phonograph that is revolving







BIRTH OF A CUMULUS CLOUD

Model designed by Eric Sloane

For purposes of scientific research, we acknowledge the existence of measurable atmosphere as high as 250 miles above the surface of the earth. But we cannot live long without oxygen masks above 20,000 feet or at all above 50,000 feet even with such masks,—less than 10 miles.

This model, depicting the Birth of a Cumulus Cloud shows the relatively low altitude at which one of our most familiar weather phenomena often takes place.

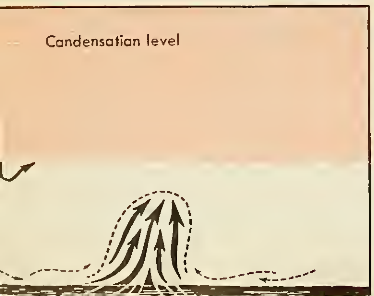
When one section of land is heated more than adjacent areas, warm air rises to form this type of cloud, the fair-weather woolpack cloud so common in our summer skies. In the left-hand part of the model a young cumulus cloud is forming through the action of one of these "pulsating thermals." To the right is a mature cumulus, its base flat, its upper surface domed, lumpy, cauliflower-like. The column at right shows how temperature affects the visibility of water vapor under different conditions of humidity.

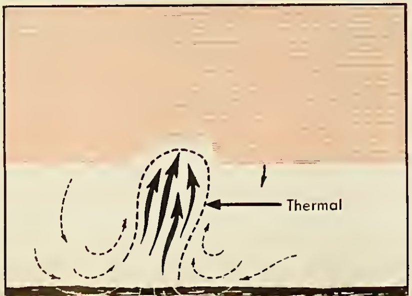
Between the rising columns of air that form cumulus clouds there are downdrafts, particularly where woodlands retard the heating of the atmosphere. The adjacent up and down currents make their presence known to flyers as "bumpy air." Soarers take advantage of updrafts beneath cumulus clouds to help keep their motorless planes aloft. Above these clouds there is a cool layer.

▼ THE WARM COLUMN of air balloons upward, expanding and cooling as it rises. The ascending column of air is called a thermal

▼ AT 4000 FEET its temperature has reached the dewpoint, which is where its moisture begins to condense as a visible cloud

▼ THE FLAT BOTTOM of the mature cumulus marks the level of condensation—55° F. in this example, or 22° colder than on the ground





THE COLD FRONT

Model designed by Eric Sloane

All weather is caused by new air taking the place of old. You may think that you are breathing yesterday's air made warmer or colder, but the chances are that you are breathing new air from another region. Possibly it has come all the way from the Arctic or the Tropics.

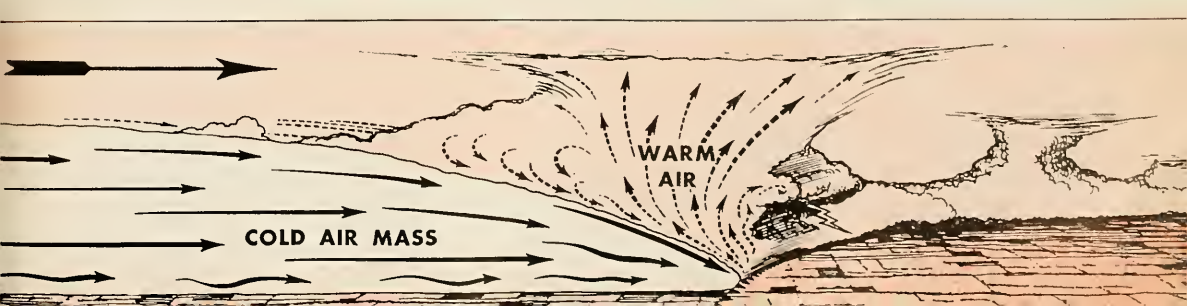
These invasions of foreign masses of air often produce large-scale changes in the weather. At times they may seem annoying, but it must be remembered that without clouds, rain, and atmosphere in general, we would not even exist.

This model shows the invasion of a Cold Front. Like the front of a great plow, it kicks up a disturbance and creates the atmospheric equivalent of whitecaps and breakers. Thus, a stormy area usually exists along the front part of one of these invading air masses.

A cold front can cause either rain or snow, depending upon the temperature. The model shows what happens when a cold front breaks a hot spell in summer. At ground level, the disturbance along the leading edge is felt in the form of violent gusts and squalls. Indeed, only heavy drops or hail can ordinarily fall through the strong updrafts along the forward edge of a cold front. The cloud formation capping a cold front is called an anvil top because of its shape.

Four other models depicting The Warm Front, The World of Clouds, The Atmosphere, and The Formation of Rain complete the new Willetts Memorial Exhibit on Weather Science in The Hayden Planetarium. By means of illuminated labels and various mechanical effects they illustrate the primary principles of aerology that are interesting both to flyers and to the average person who wants to know more about the weather.

▼ THE LEADING EDGE of the cold front sweeps under the existing warmer and lighter air, forcing it upward and causing winds and heavy showers



Chiquito- A GUANO BAT

Bat, Bat, come under my hat
And I'll give you a side of Bacon.

A Mexican free-tailed bat becomes a non-paying boarder in an unconventional environment, where his peculiar behavior makes him an interesting subject for observation

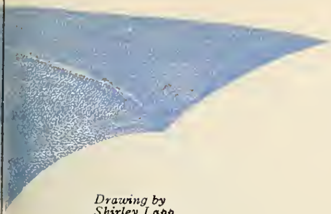
By Mary Louise Perry

THIS nursery rhyme sprang from the deep-rooted European tradition that bats like fat and that they gnawed hams and bacon hung to cure in old-fashioned chimneys or in well aired rooms. Zoologists have exonerated the bats and think that rats were the culprits, arguing that the bats unwittingly chose the storage larders as roosts. But to judge from his tastes, Chiquíto believes in enjoying the luxuries of our civilization about as much as the rats. He is quite the epicure, willing to feast on raw liver, bacon and eggs, hamburger, milk and various cheeses, melon, and mince pie, in addition to a more chiropteran menu of meal worms and dried insects.

Sometimes he prefers to forsake the twilight shift to beg for a midday snack and human companionship. Evenings Chiquíto often listens to music on the radio and record player, one of his favorite selections being Wagner's "Fledermaus Overture." He accepts the heat of the human hand as a substitute for the warm proximity of his former colonists and clings obstinately to this heating unit when attempts are made to return him to the isolation of his roost box. Chiquíto pays for his board and lodging by disclosing, despite his assumed sophistication, a few secrets about his innate behavior and by proving that at least one member of his species is tamable.

On April 1, 1946, Chiquíto was captured on the floor of a hardware store in Oakland, Alameda County, California. He proved to be an adult male Mexican free-tailed bat, or guano bat (*Tadarida mexicana*), measuring three and one-half inches from nose to tail tip and weighing ten grams (about 1/3 ounce). He was in good health, except for being lame. The left wrist was stiff and swollen, causing the wing to remain partly unfolded; and the right thumb was swollen, although the claw still functioned as a hook for climbing. If the injuries were old, the bat probably escaped starvation because of remaining dormant during the winter months. He was brought to my Berkeley home and given a waste-basket of wire mesh for a cage. In deference to his being a Mexican free-tailed bat, he was given the Spanish name of "Chiquíto," meaning "little (one)."

I observed the bat's rate of breathing to vary from about 40 to 215 respirations per minute. The rate approximates 78 respirations per minute when Chiquíto has been



Drawing by
Shirley Lapp

asleep and is just awakening and 215 per minute when he is fully awake and has been running around the table-top eating. The lowest rate was observed on the evening of the date of capture. Chiquíto's body temperature varies with his respiration rate. He is noticeably cold to the touch when sleeping in his cage and warm when active.

Chiquíto is one of limited interests—namely, food and a warm hand to hold him. Although at first distrustful of my hand, he neither scolded nor bit when held. Within five weeks he was tame and utterly fearless, and he would voluntarily crawl into my hand whenever I placed it near him.

His tastes

Live meal worms—the larvae of the grain beetle, *Tenebrio molitor* —form the bulk of his diet. Although he will try anything, I thought it better for his health to cater to his insectivorous preference. He accepted meal worms and water from the start, eating on the table-top, in my hand, or hanging upside down in his cage. He snatches meal worms from the feeding forceps and chews them thoroughly with a noisy, vicious greed. The chitinous exoskeleton of a meal worm not recently molted is tough and horny; yet Chiquíto, during his first six weeks of captivity, contended that meal worms were good to the last milligram. Thereafter, he left the shell uneaten.

In the first feeding he became accustomed to the small forceps that held the offerings of meal worms. When he sensed the presence of the forceps, he would give them a terrible bite. If I scraped the table-top with them when he was one foot away, he would scramble up for another meal worm. In three weeks he began to beg for food by rearing and rapping his wrists rapidly on the table as he followed

▼ CHIQUÍTO POSES for the photographer. His tail is distinct from the tail membrane, a characteristic of the Molossidae, a family of velvet-furred, free-tailed bats. Note the vertical grooves or wrinkles in the upper lip, characteristic of *Tadarida*

By Berkeley Commercial Photo Co.

the forceps about and also by cuffing vertically with one or the other wrist. He is always excited when fed meal worms. His nightly allotment consumed, he spends about ten minutes searching and begging for more. Then, discouraged, he crawls into my hand and quiets down.

When it comes to locating meal worms by his own senses, Chiquíto is "as blind as a bat." Meal worms can crawl circles around him and all over him with impunity. But woe unto any meal worm that touches his mouth, for Chiquíto is then stimulated to bite. Seven weeks after the date of capture, I tried teaching him to eat from a jar lid two and one-half inches in diameter and a half an inch high. I filled the lid with meal worms and suspended Chiquíto over the dish on a finger until he grabbed a meal worm that touched his lips. Then I set him down beside the dish. If he had not fed himself within three minutes after finishing the meal worm, I repeated the procedure. He learned on the ninth trial to recognize the jar lid as his feed dish and never forgot this lesson. His ability to learn and remember plus the tactile capacity of his lips enabled him to feed from the dish. He simply pushed his snout around the lid like a vacuum cleaner and grabbed the meal worm that touched his lips. He was able to find the jar lid himself when it was placed on a card table 30 inches square. Often meal worms prolong the bitter end of their fate by clinging desperately to the bat's face with six legs and perhaps a few mouthparts. Chiquíto then curls up and uses his tail membrane as a support while he obtains a better grip on the meal worm.

Sleepy breakfaster

Chiquíto is quite willing to be roused and fed meal worms at any time during the day, but he usually awakens gradually, not reaching full consciousness until about five meal worms have been eaten. Ordinarily, he is fed one meal in the evening, when he is more active.

Chiquíto, with almost no exercise, fares very well on an average nightly ration of twenty full-grown meal worms totaling in weight between two and three grams, but he usually discards the chitinous exoskeletons which form about 20 per cent of the weight. At one sitting he once ate all of the forty-eight full-grown meal worms I had on hand, a total of almost five grams, or half his weight, even though he left the exoskeletons of the last fourteen. One time, when supplied with twenty grams of meal worms, I let him eat until satiated. He ate the juice of forty-five meal worms, or 3.9 grams—about forty per cent of his body weight.

On his fifth night in captivity, I tried feeding him prepared turtle food containing ant eggs and dried water boatmen of the family Corixidae. On the initial feeding he rejected the moistened bits offered with the forceps unless they were slyly dropped into his mouth while he was chewing a meal worm. He gradually acquired a taste for them and a week later ate forty-two water boatmen along with six meal worms. His appetite for subsequent offerings was capricious; at times, he would snatch one after another from the feeding forceps and cast them away with a vigorous toss of his head. These dried insects provide bulk but probably little nourishment.

On December 4, 1946, Chiquíto immediately accepted a new addition to his bill of fare—a crumbly mixture of cottage cheese, "Pablum" cereal moistened with water or evaporated milk, and moistened water boatmen. He relishes cottage cheese as much as meal worms. Chiquíto eats the above formula from his feed dish, chewing the food thoroughly. He will eat a teaspoonful at a meal, this measure being my idea of sufficiency. He stuffs his face with each mouthful and eats while standing in the dish on his hind legs and on the wrists of his folded wings.

Chiquíto drinks water by dipping his muzzle into it and raising his head in a birdlike fashion to swallow. He appears to chew each mouthful before swallowing. He locates water in a jar lid by accidentally falling into it and drinks a variable amount, at times filling up on a teaspoonful, at other times taking but a sip.

A dandy

Chiquíto has always been very particular about his appearance and grooms himself all over with his feet, which are efficient, animated combs. The five toes are all directed the same way and are tipped with strong, curved claws. He even combs the membranes of his wings and sides, even his ears, and the stubble of bristles on his face. Chiquíto cleans the teeth of the combs with his mouth and washes his face and inside his ears by rubbing the wet sole of a foot over the surface. Membranes of the body, tail, and wing are mouthed and nuzzled. He stretches the uninjured wing often during grooming as if to test it. I have observed with other uninjured captive guano bats that grooming and wing-stretching preceded flight. Chiquíto grooms himself after every meal while hanging upside down in the palm of my hand. When finished, he pulls down the shades—his ears—and takes a nap.

Like other captive guano bats I have observed, Chiquíto has quite a sizable vocabulary of sounds that are within man's hearing range, which disclose his emotions and function as a part of his sonar mechanism for the perception of his environment. In flight, guano bats continuously utter clicking notes, audible to the human ear, which by deflection, enable them to perceive obstacles in their course. This note may be imitated fairly well by rapidly snapping the tips of two fingernails. I watched Chiquíto utter this note before he attempted to fly off my hand. This non-vocal, stacatto note is made with the snout bent backward, exposing the gums and vibrating up and down with the clicks. No intranasal valves could be found upon dissection of one of this species. Perhaps each elevation of the snout shuts off the air passage in the same manner that looping a garden hose stops the flow of water. Thus each click would result from the

▲ **Chiquíto's face features a mustache and an ample supply of bristles**

sudden opening of the nasal passage as the snout was lowered to the normal position and from the corresponding forceful escape of a jet of restrained air.

On his first night in captivity, Chiquíto crawled about his cage uttering occasional non-vocal, explosive, legato nasal notes through ever-open nostrils while twitching his nose to one side or the other. This note is also made by releasing through the nose a vigorous jet of air which has been restrained by some means—perhaps by pinching off the nasal passage as the snout is bent sideways, or by raising the soft palate. This note appears to be a part of his sonar mechanism for orientation, for he utters it when hunting for the feeding forceps and when climbing about. Possibly he also manifests contentment with this note, as he utters it when resting in my hand or grooming. When Chiquíto became tame, he revealed a curious habit when held: when spoken to he would answer by grinding his jaws sideways and smacking his lips. He never withdraws from me while grinding if I hold him close to my face, talk to him, and stroke his back. This response is often accented by one or two explosive nasal notes and may be an expression of contentment.

A birdlike chirp

Chiquíto's call note is a birdlike chirp uttered with the mouth open and the snout curled up. The chirp consists of a series of high, liquid, staccatto notes, which are made with clicks; it descends slightly in pitch. He often changes the tone quality of the liquid chirp so that it sounds more like a dry "chitter." Chiquíto

By Berkeley Commercial Photo Co.

▲ Supporting the feeding forceps with his wrist and thumb, Chiquíto gets a firm grip on a full-grown meal worm, his favorite dish. At a record sitting, he consumed 48 of them

chirped commonly—sometimes in the day—during his first three months in captivity, when he lived in a wire waste-basket. He was probably disturbed by his exposed position and by the light that came through the wire mesh of his cage. If I allowed him to crawl into my hand when he was chirping restlessly, he would immediately utter a couple of explosive nasal notes and settle down for a snooze. In July, 1946, I moved him to a large pasteboard carton covered with quarter-inch wire screening and furnished with blocks of wood for climbing. Since moving, he has seldom chirped unless spoken to, although he is equally active. Perhaps by then he had grown accustomed to being a solitary bat and no longer felt the need for call notes.

Akin to the chirp notes but of a slower tempo are those uttered during urination, the number of notes sometimes corresponding to the drops of urine. These notes are modulated to form a delicate, scarcely audible tinkle. More often than not, Chiquíto, if hanging, reverses his upside-down position to urinate and defecate.

Chiquíto has an intimidation note which I define as an explosive squeak. It is a vigorous, high, sustained squeak on one pitch, uttered with a glottal click and with the mouth wide open. Three notes are often uttered at a time, the first one having longer duration than the other two. During his early feedings, he uttered this commonly when snatching one of the moistened water boatmen from the feeding forceps. Occasionally he did so when snatching a very large meal worm from the forceps; this was a habit of other guano bats I observed. I wonder if my feeding the bats with the forceps evoked a begging note, possibly uttered by young bats when their parent fed them.

A mouselike squeak without a glottal click is Chiquíto's fear or alarm note. He has uttered this when his body was suddenly restrained or hit with some object. When knocking on walls and tearing down wall boards to expose a colony of guano bats in a building, I noted that the whole colony reacted by a choral squeaking similar to the reputed confusion chorus of an alarmed flock of bush tits (*Psaltriparus minimus*).

Displeasure

Anger and pain are expressed in a low-pitched, blasphemous nasal chatter. I incurred this note only once—when I operated on Chiquíto's injured wrist without the use of anasthesia. He scolded when I restrained him in an improvised strait-jacket and also during the operation when I excised from his wrist what I supposed to be a foreign object but which turned out to be a deep, black scab. I heard occasional, intracolonial squabbling among the aforementioned bats when I stood quietly by their roost before attempting to expose and capture them. Chiquíto indicated mild displeasure by uttering three loose, breathy, explosive, nasal notes while withdrawing and turning his head to look at the source of the annoyance.

Bats of the family Molossidae are better adapted for terrestrial locomotion than most other species. With the exception of a related New Zealand species, Molossine bats alone have a functional fibula. The broad hind foot of the Molossines is entirely free from the body membrane—the plagiopatagium—so that the latter can be completely folded, thus giving more freedom of movement to the forearm. Folded wings serve as front legs, the wrists substituting for fore-feet. Chiquíto is very agile on horizontal surfaces, running rapidly forward and backward, with the tail and body held high. For terrestrial locomotion, he bends in the long heel spurs, or calcars, thus collapsing the uropatagium. The latter loosely envelops the tail, and so when he hoists the tail, the membrane is pulled farther toward the body. For flight, the heel spurs are probably bowed outward, and the uropatagium is spread out toward the tip of the tail.

Chiquíto was an expert climber until he lost the claw on the injured right thumb seven months after his date of capture. This mishap greatly handicapped him. Before the loss, if unable to start up a vertical surface head first, he would often turn around and reach up with the feet to obtain a hold; if successful, he would right himself and continue head first. It has not occurred to him to replace all forward progression on vertical surfaces with reverse gear; he still fumbles along, trying to use the missing thumb claw. Chiquíto often sits down when eating. Because of his injured left wrist, he can only break a fall in attempted flight by flapping both wings, and he can take off from horizontal surfaces, although in this instance his handicap limits his altitude to six inches. I observed uninjured guano bats, as well as other species of bats, fly off horizontal surfaces.

The man who came to dinner

Chiquíto's original status at my home was that of a patient under observation, to be released when well. I soon learned that his wing injury was permanent and, further, that the life span of a bat approximates twelve years. If Chiquíto has thrived on nine months of captivity, he is likely, in due time, to ripen into a chiropteran Methuselah. However, judging from the wear on his teeth, I suspect that Chiquíto is not a young bat. For the past month, half of his mealworm ration has been replaced satisfactorily with the mixture of cottage cheese, Pablum, and turtle food. Anything reducing the minimum of live insects required simplifies the care of such a voracious little guest.

Chiquíto has contributed information on his innate behavior concerning food capacity, grooming, voice, sensory capacity, learning, sleeping, locomotion, and tamability. His domestication has given observers much amusement. Although Chiquíto's antics are becoming a bit threadbare, his warm response to "the good provider" is still sufficiently touching to guarantee him a free meal ticket and a place to hang his toenails.

▼ While eating from a jar lid, Chiquíto often sits down beside the dinner plate

Photo by Willis Routson

Elephant Trees

Pale yellow bark, a trunk like the leg of an elephant, and sap the color of blood startle the occasional traveler who invades their forbidding desert homeland

By KEN STOTT, JR.
Curator of Mammals, San Diego Zoo

Photos by G. E. KIRKPATRICK

IN the southeast corner of the road map of California you will see "ELEPHANT TREE AREA," printed in the conspicuous red type used to indicate features of unusual interest; and almost any native of southern California can point out the very locality and give you explicit directions as to how to get there. But if you seek more detailed information about the trees, you will probably discover that the authority with whom you speak has never seen them, or even talked with anyone who has.

The elephant trees are not easy to reach. In California they are found only in a very limited area, which lies ten miles from the nearest surfaced highway. You have to drive for six miles over half-obliterated wheel tracks in the shifting desert sands and, after the road dwindles into nothing, continue by the most primitive of all methods of transportation.

Each footstep under the intense and merciless sun of the Colorado Desert is little short of torture, and the yielding sandy soil doubles the effort required. Burning rocks send their heat straight through the soles of your boots, and cholla cacti leave stinging, barbed needles in your legs as you brush past. Cat's-claw (acacia) and smoke trees dig long garnet-colored furrows in your arms, and the calls of the cactus wrens, increasing in volume, become a monotonous, droning roar, beating against your eardrums.

THE ELEPHANT TREE grows in an inaccessible section of southern California and is not seen by many persons

➤THE LIMBS TAPER RAPIDLY. Terminal branches are cherry red, with sparse clusters of pinnate leaves

Finally the thought of retreat bursts full-blown from your subconscious, and you wonder whatever could have prompted you to undertake so rash a project. Before turning tail, you take one last look at the sunbaked waste, and suddenly—there they are, the elephant trees.

The elephant tree is well named, for its trunk and lower branches do suggest the squat, stubby legs of an elephant, and at first glance the texture of the bark reminds one of an elephant's skin. The trunk is short, sometimes almost nonexistent. The branches, quite thick near the trunk, diminish rapidly toward the tips, where each bursts into a spidery spray of twigs. A branch six feet from base to tip is a long one. Most of the trees reach a height of only four or five feet, and few climb to ten; but in Arizona they are said to reach 20 feet.

The bark of the trunk and lower limbs is tissue-paper thin, scaly, and pale yellow. In contrast, the upper branches and twigs are a cheerful cherry red.

To the Indian the elephant tree is known by two interesting names, one of which, "Bleeding Tree," is most appropriate. Whenever the bark of the tree is in any way injured, sap collects rapidly to run from the wound in a viscid stream just the color and consistency of venous blood. The other Indian name, "Medicine Tree," refers to certain questionable therapeutic properties that are ascribed to it. The scientific name is *Bursera microphylla* A. Gray.

In addition to their limited range in California, elephant trees are found also in southern Arizona, in Sonora, and Lower California. But nowhere can they be observed without effort. In spite of their uniqueness, they are destined to be well-known only by reputation until such time as civilization pushes a macadamized tentacle in their direction.

➤THE BARK is pale yellow and tissue-paper thin. When injured, it exudes sap as red as elephant's blood

FOREST OF STANDING STONES Continued from page 173

upon a high spire on one of the canyon sides. His description was so vivid that I decided to go to see it.

A horse trail led to the canyon below, but it was necessary to climb a very steep slope to reach the best vantage point. We arrived at the spot, tied our horses to some oak trees, and began the ascent. The canyon side inclined upwards at an angle of about 80 degrees, and, in the somewhat rarified atmosphere of well over a mile above sea level, we found the going a bit breath-taking, but the effort was well worth while. The formation was simply incredible. It should be called the "Winged Victory." Before us a huge rock, supported by a very small base, stretched out from the central column like a gigantic piece of heavy fabric blowing outward in a high gale. It was the most graceful flying mass of rock we had ever seen.

Not far from the Winged Victory is Echo Canyon, where one's voice comes back many times from the deep recesses of the tree-covered precipices. In this secluded spot there are many massive, lichen-encrusted columns that stand apart and cause one to suffer from a crick in the neck, owing to the constant temptation to look overhead. Weathering has carved deep crevices in these rocks, where swallows sometimes nest. One especially large, trunklike pillar was creased like the folds in an elephant's hide, and indeed it suggested an elephant in general outline. A small, fern-banked brook coursed the canyon floor in the heavy shadows cast by tall pines. It is a quiet, strikingly beautiful section of the Monument, where it seemed somehow out of order to shout just for the dubious satisfaction of hearing one's voice repeated.

Cooke said that people were usually very curious regarding the origin of the columns and that he had to answer endless questions as to "how it all happened." Through the years many explanations have been offered for the castellated turrets and battlements of the forest of rocks. Some of the explanations have been pure nonsense. One theory said that the standing pinnacles were the result of some astronomical cataclysm. It was thought that a meteor or other "space-body" foreign to the earth had exploded and driven the rocks into the mountains, as one would throw knives into a soft board. Just how the stone shafts had remained upright or unshattered after being projected with such great momentum was not explained.

Scientists have discovered basic facts about this weird landscape which do not agree with the legends that have been current. While plausible answers are by no means simple, they have nothing to do with any miraculous occurrence. The rocks that were destined to give this landscape its curious appearance came into being as a result of terrific heat, volcanic heat that forced materials up from beneath the earth's surface in blinding, flaming, molten masses. Volcanic lava once flowed with varying speed over an area that was comparatively level, spilling over the surface and building what was to be a completely new landscape. The semi-liquid substances cooled and hardened, layer upon layer. This earth-building process did not occur all at one time but extended over periods of thousands of years. Some of the lava flows were exceptionally thick and spread outward in broad, wide layers across the land, while other eruptions were of short duration and formed thin shields of new rock, often contrasting in color with the surfaces upon which they flowed. As the lava of different thicknesses cooled, large cracks appeared at various spots, and many of these were to form future canyons.

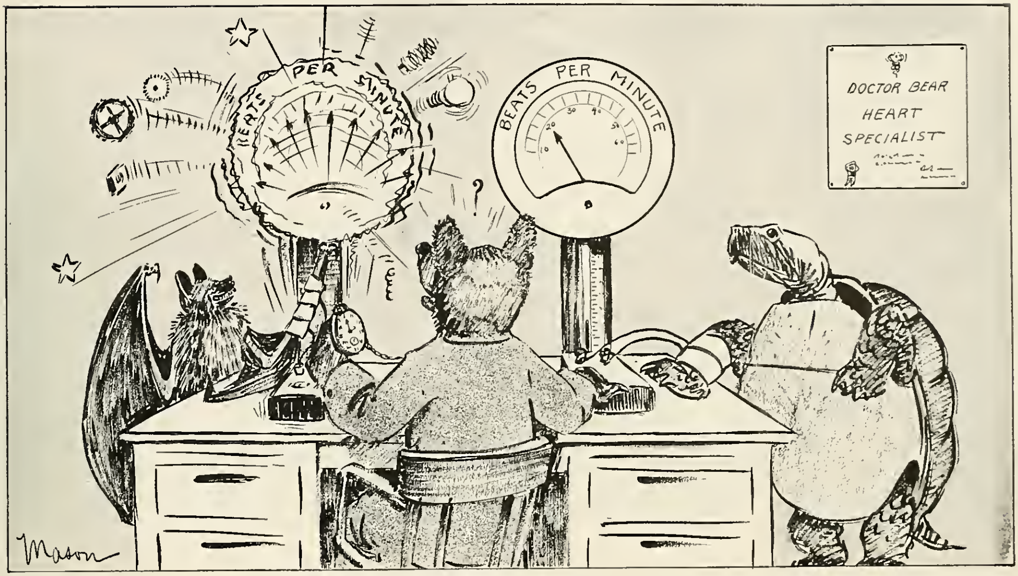
When eruptive activity ceased, movements of the earth's crust forced the masses of rock upward until mountains appeared on the horizon, somewhat as they are today, only vastly higher. Then the powerful forces of erosion, of slow but certain destruction by wind, water, and frost, began to work upon the exposed and tilted rock surfaces. The disintegration of stone fragments produced soil, which offered foothold and food for plant life. Root systems searched out seams in the rocks and ultimately aided in the general disintegration. Most destructive of all were the streams of running water, carrying small particles of hard material, wearing away the rocky structures, grinding and sculpturing the mountains. Canyons slowly took shape and deepened. They are still becoming deeper and wider today, as the work of erosion goes ever forward.

As the land was gradually worn down, the old cracks became larger and new ones were created. Harder material weathered less rapidly than softer, and as a result, standing rocks began to appear. Millions of individual fissures were eroded until resisting rock columns stood higher above the receding surface. The process of pillar-forming still goes on. Old columns topple and fall; new ones are in the making. A single lifetime is not enough to witness much change, but change there is, constant and unrelenting.

Persons interested in earth processes will find much to examine here. At one point, road crews uncovered the unmistakable remains of an ancient lake bed—softer rock which was once the bottom of some ancient body of water, formed when a flow of lava blocked and dammed a stream channel. As Cooke says, "People are anxious to be told how these things happened. Anyone who thinks they aren't, underestimates their intelligence and fails to do a good job of guiding!"

There are endless surprises in the Chiricahuas, and the visitor to the great American Southwest will do well to head his automobile toward this corner of Arizona to view the public domain for himself. Rarely in this life can we gaze upon a scene that causes us to lose ourselves in the realm of fantasy and imagination. The Chiricahua National Monument is an almost unreal world, where mundane and troublesome things will be forgotten in a sweeping realization of the vast and timeless agencies that have shaped the earth.

HEARTBEATS



By JOHN ERIC HILL

Drawing by
G. FREDERICK MASON

THE heart of a warm-blooded vertebrate is an extraordinary, hard-working pump, functioning at a level of activity unequaled by any mechanical device. The wonder is that any heart beats as long as it does. The average person's heart beats about 72 times a minute, 4300 times an hour, 103,700 times a day, 37,800,000 times a year, and more than 2,500,000,000 times in a lifetime of 70 years. While you are reading this, each minute your heart pumps about 10 quarts of blood, doing work at a rate of about 200 foot-pounds per minute. If you are in good physical condition and run quickly up a flight of stairs, your heart may work three times as hard.

The pulse rate varies greatly in different mammals. When a mouse is resting, its pulse is at about 700, ten times as fast as man's. A cat's heart beats about 120 per minute, a dog's 85 to 125, while a horse's or cow's heart beats only 35 to 45 times a minute. The heart beats more rapidly in a young mammal than in an older one. Even in adults of the same species a small individual has a faster heartbeat than a large individual. A toy terrier, for instance, may have a pulse more than half again as fast as a St. Bernard's. From this, the conclusion may be drawn that the heart rate in mammals generally decreases with an increase in size.

This is because a small mammal lives at a high speed. A mouse's metabolic rate, measured by its consumption of oxygen per unit of weight, is about 20 times that of a man. A small dog may need, for its size, twice as much food as a large dog. The rapid loss of heat by radiation from a small body requires the "fires" of life to blaze high continually.

Some of the extra circulation necessitated by these factors may be provided, in part, by relatively large hearts. The normal human heart is about one two-hundredth of the weight of the body. The heart of a small bat may be relatively three times as large. Mammals that lead a very active life, as diggers or swift runners, may have disproportionately large hearts. That of a deer, a badger, a wolf, or a weasel may be one one-hundredth of its weight. In contrast, hearts of sedentary domestic animals or secretive rodents are only about one-half or one-third as large. A jack rabbit's heart is almost three times as big as that of a domestic rabbit weighing the same amount; and when it is resting, it pumps about the same amount of blood but at a rate only one-third as fast. When the jack rabbit must run for its life, its heart can speed up and pump four times as much as while resting.

There is a relation between the speed of the heartbeat and the life span of an animal. The mouse, with a pulse rate of 700, lives only about two years; its heart performs a total of some 700,000,000 beats. A cat or dog lives through about the same number of heartbeats, and an elephant may live through 1,000,000,000. Some of our smaller bats, with the fastest heartbeat of any mammal, live eight years or more. If they hibernate, as they do in the north, the heartbeat drops from 700 or more to only 30 a minute. Allowing for this decrease in activity, such bats have a heart-life of some 2,000,000,000 beats.

▲ A MALE FIDDLER CRAB hiding behind his over-sized claw

Just Fiddlers

▼ YOU WILL SEE THEM by the thousand, but they nimbly scurry out of your way

By HUGO H. SCHRODER

Photographs by the author

SOME people dismiss the masses of small crabs visible at low tide in many places along the coast as "just fiddlers." Others think of them only as good bait when they want to go fishing. Still others, like myself, find these fiddler crabs, scurrying along the sands by the tens of thousands, very interesting to watch.

Wherever fiddler crabs congregate, you will notice that many are equipped with one extra large claw, while others have both claws of a normal size. The former are the males, and you will see them raise these claws frequently as they move about over the feeding grounds. Perhaps they are attracted by a near-by female and are showing their interest by waving their claws. Maybe they are only greeting an old pal. But whatever the gesture signifies, it is possible to see waving claws everywhere.

I have seen thousands of fiddlers covering wide expanses of tidal flats—masses of crabs so numerous that it seemed impossible for them to get out of one's way. Yet no matter how much I walked through the feeding grounds, every crab managed to scurry to safety by putting on a little extra speed.

The huge claw of the male fiddler may be extremely useful for defense, but it is a handicap at times. Female fiddlers pick up tiny particles of food and carry them to their mouths with both claws; but the male, like a man with a stiff elbow, can't do this with his large claw. It may be either his right or his left.

Fiddlers are preyed upon by numerous enemies, feathered, furred, and others. Fishermen gather them by the bucketful. Yet they are always found in great abundance—except at times when some bait is wanted in a hurry. Perhaps the reason they are scarce at such times is that the search is made during the wrong time of day, when they are snugly hidden in their burrows.

SPIDERS THAT LASSO THEIR PREY

Continued from page 158

spiders. Following the first true molt, most spiders break out of the egg sac, and no doubt that happens often with *Mastophora.* However, very frequently another molt is undergone within the egg sac before the males walk out of the sac—perfect adults as far as we are able to judge on the basis of external appearance. Naturally, we have no way of knowing without resorting to histological means whether a corresponding maturity is present within the creature, but from analogy with most other spiders, we can predict that this is probably so.

From an egg sac of *Mastophora cornigera,* sent to me from California through the generosity of Mr. Hutchinson, there issued on September 1, 147 spiderlings, of which 72 were baby females and 75 mature males. The young sisters that desert the egg sac in company with their tiny brothers must undergo several molts before they attain maturity. The question that immediately arises is whether there are in the vicinity contemporary, mature females to be matched with the precocious males. If emergence occurs in the fall, which in California may be a more frequent occurrence than is generally supposed, many females may still be available, and perhaps even the parent female may be visited by one of her precocious sons. Such a situation is illustrated in one of the photographs in this article that shows graphically how different in size are the adult males and female Bolas Spiders. On the other hand, it is probable that the new generation emerges oftener in the spring, and that the tiny males must then live through the long months until the female spiderlings attain adulthood.

Rarely within the limits of one small group of creatures do we find such an array of startling peculiarities and amazing habits. Such sensational performers deserve fuller study from biologists lucky enough to come in contact with them.

Can You NAME The Young?

By Mabel Irene Huggins

Would you call an adult mud puppy a mud dog, or a young prairie dog a prairie-pup? Is a little sea horse a sea-colt? How well do you know the names of young animals and birds?

Write the right number in each of the blank spaces in each of the four groups of animals below. Then turn to page 192 to see how many you got right.

A

ADULTS	YOUNG
1 Bighorn	( ) *Eaglet*
2 Camel	( ) *Elver*
3 Eagle	( ) *Cub*
4 Eel	( ) *Lamb*
5 Fox	( ) *Colt or foal*

B

ADULTS	YOUNG
6 Fish	( ) *Fry*
7 Goose	( ) *Leveret*
8 Hare	( ) *Joey*
9 Kangaroo	( ) *Kid*
10 Mountain Goat	( ) *Gosling*

C

ADULTS	YOUNG
11 Muskrat	( ) *Squab*
12 Owl	( ) *Spat*
13 Oyster	( ) *Tadpole*
14 Pigeon	( ) *Kit*
15 Toad	( ) *Owlet*

D

ADULTS	YOUNG
16 Seal	( ) *Poult*
17 Swan	( ) *Fawn*
18 Turkey	( ) *Cygnet*
19 Virginia Deer	( ) *Calf*
20 Whale	( ) *Pup*

Turn to page 192 to see how many you got right

LETTERS

Continued from page 145

Mr. Kastner, I am constrained to say that the story he read is unadulterated "bunk." I might be asked how I can prove such an uncompromising opinion and statement. My answer is that it is unnecessary to do so, because the burden of proof is entirely on those who make or credit the yarn.

It hardly seems necessary to go into the physiology of this matter. A man might well be swallowed by a sperm whale; indeed, since sperm whales have been known to swallow West Indian seals, it is quite likely that they have also engulfed sailors during some of the many fracases between the whales and Yankee whaleboats manned by six whalemen. Plenty of such individuals have disappeared after the wrecking of their frail craft, and it is not to be assumed that they all merely "sank."

If and when a man was swallowed by a whale, without being killed beforehand, he would remain alive just about as long as he would if he were held under water.

The wording of the tale, however, contains a number of time-honored clichés, which tend to indicate that it may all have originated as a hoax. The writer of the magazine story does not quote his source. He was merely "browsing through some old records;" thus he encountered "well-authenticated" facts. When the victim was being swallowed "he was engulfed in darkness" (naturally enough); the heat of the whale "drained all the strength from his body" (the body temperature of a living whale is perhaps 1° F. higher than our own); the man's skin was "bleached as white as snow." All the foregoing have an ancient and familiar ring.

The *Star of the East* was apparently not an American whaleship. I have not troubled to hunt up the published records to see whether she was British and whether she was actually cruising near the Falkland Islands in February, 1891. My reason is a suspicion that the *Star of the East* may well be wholly apocryphal, although, of course, I would not categorically assert that.

Reading by Firefly

Sirs:

In the Natural History for November, 1946, there was an interesting article by Frank W. Lane, "Strange Uses for Animals." In this article Mr. Lane mentions the employment of fireflies confined in a bottle in lieu of a flashlight.

This letter is not intended as a criticism of Mr. Lane's excellent description; he appears to have taken the material from known authorities.

It does seem, however, that a false impression is conveyed. I have been informed by travelers in the tropics that these large, light-giving beetles are not bright enough to read by unless their bodies are gently pressed against the paper or other objects which one desires to inspect. These travelers affirm that any reasonable number of beetles in a bottle or jar would not furnish enough light to read anything, but that one beetle alone is sufficient if handled as above.

Konrad Guenther, in his book, *A Naturalist in Brazil,* indicates that a beetle kept in a bottle for the purpose of telling time at night had to be shaken in order to get enough illumination. Capt. Mayne Reid states that fifty cucujos in a jar would not give very much light but that one treated as described above made reading easy.

There must be some one on your staff who could make an authoritative statement on this question. I hope you will do so in "Letters" in some early issue.

I always enjoy each issue of NATURAL HISTORY and keep them on file for reference.

PHILIP LEROY WEEKS.

Vancouver, Wash.

° ° °

The following comments are offered by Dr. Mont A. Cazier, Chairman of the Department of Insects and Spiders at the American Museum of Natural History.

The beetles referred to by Mr. Lane in the November issue of NATURAL HISTORY are undoubtedly the remarkable members of the family Elateridae, belonging to the genus *Pyrophorus,* and more commonly known as "fire beetles." The particular insect referred to was probably the best known species, the cucubano (*Pyrophorus luminosa*) of the West Indies, which emits a brilliant greenish light from a pale spot on either side of the base of the pronotum and a reddish light from the venter of the abdomen. In addition to the authorities cited by Mr. Lane, we have received reliable reports from associates of this department corroborating these observations and further stating that a newspaper can be read with the aid of one to two or three of these beetles held about one-half inch from the paper. The insects have to be agitated occasionally to keep their lights going. The West Indian natives attach them to their feet and hands, but it is unlikely that they function as effectively as flashlights, at least as we know them. However, they do aid the natives in walking through dark places and thus serve as flashlights, as stated by Mr. Lane, although much less effectively than the man-made dry cell flashlight. These insects emit a brighter light and at a more constant rate than do the common fireflies referred to by Mr. Weeks.

° ° °

Separate Covers

SIRS:

It has been my intention to suggest some way of saving the very beautiful cover pictures of NATURAL HISTORY Magazine. Would it be possible to reproduce them in color on postcards?

Though I pass all magazines along to libraries, friends, schools, etc., I find myself holding back on NATURAL HISTORY because of the rare loveliness and timeliness of its covers. They would make such a pleasing addition to any birthday letter, greeting to the sick, etc.

(MRS.) STELLA HORN GUTHRIE.

Edgeworth, Sewickley,
Pennsylvania

A few extra covers of NATURAL HISTORY are printed separately each month in the original size, and these can be obtained at 5¢ each, plus 5¢ for postage on any number up to ten, from Mrs. Marion Carr, The American Museum of Natural History, 79th Street at Central Park West, New York 24, N. Y. Various postcard sets (other subjects) are also available.—ED.

° ° °

SIRS:

I am enclosing a check for $10.00 with which I wish to renew my Annual Membership for another year beginning February 1. I am doing this a little ahead of time as I do not want to take any chances of missing a single copy of your splendid publication, NATURAL HISTORY, which I enjoy thoroughly and always look forward to reading . . .

JANE E. WILLIAMS.

White Plains, N. Y.

° ° °

Correction

In the Cover Script for the January issue, it has been discovered that through a slip of the pen *"Pereskia"* was written instead of *"Rhipsalis,"* which should have been named as the only member of the cactus family native to the Old World.

We appreciate the astuteness of several of our readers in calling our attention to this.

Some botanists believe that these Old World plants may have been carried as seeds from the New World by migrating birds, as the species appear to be the same as those in tropical America.

—H. K. S.

YOUR NEW BOOKS

Continued from page 151

approaches to successful painting, he can profit from the author's sound logic. Also the patron of art or one just interested in how an artist's paintings "get that way" will find it delightful and interesting.

Some may consider this book too academic, but on such a subject one cannot go back too often to the basic principles that help to keep one on the right path. Even though the artist may become successful by deviating from the realistic into highly stylized work, he still should not neglect the fundamental principles.

Those who read this book will soon be impressed with Mr. Wilwerding's profound understanding of his subject, so richly illustrated with many sketches and paintings to enforce his points. It is refreshing, indeed, to have from the pen of such a qualified artist the "know how" of his art, which, in the reviewer's opinion, is a far cry from the ultra modernism which all too often reeks with "bunkum."

The author also includes excellent information and useful advice on mediums, techniques, and the use and care of materials.

The book covers so many phases of this almost limitless subject that reference to them all here is quite impossible. Suffice it is to say that it is an informative and well-written book, to be read, studied, and cherished by those who earnestly desire to know how a real artist eventually attains that elusive goal of ultimate success.

James L. Clark.

ANSWERS TO QUESTIONS ON PAGE 190

SCORE: 20—Perfect
18-19—Excellent
15-17—Good
12-14—Fair
Below 12—Poor

A

ADULTS	YOUNG
1 Bighorn	(3) Eaglet
2 Camel	(4) Elver
3 Eagle	(5) Cub
4 Eel	(1) Lamb
5 Fox	(2) Colt or Foal

B

6 Fish	(6) Fry
7 Goose	(8) Leveret
8 Hare	(9) Joey
9 Kangaroo	(10) Kid
10 Mountain Goat	(7) Gosling

C

11 Muskrat	(14) Squab
12 Owl	(13) Spat
13 Oyster	(15) Tadpole
14 Pigeon	(11) Kit
15 Toad	(12) Owlet

D

16 Seal	(18) Poult
17 Swan	(19) Fawn
18 Turkey	(17) Cygnet
19 Virginia Deer	(20) Calf
20 Whale	(16) Pup

PICTURE QUIZ: Which of these five people gives the right reason for buying U.S. Bonds?

(ANSWER BELOW)

1. **Easy to save!** "I'm putting my money into U. S. Bonds because it's the *easiest way* for me to save. Under the Payroll Savings Plan, I put aside a regular amount each week for Bonds. So far, I've saved $500 without missing the money!"

2. **Good investment!** "Getting back $4 for every $3 I invest—the way I will in ten years' time with U. S. Bonds—is my idea of a *good investment*. I know it's safe and sound, too, because it's backed by Uncle Sam. Buy Bonds, I say."

3. **Plans for the future!** "Ten years from now, the money I'll get for my U.S. Bonds will help to send my kids to college, or buy our family a new home. I think that buying U. S. Bonds is the wisest thing a family man can do."

4. **Fights inflation!** "I want America to stay economically sound. That's why I'm putting all our extra dollars into U. S. Bonds. It's like buying a share in our country's future prosperity!"

5. **Rainy day!** "Maybe a rainy day's coming for me. Maybe it isn't. But I am taking no chances. That's why I'm buying all the U. S. Bonds I can through my Payroll Savings Plan."

THE ANSWER

Every one of these people gives the "right" reason—because there's more than one right reason for buying U. S. Bonds.

Whichever way you buy them—through Payroll Savings, or your local bank or post office—U.S. Bonds are the best investment you can make!

Save the <u>easy</u> way..buy <u>your</u> bonds through payroll savings

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CHARLES FRANCIS PRESS
NEW YORK

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Prehistoric Peru · Popcorn · Hummingbird · Chiggers

VOLUME LVI No. 5

FIFTY CENTS

Man-of-War Fish

SIRS:

In your March issue, Joseph Bernstein mentions the small fish that swims safely among the dangerous tentacles of the Portuguese man-of-war. I would like to know the name of this fish and why it is able to brush against the poisonous tentacles without being stung, as are other creatures of the sea.

ROBERT JOHNSON.

East Northport,
Long Island, N. Y.

° ° °

The fish is popularly known as the Man-of-War Fish and scientifically as *Nomeus gronovii*. Its immunity from attack by the Portuguese man-of-war offers, at first glance, a baffling exception to the rule. But specialists who have studied this curious partnership have concluded that physical contact alone is not ordinarily sufficient to cause the nettle capsules of the Portuguese man-of-war to release their thousands of poisonous barbs. It is necessary that there be some chemical activation as well, which this particular fish does not provide. However, the little fish is not always immune. Portuguese men-of-war have been found with partly digested *Nomei* in their grasp. Perhaps when the Portuguese man-of-war gets particularly hungry, it attacks even the little fish that ordinarily helps to lure its food within stinging range.

EUGENE W. GUDGER,
The American Museum of Natural History.

New York, N. Y.

Frederick the Great

SIRS:

I can't tell you how much I enjoy each issue of your Magazine. As a newcomer in this country (I immigrated one year ago), I must confess I never saw such a beautiful and interesting magazine of natural history.

May I correct two small mistakes in the March issue: (1) The picture of Frederick William inspecting potatoes (p. 133) does not show the Berlin-Lustgarten but the small Schlossgarten behind the castle; (2) Frederick the Great was not the grandson of Frederick William, the Great Elector, but his great-great-grandson. The son of Frederick William was Frederick I, the first king of Prussia: then came Frederick William I, the father of Frederick the Great.

(Dr.) LUDWIG KEMPE.

Union, N. J.

(1) Schlossgarten, yes. (2) Of the 25 or more Fredericks and Frederick Williams commonly listed as rulers, two *did* come between the Great Elector and Frederick the Great; but shouldn't we split the difference and say simply "great-grandson"?—ED.

Coca Strike

SIRS:

The article, "Coca," by W. H. Hodge, in the February issue of NATURAL HISTORY, recalled to my mind this incident:

Some twenty years ago a young Cornish mining engineer, who had joined my camp on the Isthmus of Tehuantepec, asked me for the name of a United States bank in which he could safely deposit a two-year salary check. Although he held a three-year contract and had worked only one year, he was paid according to full contract. The reason for this discrepancy is interesting.

The mining engineer had been employed by the Guggenheim mines in Chuci Camata. A young doctor from the States, obviously still "wet behind the ears," was assigned to the mines, and when he heard that the Indian laborers were allowed three fifteen-minute periods daily for coca chewing, he threw up his hands in horror at what he considered the immorality of the drug. He enforced an edict outlawing coca chewing, with the result that one of the richest mines in the world was closed down. The Indians simply walked out. It was quite clear that the ancient coca habit was regarded, shall we say, as a divine right.

Without miners, the doors of the company were shut for several years, and although the doctor was fired, it took several more years before the Indians were persuaded to return to work. Millions of dollars were lost, but this apparently meant little to the Indians when coca chewing was at stake.

I have often used this example to convince North American business houses entering the Latin-American field that, before risking capital, they would do well to study the customs and wants of the people. North American methods and ideas cannot be forced upon people who have never heard of the United States.

FRANS BLOM.

Mexico City, Mex.

Trading Insects

SIRS:

For many years I have been a subscriber to your journal . . . and can recommend it highly to anyone interested in natural history . . .

I have been something of an amateur collector of butterflies and moths for several years and have difficulty in finding other collectors interested in the trading or selling of specimens . . . I am wondering whether you know the names of any persons living either in the United States or abroad, particularly in Central or South America, with whom I might get in touch.

With best wishes for your continued success,

J. A. BISHOP.

Jeffersontown, Ky.

Persons willing to exchange specimens may do well to correspond with Mr. Bishop at the address given. Furthermore, other names can be found in the *Naturalists' Directory*, issued by The Cassino Publishing Company, Salem, Massachusetts.—ED.

Fox in Fur

SIRS:

Here is a story, told as absolute fact, which seems so incredible to me that I have turned to NATURAL HISTORY—my favorite magazine—for an explanation.

A certain woman purchased some fine silver fox skins made up into a stole. The first time she wore them they slipped from her shoulders several times, but she thought nothing of it. Later, at a social function, she laid the furs carefully over the end of a mahogany bench. But when she returned from the next room they were on the floor. This did seem a little odd to her, as no other person had passed, and the fur piece had seemed securely on the bench. Several other such occurrences troubled her, so at last she took the stole to the reputable furrier from whom she had purchased it.

Incredulous and scoffing at first, the furrier nevertheless became puzzled when twice the fur slipped from a table upon which he himself had laid it. So he took the stole into the workroom, had the lining opened, and found inside a snake about ten to twelve inches long.

His explanation to the customer (for whom he provided substitute skins) was that probably a snake egg had been lodged inside when the fox skin was sewed up and that it had simply grown up there!

What do you think? Where had the egg been? Is such a thing possible?

Nobody mentioned what kind of snake it was—foxy, perhaps, but don't tell me it was a fox snake.

MURIEL THOMSON.

Kitchener, Ontario,
Canada

The following answer is offered by Charles M. Bogert, Chairman and Curator of the Department of Amphibians and Reptiles at the American Museum:

This same story appeared either in *Time* Magazine or in the newspaper some months ago. Obviously, no snake egg was laid and hatched inside the stole.

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NATURAL HISTORY

The Magazine of the American Museum of Natural History

FREDERICK TRUBEE DAVISON, President — ALBERT E. PARR, Director

VOLUME LVI—No. 5 — MAY, 1947

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You will find NATURAL HISTORY Magazine indexed in *Readers' Guide to Periodical Literature* in your library

The Cover This Month

Mitten Butte is one of many spectacular rock formations in the region known as Monument Valley, in southeastern Utah and northeastern Arizona. The butte is about 800 feet high and is one of a pair quite similar in size and shape, which project like gloved hands from the surface of the desert. These and the scores of other rock spires, pinnacles, and turrets that distinguish Monument Valley present one of the world's most extraordinary physiographic spectacles. Their tops indicate the approximate former level of the plateau—a land surface worn away except for these remnants through the ages by the tireless work of wind, frost, sand, and running water.

The area is in the heart of the Navaho Indian country about 100 miles from the nearest railroad, but the enterprising traveler can reach it by automobile. Thousands who have never visited Monument Valley have seen it in motion pictures, for it is a favorite location among Hollywood producers seeking this atmosphere.

This kodachrome photograph, which we believe to be one of the most remarkable ever taken of Mitten Butte, is the work of George Geyer.—ED.

PUBLICATION OFFICE: American Museum of Natural History, Seventy-ninth St. at Central Park West, New York 24, N. Y.

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Magazine subscriptions, Membership applications, and Advertising inquiries should be sent to Charles J. O'Connor.

NATURAL HISTORY is published monthly (except July and August) at New York 24, N. Y. by the American Museum of Natural History, Seventy-ninth Street and Central Park West. Subscription price $4.00 a year, single copies fifty cents. Subscriptions to Canada, Newfoundland, and all foreign countries $4.50. Entered as second class matter March 9, 1936, at the Post Office at New York, under the Act of August 24, 1912. Manuscripts and illustrations submitted to the Editorial Office will be handled with care, but the publisher cannot assume responsibility for their safety.

The American Museum is open to the public every day in the year without charge

YOUR NEW BOOKS

EINSTEIN • SANTA EULALIA • MAMMALS
ENGLISH WILD LIFE • RUFFED GROUSE

EINSTEIN, HIS LIFE AND TIMES

- - - - - - - - by Philipp Frank

Alfred A. Knopf, $4.50, 298 pp., 20 illust.

HERE we have a biography of Einstein written by a theoretical physicist. In fact, in 1912, on the recommendation of Professor Einstein, Dr. Frank became Professor of Theoretical Physics at the University of Prague as Einstein's successor. Dr. Frank is now a Research Associate in Physics and Philosophy at Harvard.

Einstein was born on March 14, 1879, at Ulm, in the Swabian part of Bavaria. When a year old he moved with his parents to Munich, where he spent his youth. We are told that he was no child prodigy—indeed, he was very slow in learning to speak. He studied at the gymnasium in Munich, but his interest in mathematics was aroused at home and not at school. It was his uncle and not the teacher at the gymnasium who first interested him in algebra. Later he studied at the cantonal school at Aaran, Switzerland, from which school he went to the Swiss Federal Polytechnic School in Zurich. After completing his studies there, he secured a position in the patent office in Bern.

While living in Bern, he pursued intensively his studies of philosophy, mathematics, and theoretical physics. In a very few years these were to flower into epoch-making formulations which made necessary modifications of Newtonian dynamics: the special theory of relativity (1905); the Brownian movement equation (1905); the photo-electric equation (1905), for which he received the Nobel Prize in Physics; the equation expressing the interconvertibility of mass and energy (also 1905), which grew out of the special relativity theory. In his special theory of relativity, Einstein did not include gravitation (accelerated motion), but after ten years of study (1915), he incorporated this phenomenon in his general theory. These achievements proclaim Professor Einstein as the leading mind in the development of our modern physics.

Dr. Frank, with an understanding of these accomplishments, has written an altogether fascinating story of Einstein, the very human man, including his experiences as professor at the Universities of Zurich, Pragne, Berlin, and the Institute for Advanced Study at Princeton.

CLYDE FISHER.

STRUGGLE ON THE VELD

- - - - - - - by Roderick Peattie

The Vanguard Press, Inc., $3.50, 264 pp., 17 illust.

THE story of the Union of South Africa should be of interest to the people of America as it so closely coincides with the history of our own country. The first Dutch settlement in South Africa was in 1652 at the Cape of Good Hope. As in America, explorers and hunters crossed the mountains, to be followed later by small parties of settlers seeking homes and food for their cattle. By 1760 some of these had gone as far as the Orange River. In 1814 the British had control of Cape Colony, and in 1834 slavery was outlawed by English law. As the slaves were mostly owned by the Dutch, great dissatisfaction was felt, and in 1836 the northward movement, known as the great trek, in which over 10,000 trekkers participated, was begun. After having endured great hardships, many of these families settled on the high plateau region which occupies about three-fifths of the area of the Union and on which Johannesburg and the Rand are located. This region is known as the High Veld, and this country and its people are the subjects of this book.

During the late war Roderick Peattie was at the head of the United States Office of War Information in the Union of South Africa, a position which enabled him to travel extensively and to obtain much firsthand knowledge on both the country and its inhabitants.

The book, after discussing briefly the history of the country, deals primarily with the problems of the land—native, social, political, agricultural, and economic. Dr. Peattie discusses these matters in a most scholarly, informative, and readable manner. Anyone with an interest in South Africa would find the book profitable and enjoyable.

T. D. CARTER.

THE RUFFED GROUSE

- - - - - by Frank C. Edminster

The Macmillan Company, $5.00, 385 pp., 157 illust.

WHEN the first settlers reached the eastern shores of this country, they found the woodlands populated with a multiplicity of game, including the ruffed grouse. During the preceding years the Indians had hunted the bird, but it had held its own without even developing the wariness that characterizes it today. The clearance of the forests and the encroachment of settlements began early to restrict the bird's range. Market hunting also contributed to its decline, until restrictive legislation and the efforts of conservationists began to have a beneficial effect in stopping the decimation.

There have always been, presumably, cycles of alternating abundance and scarcity with these grouse, as is the case with various other animals. While we do not know how low the population sometimes fell in precolonial times, we do know that some of the more recent lows have been alarming. Detailed investigations have been undertaken, there, at various times and places to gather information that would forestall future calamity and help the grouse over unfavorable periods. For a number of years Mr. Edminster was engaged in such studies, and, as a consequence, he acquired a broad fund of data that makes the present book complete and authoritative. Full use is also made of the work of other investigators, and each chapter closes with a list of pertinent references.

The life history of the bird is described in detail. There is ample discussion of the bird's requirements and preferences for shelter, food and water, its weather hazards, and interrelationships with other wildlife, as well as questions of conservation and management.

Lack of space prevents a recapitulation of the many interesting points brought out in this volume. The conclusion reached with regard to the periodic disturbance in abundance is that there is no single underlying cause but rather a complex combination of a number of factors not yet thoroughly understood. In any case, the study has brought out a fuller knowledge of the ruffed grouse, and we are in a much better position to assist this fine bird to remain as part of our American scene.

J. T. ZIMMER.

First penthouse dwellers of America

- - - - - by Ruth M. Underhill

Laboratory of Anthropology, Santa Fé, New Mexico, $4.25, 161 pp., 52 illust.

THIS handsome book, which first appeared in 1938, has been republished in revised form with new photographs. Dr. Underhill, who knows our Southwestern Indians firsthand and is the author of several detailed ethnological reports, writes with ease and authority.

One of the few books to deal popularly with the modern Pueblo Indians as a whole, it begins with a highly simplified account of Southwestern prehistory which tends, perhaps, to overemphasize the uniqueness and local development of Pueblo culture. The book continues with an account of the modification that took place under Spanish and Mexican rule and finally their curious adaptation to modern mechanized civilization. Dr. Underhill describes with skill the characteristics which set apart the various Pueblo villages, sprung as they are from an essentially similar cultural background. The peaceful Hopi, whose passive resistance turned the onslaught of Spanish culture and serves as a protective armor against our own, contrast sharply with the warlike, secretive Keresans. The author describes the rich pageantry of the pagan Zuñi ceremonies and the Catholic rituals of the Spanish influenced Tewa.

The specialist might feel that Pueblo culture is presented as hypersophisticated and super-American-Indian, whereas actually it is not so vastly different from that of other tribes. The reviewer found the picture captions not particularly informative, although the photographs themselves are uniformly excellent. The author conveys a picture of the daily life of these interesting Indians, their colorful ceremonials, their ancient crafts, and their adjustment to a changing world.

Harry Tschopik, Jr.

A treasury of English wild life

- - - - - edited by W. J. Turner

Hastings House, Inc., $5.00, 324 pp., 48 color plates, 138 black and white illust.

BEAUTIFULLY illustrated and purposefully written, *A Treasury of English Wild Life* is a delightful classic which would grace anyone's bookshelf. The free flowing informative essays make it clear that the authors, of which there are several, have a broad and clear conception of their subject.

This is not a detailed summary of wildlife in Britain, but rather a summing up of the lovely, the ordinary, the strange and historical aspects of the English countryside, a history of natural history. There is a healthy freedom from antiquated nonsense, and while the trained naturalist will find this book a haven of restful relaxation, there is food for the intellectual reader who rarely strays beyond the shadow of tall buildings.

In his introduction to the trees of Britain, A. L. Howard writes, "Forests are a vital necessity to the life of the people. Without trees the soil can no longer produce and the country becomes a desert."

Geoffrey Gregson has an excellent understanding of wild flowers. And C. M. Younge describes the wonders of marine life in a stimulating introduction to the general science of the sea.

F. Fraser Darling, with his usual literary ability, gives a colorful picture of wildlife in Britain. His approach and style are full of thought and interest, capable of guiding the reader in the field of wildlife conservation and making him natural history conscious.

The text of James Fisher's bird's-eye-view of Britain is admirably executed, and his selection of illustrations is deserving of even greater praise. Outstanding works of such noted artists as Gould, Wolf, Donovan, and Audubon are represented.

Perhaps the most brilliant chapter in

the whole book is Geoffrey Taylor's highlights on the more than 12,000 species of insects in Britain. "The relationship between flowers and insects is one of the most attractive of natural history studies. There can be no doubt that flowers as we see them were primarily invented for insects, and only secondarily, perhaps, for our delight. They are the sexual organs of those vegetables that bear them, and insects are the means of consummating the 'Loves of the Plants.'"

George G. Goodwin.

Patterns from Nature

- - - - - - Photographs by Horst

J. J. Augustin, $10.00, 107 pp.

THIS book of nearly one hundred superb photographs must be as surprising as it is attractive to artists and art students. Nearly all the pictures are of common objects that we see daily without realizing their beauty of design and form, such as leaves, bark, fungi, cultivated vegetables and flowers, butterfly wings, shells, minerals, and even sun-cracked mud. To see them is to be convinced of their intrinsic beauty.

Photographers, both amateur and professional, will be interested in the technical index, in which it is carefully stated how each and every photograph was made—the type of camera, the filter, the kind of film, the film developer, the paper developer, and the location. Each plate in the book is from an enlargement approximately 9 x 12, and this large size adds to the impressiveness of the pictures.

The objects have been photographed without artificial arrangements and special effects. They are indeed patterns from nature, seen through the eyes of a photographer who is at the same time a poet-naturalist. Art is nature plus a seeing eye.

The last ten pages are photographs shown in simple repeat. It is evident that the resulting designs or patterns would be most attractive in various industrial fields such as textiles, wallpaper, carpets, plastics, glass, ceramics, china, jewelry, leather, and bookbinding. How beautiful a piece of upholstery would be with the design from the leaf of an Elephant-ear plant or from a Bracket-fungus! How attractive curtain fabrics based on the design of Coleus leaves! How exquisite a wallpaper with a Maidenhair fern design! Here is a great potential source for design, for there must be thousands of objects in nature that would lend themselves as well as those chosen by this artist-photographer.

It would have added much to the interest of the book if the author had given a bit more information in the captions for the photographs. In many cases, only the Latin scientific name is given.

Clyde Fisher.

Mammals of California

- - - - - by Lloyd Glenn Ingles

Stamford University Press, $4.00, 258 pp., 42 plates, 57 figs.

After a relatively long period when few mammal books were published, a large number have come on the book stands. This is another state-wide treatment, less detailed than several others of recent date, a fact which may be explained by the extraordinary wealth of the mammal fauna of California. In several other ways the book falls below the standard set by the works of Burt, Hall, and Bailey. Little new information is included, and some of the compilation shows less natural history background than might have been expected.

For the most part all the species of mammals found in California are included in the keys. The descriptions, however, are those of species chosen as examples of the genus. The bats are treated even less fully than this; only a single bat, the Mexican free-tail, is given detailed discussion.

There are excellent photographs, representing most of the genera of Californian mammals, but they are not reproduced on surfaced paper to bring out their best qualities. The photographs are largely the work of the author and have involved a great deal of care and skill. In contrast with these, the line cuts illustrating tracks and cranial characters are not up to the same standard.

Although several works on mammals are mentioned in the introduction, there are no bibliographic references to these and no bibliography. This would have added somewhat to the usefulness of the book.

The binding, paper, and type are excellent.

In spite of the several defects mentioned, Dr. Ingles' book should be very useful to students and interested amateur naturalists who live in or visit California.

J. Eric Hill.

Sonora Sketch Book

- - - - - - - - - - by John Hilton

The Macmillan Company, $5.00, 333 pp., 44 pp. of illust.

One evening as he sat in his studio in the little desert town of Thermal at the edge of California's Salton Sink, John Hilton found himself wishing that he could get back to Sonora. Nostalgically he drew out a few of the old sketch pads that he had filled during his sojourns in the Mexican state. Soon he found himself watching Chavelita as she patted out her tortillas. With other drawings he caught the odor of violets as the beggar approached, or he saw the urchin bringing in the snake dangling at the end of a noose—in retrospect the innumerable pleasures of his travels in Sonora during the past eight years all came back to him as he thumbed through the sketches. He resolved to write a book, one that would "bring the reader to a better understanding and appreciation of a land and a people" that he had learned to love and admire.

On one trip into Sonora, Hilton accompanied a botanist. Later he joined an ornithologist, and at other times he un-

Continued on page 240

THE MYSTERIOUS

Surviving the centuries as a spectacular example of human diligence, the curious lines and geometric figures shown in these photographs represent one of the most intriguing archaeological riddles in the Western Hemisphere.

Though these markings were seen and photographed from the air as curiosities by various tourists in the past, Dr. Paul Kosok was the first to take several hundred photographs of them, in 1941, for the purpose of making a systematic study. With superior equipment, the Servicio Aerofotografico Nacional del Peru took further aerial photographs showing many more details.

Through the interest and courtesy of Mr. P. L. Thommen, representative of Fairchild Aerial Surveys in Peru, and the efforts of Miss Maria Reiche, some of the photographs have been made available to NATURAL HISTORY. *This magazine is thus able to present for the first time to the American public one of the most perplexing series of photographs ever to challenge American archaeologists.*

Were the lines roadways? Or irrigation canals? Or was their design a secret of the early astronomer-priest? An explanation is offered in this article by Professor Kosok, who, with the aid of Miss Maria Reiche of Lima, has undertaken a scientific study of them.—ED.

AERIAL MOSAIC showing region of great abundance and complexity of markings. Various centers from which the lines, "roads," rectangles, and trapezoids radiate can be distinguished. The area shown is about 4½ miles long and is on the plateau just south of Rio Ingenio, which runs parallel to the valley of Nazca. The view reveals the relation of the desert plateau (*top*) to the deeply eroded slopes leading down to the narrow irrigated parts of the valley below. The black line running diagonally from the upper left-hand corner is the Pan American Highway

MARKINGS OF NAZCA

When first viewed from the air, they were nicknamed "prehistoric landing fields" and jokingly compared with the so-called canals on Mars. Science now attacks the problem and comes up with a surprising answer that sheds light on the prehistoric inhabitants of the region

By PAUL KOSOK
Long Island University, New York, N. Y.
With the collaboration of
MARIA REICHE
Lima, Peru

FLYING over the dramatic desert plains and hills along the lower branches of the Rio Grande River in southern Peru, one sees the strange and unique networks of lines and geometric figures shown in these photographs. They are visible in many places, sometimes lacing back and forth in extremely complex and apparently chaotic ways across an extensive area more than 40 miles long and some 5 to 10 miles wide.

This region is one of the driest deserts in the world. A number of neighboring rivers, running from the Andes westward toward the Pacific and combining near the coast to form the Rio Grande River, provide the water necessary for irrigating the adjoining fields. These

Photo by Paul Kosok

▲ HOW A "ROAD" looks from the ground: a view from the plateau near Palpa. This is near the place where a sunset viewed on the day of the summer solstice first revealed the astronomical nature of the markings. The white portion of the "road" shows where the pebbles were removed, exposing the lighter subsoil. Near the plateau, only the sides of the "road" were completed. Parallel to it can be seen parts of what appear to have been an uncompleted "road"

fields are not extensive, for the rivers are small and have water only during four to five months of the year. Each valley contains only one or two villages and supports today, as it undoubtedly did in the past, a population of no more than several thousand. The markings are found on the slightly elevated desert plateaus and on near-by ridges between the banks of adjacent rivers.

The lines themselves run straight as an arrow in various directions, sometimes only a few yards, sometimes for many miles. Most of them are actually double parallel lines and look like roads with slightly elevated edges. They all seem to have been made by the simple process of removing the many pebbles that have been darkened by exposure to the air from the lighter colored soil in the center of the "road" and piling them in a uniform way along both sides. The lighter color of the smooth central portion makes the "road" easier to see. Today the elevated sides of the "road" are generally only a few inches high, in some cases so low that they are barely perceptible even in the early morning or late afternoon when the shadows are longest.

The geometric figures—triangles, rectangles, and trapezoids of various sizes—were made in the same way as were the "roads."

The Spanish conquerors, unfortunately, never mentioned these markings in any of their writings; and the present inhabitants of the region, while knowing of them, possess no traditions or legends that might help to explain them. The people sometimes refer to them as "Inca Roads," but their very nature, size, and position indicate that they could never have been used for ordinary purposes of transportation. The possibility that they are the remains of ancient irrigation canals must also be ruled out, for they are often found running over hillocks. And where this is not the case, they have no possible physical connection with the river, which would be the primary requisite for irrigation canals.

The Key to the Problem

Some years ago, while studying the extent and nature of the ancient irrigation systems along the coast of Peru, my wife and I decided to see what logical explanation might be given for the markings and whether they might be related to our major study.

Our first clue came one day when we went out on a Peruvian government truck to explore one of the "Inca Roads." Following a wide one that crossed the Pan American Highway to the south of Palpa, we found that after about half a mile it led straight up the steep side of a small mesa, or plateau, and stopped.

On top of this mesa, we saw that this "road" was the largest and most impressive of several other similar but narrower ones which, together with a number of single lines, radiated from a kind of center near where we stood.

Roaming around the top of this flat plateau, which extended for several miles in an easterly direction toward the near-by mountains, we found not only many more lines but also two huge rectangles or trapezoids. One of these had rows of pebble-heaps along two sides, the other had a series of very short parallel lines, both of which looked like recording or counting devices. Most amazing of all, we found adjacent to one of the rectangles and close to the original center, the faint remains of a huge, peculiar pebble and dirt drawing over 150 feet long, which reminded us somewhat of the designs found on the old Nazca pottery of this region. (See illustrations of some of these large figures on pages 204-5.)

Finally, with our minds whirling with endless questions about these strange and fantastic remains, we returned to the center of radiation to view an impressive sunset. Just as we were watching the sun go down behind the horizon, we suddenly noticed that it was setting almost exactly over the end of one of the long single lines! A moment later we recalled that it was June 22, the day of the winter solstice in

the Southern Hemisphere—the shortest day in the year and the day when the sun sets farthest north of due west. With a great thrill we realized at once that we had apparently found the key to the riddle! For undoubtedly the ancient Nazcans had constructed this line to mark the winter solstice. And if this were so, then the other markings might very likely be tied up in some way with astronomical and related activities. Had we actually stumbled upon a huge aggregation of historic astronomical formations, somewhat similar to those found in Great Britain, Northern France, and other parts of the world?

Even though our theory was a very tenuous one, we nevertheless realized that we had probably found an entering wedge which would help to take the problem out of the realm of idle speculation and place it where it could be subjected to rigid scientific tests.

With what seemed to us "the largest astronomy book in the world" spread out in front of us, the question immediately arose: How could we learn to read it? In the few weeks at my disposal, during which I was forced to continue the investigation alone, I decided to make a general survey of the whole region and to take directional readings of as many lines as possible. Through the courtesy of the Faucett Aviation Company, I was able to make several flights over the area. Ingeneiro Galvez, the Mayor of Nazca, and others in the region gave me valuable advice and aid in arranging trips. I was soon able to get a general picture of the whole layout, with the result that I succeeded in locating at least a dozen radiating centers in various parts of the pampas.

Then I ascertained the direction of many of the lines radiating from some of these centers, by means of a good compass, the readings from which were corrected by data furnished by the Huancayo Magnetic Observatory. A number of the lines and "roads" were found to have a solstitial direction; a few with equinoctial direction could also be identified. Moreover, various alignments were found to be repeated in many different places, though I could not identify them in the time at my disposal. After only a preliminary survey this astronomical approach had produced some positive results, for some sign of order had been detected in what had been an apparent chaos.

At this juncture, I was forced to interrupt these observations at Nazca and to return to the north of Peru. But I gave the information to Miss Maria Reiche of Lima, Peru, whose training in astronomy and mathematics enabled her to go ahead with the computations. From the material at hand, she drew up several preliminary work charts.

▼ The ancient people apparently lived along the edges of the irrigated fields at the right, where ruins of dwellings have been noted. From here they could on one hand tend their crops and on the other visit the sacred markings by mounting the escarpment. This is an oblique view of the region shown on pages 200 and 201

▲ As SHOWN HERE, some figures are superimposed over others, indicating they were made at different times. Associated with the figures in this photograph may be seen dim outlines of "animal" drawings, comparable in some ways to those reproduced on these two pages

Since then, the work has been carried on jointly by both of us. She visited Nazca during the period of the summer solstice in December, 1941, and confirmed the solstitial nature of some of the lines and roads I had plotted on the basis of my compass readings. She did this by actually watching, as the ancient Peruvians had done, the sunrise and sunset from several centers. Up to the present, twelve solstitial lines have already been confirmed in this manner.

The Progress

Since the end of the war, Miss Maria Reiche has resumed her field work, visiting Nazca during the periods of the September equinox and the June and December solstices of 1946. The extensive observations and new charts prepared have not only confirmed the validity of our whole approach but have raised the results to a new level. In this article it is only possible to give a short summary of our joint findings and theories. For the sake of clarity, they may best be presented in the following order:

1. The apparently chaotic mass of markings possesses a definite element of *organization*. Many of them radiate from a relatively limited number of centers, which are often located on little hillocks. In some cases the centers are on the flat plain but contain the ruins of small stone structures that probably were once used either as observation posts or "altars," perhaps as both.

Because of the importance and sacredness of such centers, they may contain burials. If this is so, the material from them should enable us to relate them to some specific archaeological period or periods of the region and thus obtain their relative ages.

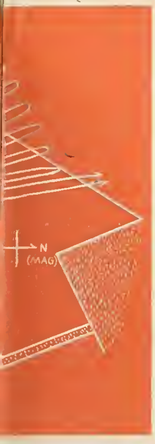
In certain cases, roads and lines that do not leave from centers are associated with the large rectangles and triangles. No lines or figures have been found that are not associated with others in some organized fashion.

2. The *single lines* form only a minority of the markings on the pampas. A number of these have been identified as solstitial lines by actual observation in the field. In June, 1946, during the period of the winter solstice, Miss Reiche discovered an unusual variant of a solstitial line. It was not a *sight* line, but its position marked the movement of the shadow of an important hill across the plain during the course of the day. Since there were several other similar lines near by, she assumed that these probably represented the position of the shadow on other important days of the year.

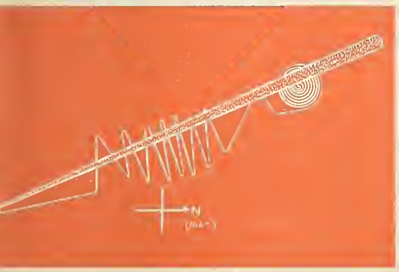
3. The great majority of lines are really *double lines* that appear like roads. Possibly they were sacred ceremonial roads as Mejia Xesspe already suggested in 1939. And they may have led to important burial centers as proposed by Professor Hans Horkheimer of Trujillo, Peru, who visited this region last year and who kindly put his findings at my disposal. But the fact that some of the "roads" have now been shown to have a solstitial direction indicates that they were not built in a hit-and-miss fashion but were given definite sacred alignments, determined by the position of heavenly bodies.

The solstitial lines and "roads" are easy to confirm in the field because, unlike the stars, the rising and setting position of the sun on the horizon does not change sufficiently in the course of one or two thousand years to obscure identification. This is why they were the first to be isolated in our work. But this does not mean that

Huge drawings which are closely associated with the rectangles, "roads," and lines. Eighteen of them have been found by Maria Reiche. Are they clan totems? Symbols of heavenly bodies? Or both?



◄ A well-defined, stylized drawing of a bird about 400 feet long. The "road" paralleling the wings is a solstice line. Such huge animal drawings have been found in other parts of the world



▲ This peculiar and undeciphered drawing is almost a half mile long (2500 feet). Spirals like the one here are found on other drawings in this region

▲ The two body divisions and eight legs of this figure indicate that it is a spider

the ancient Nazcans were necessarily sun worshippers. It merely means that they already knew and marked the basic sun alignments. Only when the many other lines and "roads" that have a repetitive pattern have been accurately studied to determine any relation they may have to the motions of the other heavenly bodies can we gain some idea of the extent and character of the astronomical knowledge of the ancient Nazcans.

4. The triangular, rectangular, and trapezoidal figures are of various sizes, the largest being over five hundred feet wide and several thousand feet long. Their purpose has not yet been determined. But since hundreds and even thousands of people could easily have gathered within their limits, these figures may well have been used as special ceremonial enclosures or "temples" by the various local kinship groups or other social units from the near-by valleys. They would thus be similar to the more developed ones found in other parts of Peru and among other peoples of the world. If so, their sides, like those of similar enclosures and temples elsewhere in the world, may prove to have definite astronomical alignments and their shapes some sacred significance.

Most of the geometrical figures have a large stone heap near one or both ends. These heaps, like those found at several "centers," may likewise be the remains of some kind of observation posts or altars, or both. They may also be found to have burials beneath them. In many cases it was found that lines outside the enclosed areas pointed directly toward these "altars."

5. The huge "drawings," which were made in the same way as the lines, are often several hundred feet long. They remind one somewhat of the animal mounds in northern United States and of sand and dirt drawings in other parts of the world. I found one near Palpa in 1940, but Miss Reiche has recently located eighteen additional ones in the Nazca region. She writes that "they have the shapes of plants, many-headed serpents, and other animals, while some consist of geometric designs, including spirals. Their general appearance is similar to the various Nazca pottery and textile designs." Since the chronological sequence of the different types of these designs is known, it should help to determine the relative dates of the dirt figures and their related markings. One peculiarity about them is that most of them seem to have been drawn by means of one uninterrupted line or narrow path. The line or path begins at one

▼ Ground view of spider drawing. The outlines of the drawings are so low that they can generally be seen only at sunrise and sunset when the shadows are long. They can be made more distinct, as in this case, by carefully dragging a stone attached to a rope along the slight ridge, so as to expose the lighter colored soil beneath the surface of darker pebbles. The straight line running across the drawing is an astronomical observation line

Kosok photo

◄ PATTERNS like the elongated triangles in the middle distance at left recur frequently but are not yet fully understood. The structures at bottom are modern animal corrals, not related to the ancient figures

side of the figure and turns and twists in various directions until it runs out near the original starting place. Since the path does not cross itself, it could have been used as a procession path during ceremonies.

In one case, at least, it has been found that the line forming one of these drawings is a continuation of a long, straight solstice line, thus linking these figures with astronomical observations.

The figures are always found closely associated with a large enclosure or a wide road. A possible explanation is that these figures were totem-like symbols belonging to the various kinship groups or other organizations that used the ceremonial enclosures. This explanation is probably not too far-fetched, for it is doubtful whether the social and political organization of the people in these small valleys ever developed much beyond federations of kinship units. And if it did, these people, like most others, undoubtedly retained many of their kinship social forms and traditions. This would not prevent the figures from also having become symbols of various heavenly bodies, for elsewhere in the world at a certain transitional stage of social development, the old totem figures have sometimes become identified with certain heavenly bodies or constellations. In fact, the names of some of our present-day constellations are undoubtedly of totemic origin.

6. Series of pebble-piles and short parallel lines found in conjunction with the geometric figures may have been recording devices for heavenly or earthly events. But these require further study.

What Remains to be Done

Our general results thus far directly support our original hypothesis of the astronomical nature of these markings—in any case they are not at variance with it. Whatever may have been the social purposes of these various kinds of markings, the astronomical orientation or relationship serves as an integrating factor whose solution will help us to acquire a better understanding of the Nazcan culture and that of Peru as a whole.

The most difficult part of our problem, however, still remains: namely, to identify the large number of lines and "roads" that are not directly related to the solstices or equinoxes. Five additional possibilities present themselves in connection with these—possibilities dictated by the facts of astronomy and supported by the astronomical knowledge that other peoples are known to have possessed in similar stages of cultural development.

1. *Risings or settings of the sun on other days than the equinoxes and solstices.* In England, for instance, the ancients had sight posts or lines dividing the year into eight parts. And in Yucatán, still other days of the year were apparently used in recording the movements of the sun.

2. *Risings and settings of the moon throughout the years.* These have generally occupied the interest of both primitive and civilized peoples, for lunations and the 19-year moon cycles were used widely in reckoning time sequences. Spanish records mention the importance of moon worship along the coast of Peru.

3. *Risings and settings of the various planets.* These presented a more complex problem to the early astronomers; but we know that many peoples of the world, including the Mayans of Yucatán, had gained an accurate knowledge of the movements of planets even in early times, and that the planets were often an important part of the religious cult. That this was likewise true among the ancient Peruvians is indicated by a few remarks on the subject by the early Spanish chroniclers. The periodicity of Venus, and possibly Jupiter and Mercury, were apparently used by the priesthood for calculations.

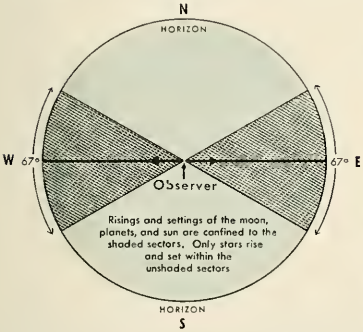
4. *Risings and settings of important stars.* Various studies have shown what weight certain early peoples attached to the heliacal risings and settings of a particular star or star group that might be connected with important economic or religious activities. We know that in Peru the Pleiades provided a common time marker; in fact, among the Chimus this constellation was supposed to have been the dominant star group. Since in the Nazca region the Pleiades in the course of the centuries rose and set near the solstices, some of the observed solstice lines may have also been Pleiades lines.

5. *Derivative directions.* Some of the lines and "roads" may not have been sight lines but may have been made to connect important lines and points or to construct related figures.

Because of the complex nature of the problem, it may at first seem well-nigh hopeless to identify the various lines and "roads" in the Nazca region. However, a further analysis shows that we can concentrate on one aspect of the problem at first. If we were to stand at a point in the desert and watch all the risings of the sun, moon, and planets in the course of the years, we would find that they would all occur within a relatively narrow arc of about 33 to 34 degrees north of east and the same distance

➤ THE DARK EDGES of the figures are stones placed along the margins of the "road." The two horizontal lines, which do not run perfectly straight, are not part of the ancient lines. They are modern desert paths superimposed over the markings

south of east—that is, a total angular range of about 67 degrees on the horizon. The same holds true of the settings in the west. (See shaded areas in diagram.) Of course, the very richness of this field makes it difficult to work with, especially since within these two arcs we also find the rising and setting points of certain stars. However, the much larger arcs to the north and south along the horizon (the unshaded areas on the diagram) would give us sight lines that refer only to stars. This simplifies the problem considerably



and indicates where a systematic study may well begin. In fact, the groundwork for this has already been laid.

One difficulty still remains. The point at which each star rises or sets shifts noticeably in the course of the centuries. This obviously makes identification of a star with its corresponding line difficult. However, since the number of bright stars that would have been used for sighting purposes is limited, the association of certain recurrent lines with important stars becomes possible.

This difficulty is really a blessing in disguise. Since the annual shift of each star is now known with great accuracy, we can, by working backward, determine the approximate date when the corresponding sight line was made. Such a procedure must, of course, be carried out with great care and skill in order to avoid the errors that have sometimes been made in studies of this sort in Egypt and elsewhere. Even an approximate dating of these remains would be of great importance to Peruvian archaeology.

It can be noticed that some of the lines of one center or figure are often built over the lines and markings of other centers, indicating different periods of construction. This indicates chronological sequence. If we can correlate such sequence with the culture sequence of the region and perhaps even with rough datings, new vistas in archaeology may be opened.

A solid year of fieldwork would no doubt yield the answers to certain basic questions. Aerial surveys of this region now in progress will be most useful in getting the overall picture and in locating certain details. However, the basic work lies in determining accurately by means of a theodolite the orientation of all the lines, "roads," and figures, together with the angles of elevation of the rather irregular horizon. Actual observations of the risings and settings of the various heavenly bodies while in the field would act as a valuable check on the results.

During this time the most important pyramids, walls, and other structures along the northern coast of Peru should also be surveyed. In that section the social and political organization reached a considerably higher stage than in the Nazca area and with it probably certain aspects of astronomy. This would be the first attempt to open up the whole problem in the North, and the results would almost certainly throw light on the development in the Nazca region. In 1941, while in the North, I measured with a compass the alignments of various pyramids and found somewhat similar evidence of solstitial and equinoctial alignments as well as the repeated pattern of several other alignments that have not yet been identified.

The fieldwork must be done soon, however, because plans are already under way to irrigate some of the most valuable areas within a few years. This will destroy at a stroke what has come down to us unharmed as a priceless heritage from the distant past.

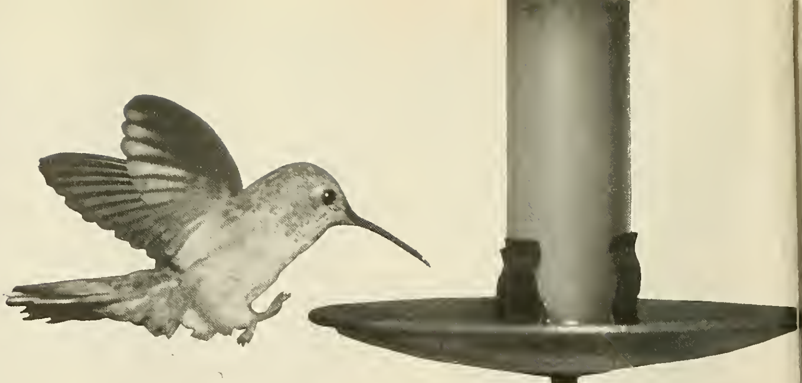
The Significance of the Nazca Lines

It might at first seem astonishing that the Nazcans and other people in the early stages of civilization should have taken such an intense interest in astronomical observations and have developed elaborate astrological cults. On closer analysis, however, it seems less surprising. The rise of a more developed

Continued on page 237

By
Walker Van Riper
and
Robert J. Niedrach

Colorado Museum of Natural History



▲ "Re-fueling" in flight

hummingbird in action

A MIGHTY mite is the Hummingbird, describable only in superlatives. On wings that beat as fast as 75 to 200 times per second, it can fly straight up, poise stationary in the air, move backwards or sideways (no other bird can), and attain a forward speed of 50 to 55 miles per hour. This speed compares, for example, with 30 to 35 miles per hour for the racing pigeon in still air.

Hummingbirds are known only in the Americas. There are something like 500 species of them. Most of them are tropical, but about 20 have been recorded in the United States. These migrate northward in the spring for breeding and nesting and return to Central and South America for the winter. In migration, long distances are covered, several species crossing the 500 miles of open water of the Gulf

▲ Female Broad-tailed Hummingbird about to land on nest

▼ Landing. One of the eggs can be seen

of Mexico. The Broad-tailed Hummingbird, pictured here, is *the* hummingbird of the Rocky Mountains. It nests in towns and cities and in the mountains at an altitude near timberline. We have reason to believe that the same one returned to build its nest on the same spot in a maple in Denver for three years in succession. Probably it passed its winters in Guatamala. The Rufous Hummingbird, which is to be seen in Colorado on its southward trek in July and August, nests as far north as Alaska. Indian folklore, to the effect that these long journeys are made by riding the backs of larger birds, is entirely discredited by the experts.

As for courage, the Hummer appears to be almost without fear. She will attack and put to rout any larger bird that comes near the nest. We have often seen robins, doves, and even squirrels chased away. The technique is interesting. She stops, poised for a moment a couple of feet above and a little to one side of the enemy; then she swoops suddenly toward the back of its head, reverses, and stops poised again at a similar point, the line of attack being U-shaped, with the victim at the bottom of the U. Back and forth she goes at lightning speed, never, we think, actually hitting the enemy, but unnerving it and soon putting it to flight. She has few, if any, really effective enemies. Only once or twice in all the literature concerning hummingbirds is there a record of one being captured by a predatory bird. Probably, however, squirrels, chipmunks, and the like take some toll of the eggs and young.

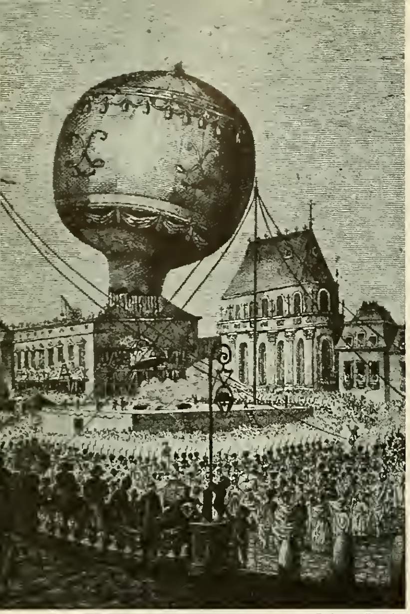
Her lack of fear makes the Broad-tailed Hummingbird a wonderful photographic subject. The nest shown here was on a branch of a small spruce, only 18 inches off the ground, at the Evans Ranch at the foot of Mt. Evans, a little over 8000 feet above sea level. All the pictures were made with the high-speed flash devised by Dr. H. E. Edgerton of the Massachusetts Institute of Technology, and rigged to operate on a storage battery. The exposures were about 1/30,000 of a second. The photographer, with his camera and light, worked within two feet of the nest. A blind was not necessary, nor was remote control of the camera and light.

When first found, the nest contained one tiny egg, white and about the size of a dried field pea. The second egg was laid the following day. The bird could be driven from the nest by waving a hand about six inches away, but she would soon return, and the flying pictures were shot as she was about to hit the nest. Sometimes on returning she would give the apparatus and the photographer a thorough going-over before flying to the nest, first "buzzing" the man (stopping in the air within a foot of his face), then the camera and the light, and finally circling the tree to the nest.

The male, a little dandy with no domestic responsibilities, was not to be seen in the vicinity of the nest. He is more ornamental than the female, particularly because of a brilliant crimson throat patch. In both, the back and wings are iridescent green, and the female has a series of brownish spots on the throat corresponding to the male's red patch. These spots are also iridescent and in the sun look like flecks of bronze.

▼ The helicopter of the bird world comes to rest

▲ Portrait—The tiny grains over the nose are pollen from flowers of the thistle from which she had been gathering nectar



Culver Service

▲ THE FAMOUS hot-air balloon of the Montgolfier brothers, which rose at Versailles on September 19, 1783, with a ram, a rooster, and a duck as passengers. A year later a hydrogen balloon carried weather instruments aloft

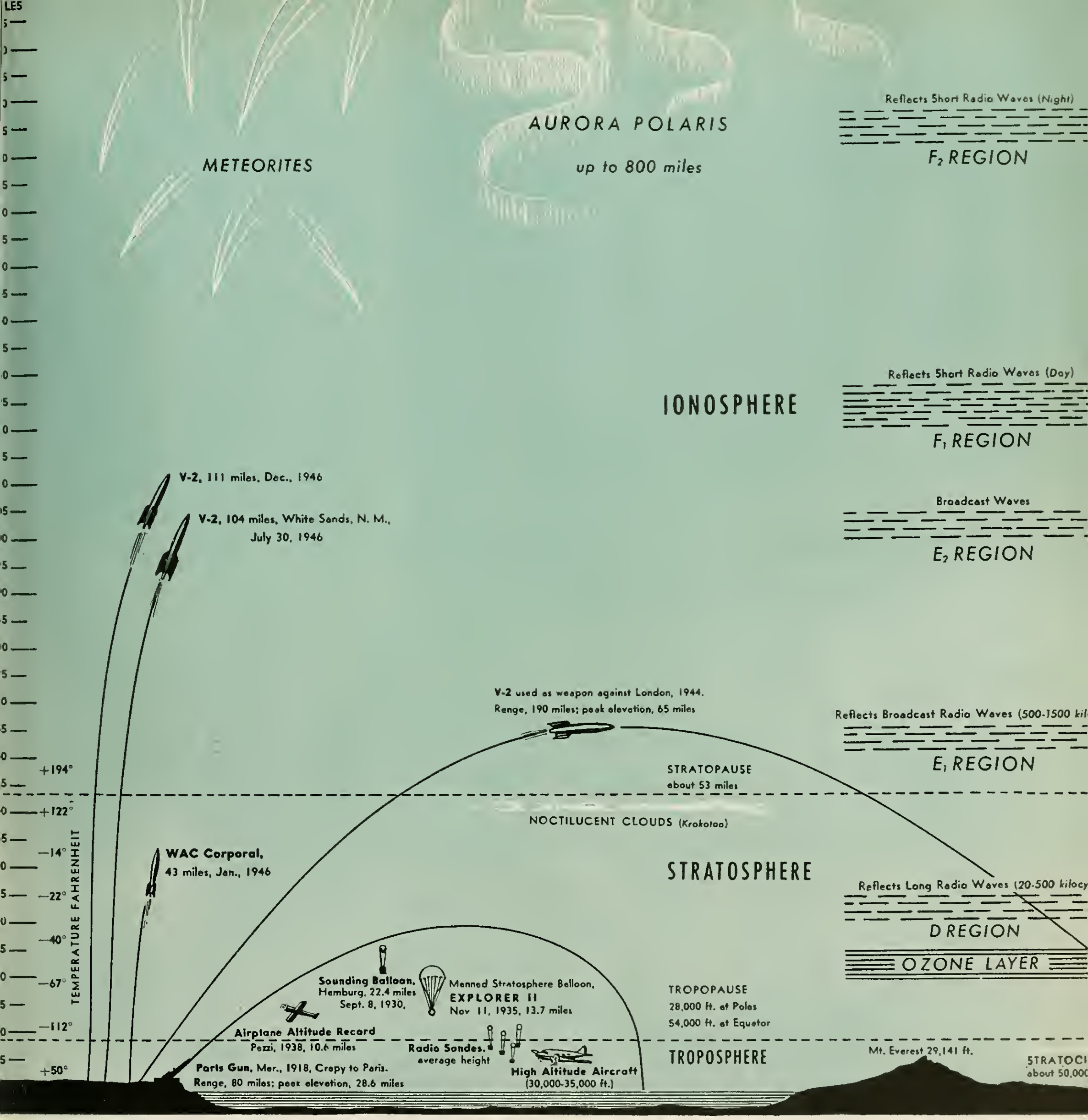
Conquest of the Third Dimension

Exploration of the upper atmosphere enters a new era. Rockets can now carry weather instruments to an altitude of 100 miles and will penetrate any desired distance into interplanetary space when the fuel capacity is increased

BY WILLY LEY*

DURING the latter half of 1944 several officers, one a representative of the Office of the Chief of Ordnance and several from the Engineer Corps, traveled extensively in the less densely settled sections of the United States. They had orders to look for a large tract of land, preferably flat, preferably in a dry climate but with water available. It should be as unsettled as possible but within easy driving distance of a railroad track. It should, if possible, be near a highway but not crossed by one, certainly not by one with heavy traffic. It should preferably be on state or

*The author was one of the founding members and for several years vice-president of the German Rocket Society. This society was dissolved soon after Hitler came to power, and in 1934 Mr. Ley began preparations for leaving Germany. He arrived in this country in February, 1935. Since then he has written several books and contributed a great number of articles to popular magazines. He was granted U. S. citizenship during the war and is now employed by a Washington firm.



Museum Illustrators Corps

federally owned land. This was a long list of preferences, and the search was not easy. But in the end the commission succeeded in finding a tract of land which, while not absolutely perfect, came close enough to the specifications to be satisfactory.

It is a large valley in southern New Mexico, beginning at the New Mexico-Texas border, north of El Paso, and extending due north for a distance of 125 miles. It has the typical vegetation of the Southwestern desert—sage brush and tumbleweed—and is flanked by the San Andres Mountains on the west and the Sacramento Mountains on the east. The flat valley floor is 4000 feet above sea level, and the flanking mountains rise 6000 feet higher. The area narrows from 40 miles in the north to about 25 miles in the south. In the northern portion the monotony of the desert is broken by formations of black lava, produced by a long-extinct volcano. In the east-central section are the enormous, shifting dunes of white gypsum sand which, in 1933, be-

◄ MODERN USE of the balloon in weather science. The balloon carries an apparatus which automatically radios atmospheric conditions at different heights. The operator at left records the information
U. S. Weather Bureau

came the White Sands National Monument.

On the 20th of February, 1945, the Secretary of War approved the selection of this site and signed a document transforming it into a proving ground for long distance and high altitude rockets and guided missiles. It is officially known as the White Sands Proving Ground.

This is the spot that is going to be the starting point for the conquest of the third dimension. Everybody knows but fails to realize most of the time that man's domination of the earth is essentially two-dimensional. We travel all over the planet from east to west and north to south but not up or down. If a mine shaft is sunk more than a mile below the surface, it is considered a big thing. The oceans are several miles deep, but nobody has dived even to a depth of a single mile into them. When airplanes rise to seven or eight miles, we speak of high-altitude flying, but the diameter of our planet is *eight thousand* miles.

White sands is supposed to change the limitations that have kept man confined to a two-dimensional sphere. A good beginning had already been made. The first thing that was done at White Sands, along with the construction of a highway to the scene of operations and the creation of living quarters for the men working there, was the unloading of 300 carloads of parts of captured German V-2 rockets. These parts had to be sorted out, inspected, and assembled. Twenty-five complete rockets were the result, but they were not fitted with the one-ton warheads the technicians of the *Wehrmacht* had intended them to carry. They were fitted with sharp-pointed noses housing scientific instruments. These twenty-five rockets, instead of being sent to carry bombs over a distance of about 200 miles, were to begin the exploration of the upper atmosphere.

It was the first time in history that direct measurements could be made in the high regions of the atmosphere—regions that had previously been explored only directly by means of radio waves, sound waves, and light waves.

But we had better go back to the beginning of the story.

It is really the story of man's attempt to understand weather. For many centuries, humanity persisted in the belief that the wise men of antiquity had known everything about everything, and this belief very seriously retarded the development of "weather science." Early studies resulted in nothing more than the realization that wind was a "flow of the air." Aristotle's studies of the weather were stifled by one of his all-embracing guesses: he stated that the atmosphere consisted of three layers—a bottom layer attached to the unmoving earth, a top layer attached to the fiery, revolving heavens, and an intermediate layer of great cold. The latter idea was presumably derived from mountain-top observations, and there is a curious amount of truth in the whole scheme. Theophrastus, a pupil of Aristotle, wrote on weather signs, but that was all.

The Arabs, with their inclination toward mathematics, tried to calculate the height of the atmosphere from the duration of twilight. They arrived at a figure which, in modern measurements, comes close to 60 miles. This is just one-quarter of the true height, but the result is as good as one could expect with the methods used.

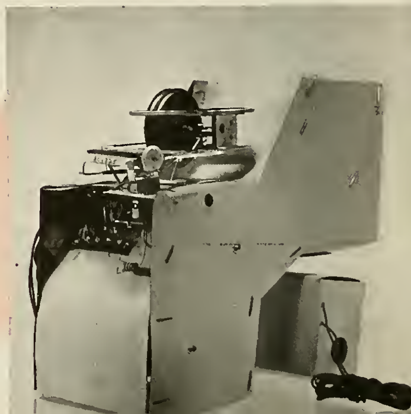
The guesses of the Arabs about alchemy were welcomed by their Christian contemporaries (although in fantastically distorted form), and their developments in mathematics were accepted; but anything they said about natural facts, whether in zoology, botany, astronomy, or meteorology, was firmly rejected. Since these facts failed to agree with Aristotle's conclusions, they could not possibly be true!

The old ideas, or rather the lack of them, did not give way to progress in weather science until about the year 1600, and the revision was actually caused by the sudden advance of astronomical knowledge brought about by Tycho Brahe, Galileo Galilei, and Johannes Kepler. The old confining crystal spheres that held the planets in their orbits broke down, and with them went the mystical force, the *primum mobile*, which was supposed to keep them moving. Astronomers no longer had use for an atmosphere extending from one planet to another, because such an atmosphere would cause friction, slow-down, and disorderliness—just the things which were alien to astronomy as they observed it.

Johannes Kepler, the discoverer of the three laws of planetary motion, seems to have realized this better and more strongly than any of his contemporaries. Possibly he knew about the calculations of the Arabs. In any case, in his posthumous fantasy *Somnium*, the space between earth and moon is decidedly devoid of breathable air. He assumed the existence of air on the moon, where actually there is none, but it was not the same as the air on earth.

Kepler died in 1630. The thermometer had been invented some twenty years earlier by Galileo; and thirteen years after Kepler's death Torricelli invented the barometer. This instrument did something of great importance. The

Willy Ley phot



➤ THE "VOICE" of the balloon: an instrument which radios atmospheric conditions automatically. It finally returns to earth by parachute and can be used again if returned to the Weather Bureau ancient idea expressed in the sentence "Nature abhors a vacuum" had been handed down through the centuries like a divine order. Torricelli's invention proved that a vacuum can exist; and only a few years later Monsieur Perier, brother-in-law of the famous physicist Pascal, carried a "Torricellean tube" to the 4790-foot summit of Puy-de-Dôme, a mountain in the Auvergne, France. The purpose of the expedition had been to prove that air pressure is less on mountain tops than at sea level. The idea was received with so much incredulity that Perier's experiment was repeated many times. And in 1650 the burgomaster of Magdeburg, Germany, Otto von Guericke, artificially created a "vacuum" in hollow metal spheres.

This was the beginning of the science of meteorology, a science whose development, more than that

Signal Corps photo from Acme

Navy photo from Acme

▲ Ready for the take-off. A few minutes after being fired, the rocket will reach a point more than 100 miles above the earth

◄ A miniature laboratory being installed in the nose of the V-2 rocket before it is fired into regions never before explored with instruments: preparations for a launching at the White Sands Proving Ground

of almost any other, depended upon technological inventions. Some twenty years after Otto von Guericke's demonstration, the airship was invented—but only on paper. Francesco de Lana-Terzi, S. J., Professor of Mathematics at the University of Ferrara, reasoned that the law of buoyancy should apply in air as well as in water. An evacuated sphere, he stated, should be buoyant in air, provided that the metal of the sphere was not too heavy itself. He described his proposed airship as a boat carried by four or six such spheres.

Of course it could not actually be built. Even today, engineers and metallurgists would find it difficult to design a sphere large and light enough to be made buoyant by evacuation. The practical application of the principle formulated by Lana-Terzi came when a gas lighter than air was substituted in a light, flexible envelope. The Montgolfier brothers employed this method in 1783, using heated air. A few months later Professor Charles produced the first hydrogen balloon, which rose from the ground on December 1, 1783, *carrying a thermometer and a barometer.* One year after that almost to the day (November 30, 1784), followed the first balloon flight specifically devoted to meteorological research. It was fathered by an American, Dr. John Jeffries of Boston, then residing in London.

The gondola carried a thermometer, a barometer, a mariner's compass, an electroscope, a hygrometer, and six bottles filled with distilled water, which were emptied at various heights and then sealed in order to provide air samples for analysis in the laboratory. Many pioneer investigators followed in the footsteps of Dr. John Jeffries—courageous scientists who sometimes almost suffocated in the high altitudes and always had to nurse frostbite and ultra-violet skin burns. European scientists had had no mountaineering experience beyond about 10,000 feet, and they had to learn the hard way that twice that altitude can be deadly to inexperienced and not too vigorous elderly men who have spent their lives near sea level.

By this time meteorology was well-established as a science. Special weather stations had been set up in several North European countries, and the Chevalier de Lamarck, in collaboration with Pierre Simon de Laplace and others, had published *Annuaires Météorologiques* from 1800 to 1815. In 1820 Brandes, a German, began to publish the first weather charts, investigating especially the movement of storms. In America, James Pollard Espy did the same and published a book about storms in 1841. Espy insisted on daily observations made simultaneously in various places.

Another invention soon presented itself for the use of meteorologists —the electric telegraph. The telegraph made it possible to compare the observations of various stations within a few hours, instead of weeks. In 1853 an international conference held at Brussels laid the groundwork for meteorological co-operation across national boundaries. In 1854 the Meteorological Office was established in London, and twenty years later a congress in Vienna put international co-operation on a practical basis.

By that time meteorologists were fully aware that they had not gathered enough information through actual observations, and they also realized that an important territory was literally beyond their reach. They needed and wanted information about the high altitudes. But few men could penetrate beyond about 20,000 feet; furthermore, balloon ascents were expensive, far too expensive to be made regularly.

It was the Frenchman Brissonet who suggested, in 1879, a practical method of getting around these difficulties. If men could not stand the altitudes, and if manned balloons were too expensive, meteorologists should send small, unmanned and inexpensive balloons to these altitudes, carrying instruments to record the needed observations. The answer he received was that the scheme was nice and logical and generally beautiful, but that there were no such automatically recording instruments.

A German scientist, Assmann, decided that things which do not exist can be invented and began to devote his time to the development of automatically recording instruments. While he was laboring in Germany, Gustave Hermite and Georges Besançon were busy in France on the same problem. They won the race. The first *ballon sonde* rose "for the honor of France" on March 21, 1893, climbing to about 9½ miles (49,000 feet). Assmann got his instruments into the air on April 27, 1894, and although he "came in second" in point of time, *his* balloon reached 71,500 feet—about 13½ miles. This is about the same as the altitude reached 41 years later by the American Stratosphere Balloon *Explorer II*, which stayed at 72,395 feet for about 90 minutes. This, however, was a manned balloon, and it carried about a ton of equipment.

The construction of these balloons, which soon settled down to a standard style, was simple. The three instruments, recording temperature, pressure, and moisture, were enclosed in a wicker container with free access for the air. Projecting loops of basket-weave also served as shock absorbers, because the box was to descend by parachute. As the balloon rose and the air pressure diminished, the rubber envelope expanded, providing a rather steady degree of buoyancy all the time. The instruments busily traced their findings on recording drums. Finally the balloon burst, and instruments and parachute fell toward the ground. When they reached denser atmospheric layers, the parachute took over and landed the instruments with not more than a reasonable amount of breakage. They then waited for someone to find them and bring them to the nearest post office, the finder to be rewarded, in due course, with a money order for about $2.00.

As time went on, the instruments were made lighter, less breakable, and more accurate. The balloons were improved so that they would rise higher, and the fabric of the parachute was lightened. The small balloons broke their own records again and again. Certainly the majority never broke or even attained Assmann's first record; they performed about as Besançon's had done. But there were always a few exceptionally good balloons, and these ultimately rose to 19 miles, or about 100,000 feet.

We all recall how, during the recent war, weather forecasts were a military secret. As a commentary on the censorship of the time, an American correspondent in London resentfully filed the following report: "Last night, at an uncertain time, an undetermined number of bombers of unknown nationality made an attack on unmentioned cities. There was no weather."

A similar announcement could have been made during World War I. There was no weather, so far as the public was concerned. This was due to an increasing realization that the weather in one part of the world often gives the key to what it is going to be in another.

Norwegian meteorologists had been in the habit of informing their coastal stations of approaching bad weather so that signals could be hoisted to warn the fleets of small fishing vessels. During the first world war they were cut off from information about the weather in England, in the mid-Atlantic, and in northern Canada. They therefore began to think more seriously than before about weather in the broad sense. Impetus was thus given to what has come to be known as "air mass analysis," and to the recognition of meteorology as a three-dimensional study.

Air-mass theory amounts to the realization that weather is the result of the interactions of gigantic masses of air moving across the map. To say that these masses are mountainous would be an understatement; there are no mountains 3000 miles in diameter and several miles high. Each air mass is essentially homogeneous, and its characteristics are determined mainly by the region of its origin. An air mass that flows down from the polar regions is obviously cold, and since cold air cannot hold much moisture, it is also dry. An air mass coming from tropical oceans is both warm and moist.

When two air masses meet, the warmer and therefore lighter mass flows up over the colder, heavier one; and in rising, the air and water vapor cools. The water vapor condenses. Result: rain. Because air mass analysis originated in wartime, it is full of military terms. There are moving *warm fronts* and *cold fronts,* and *standing fronts* where not much is happening for a period of time. There are *polar outbreaks* of cold air and on occasion *breakthroughs.* But even if air mass analysis had been a peacetime invention, the terms might not be very different, since weather activities can best be compared to battles.

With air mass analysis, height became more important than ever. Previously, weather experts were somewhat interested in knowing what was going on a mile up. Now they wanted to know what was going on at far higher altitudes. They had to know in order to understand and predict the weather accurately. And they could not wait for instruments, descending by parachute, to be picked up by someone and sent back to headquarters. The "weather plane," therefore, made its appearance shortly after World War I.

The pilot, after having climbed to his appointed altitude at the appointed time, would land at once. Meteorologists would translate the tracings of the instruments into compact sets of figures, which were telegraphed or radioed to other stations. This method was fast, but it was not cheap. So another idea was developed.

If small instruments, borne by cheap little balloons, could be made not only to record their findings but to broadcast them in some manner, the expense might be greatly reduced. If for the cost of one special airplane flight, scores of small, fully automatic weather stations could be manufactured, they would not even have to be recovered. World War I had produced something that looked like a first step in this direction. The U. S. Army Signal Corps had sent aloft small radio transmitters with direction finders in the attempt to supply long-range guns with firing data. The results were probably not too good, since the scheme was conceived and executed in a hurry. But it showed that small, battery-powered radio transmitters could be built. The problem was to modify the recording instruments so that they would make the transmitting set emit recognizable signals.

In Europe the *radio sonde,* as this new instrument was named, received a lot of publicity, but the first ones were full of minor weaknesses. A multitude of types blossomed for a while, to merge into three types which are now in use. One is known as the chronometric type, or, after its best known representative, as the Olland type. The signals sent out by this type tell their story by the time intervals between them, and the weak point is the clock required for precise timing.

In the second type, the instruments change the frequency or wave length of the transmitter, and the observers on the ground can thus interpret the message in terms of temperature, pressure, etc. This type is simple and satisfactory in action, and it can be used successfully on lonely islands and in places like northern Norway and Asiatic Russia; but it takes up too much space on the frequency bands for

Acme photo

▲ WITH A ROAR of flame, smoke, and dust, the missile rises from the Proving Ground, ushering in a new era in the exploration of the upper atmosphere. Increase in fuel capacity will permit rockets to be projected any desired distance into interplanetary space

use in the United States, where the "air" is much more congested.

The third type, which is in use in the United States, works as well as the second, without taking up as wide a band. It was developed for the U. S. Navy at the Bureau of Standards by Diamond, Hinman, Dunmore, and others and is spoken of as the Diamond-Hinman circuit. The type now in use differs from others that came earlier in different instrumentation. Temperature is no longer measured by a themometer depending on the expansion or contraction of something. It is meas-

Continued on page 236

▲ GREAT ROCK MASSES and sweeping slopes make Le Conte Canyon a favorite objective for those who are willing to journey two or three days beyond the traveled highway. A scene along the trail to Dusy Basin, above the Middle Fork of Kings River

◄ SIMPSON MEADOWS is one of the finest camping spots in the whole Sierra and is equally popular with the permanent residents of the forest. Hardly a night passes without a visit from the California Mule Deer. The brown bear comes to feed on thimble- and strawberry, and the alert traveler can see signs of fox, coyote, and mountain lion

➤ WATER, WATER EVERYWHERE, and wonderful to drink: a summer scene along the trail in Kings Canyon National Park, California. Pack animals, rented inexpensively at the portal, carry food and equipment for a few days or several weeks. Some visitors carry everything on their backs

By

JOYCE *and* JOSEF MUENCH

All photographs by Josef Muench

Afoot in the HIGH SIERRA

If you have ever thought of vacationing amid towering peaks and crystal streams, sample this journey and decide whether wilderness trails cannot enrich the recreational life of the American family

FIVE great canyons slash the western slope of the Sierra Nevada in California. The northernmost is Hetch-Hetchy, mourned by mountain lovers because it lies buried beneath an artificial lake that supplies water for San Francisco. Second is Yosemite, known the world over for its classic beauty. Farthest south and fifth is the canyon of the Kern, the only one that begins its journey in a southerly direction. Between the last two lie the incomparable canyons of the Kings River—the Middle and South Forks.

Here some of nature's grandest scenery awaits the traveler, for it is a wilderness that is pledged to remain unspoiled forever. To all who enter the portal of Kings Canyon National Park, nature flashes her welcome from snowy, sunlit peaks. She scatters flowers at the visitor's feet and lulls him to sleep with the murmur of tall trees and surging water.

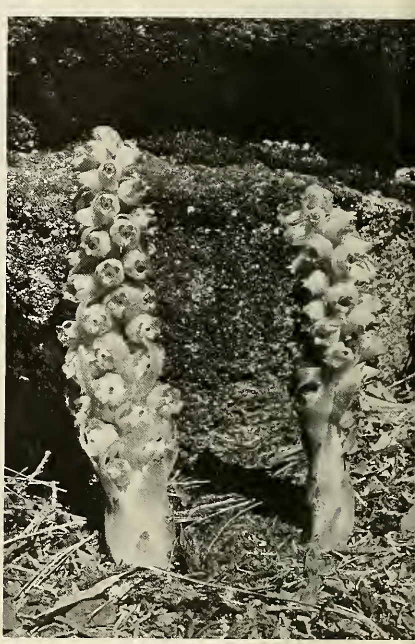
A road has been built with prodigious effort to the very floor of South Fork Canyon. It winds along the tumultuous stream and stops, as though exhausted, in the shadow of great trees. Beyond to the north extends a rugged wilderness of breath-taking splendor. You can glimpse high portions of the Middle Fork country from the General's Highway north of Sequoia Park—the tips of the Palisades and the wild canyon of the Middle Fork rising fiercely and scorning all trails as it climbs toward the stupendous mountains. Deep in this fastness lie hidden lakes; in lush meadows and bogs the white Rein Orchid grows in profusion and the exotic Leopard Lily is rampant. These beauties you can enjoy only at firsthand.

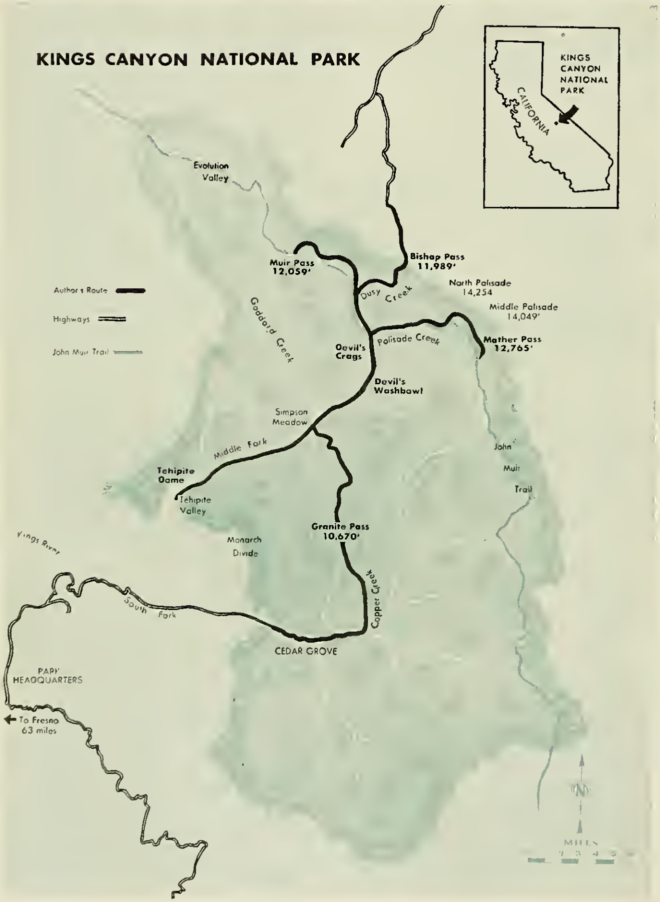
Three of us took to the trail one summer to approach the Middle Fork country. We left the pack station at Cedar Grove in the company of two stout-hearted burros, or donkeys. Occasionally a lone hiker, carrying everything on his back, fares forth into this land. These adventurers are the Spartan souls, because they can take only the barest necessities. The comfort and leisure possible with the use of pack or riding animals appealed more to us; and the cost is not prohibitive. Burros are \$1.50 apiece for each of the first five days and \$1.00 a day thereafter. Horses and mules cost \$3.50 for the first two days and \$3.00 for each additional day. A guide can be had at additional cost, but the trails are well marked, and it takes only a short time to master the technique of packing and handling the animals. They do some educating of their own along the trail, and part of the fun is in gathering tales about "Angel," "Buck," "Rock," "Gyp," and a whole procession of faithful companions that one comes to know year after year.

So off we went. At Copper Creek our trail led up innumerable hair-

◄ DEER BRUSH, whose tender leaves attract the Mule Deer, grows profusely in the Kings Canyon country

▼ THE SNOW PLANT (*Sarcodes sanguinea*) gets its name from its early appearance: it sometimes pushes itself up through winter's lingering blanket. Like our familiar Indian pipes, it has no green leaves and is a saprophyte—an organism that lives on dead organic matter. It is a brilliant red





pin turns that lifted us magically to new levels and opened up increasingly grand views of the South Fork Canyon.

At Tent Meadows we made camp and watched the night swallow the big canyon, until only the pink tips of the far-off peaks of the southern rim shone in the clear, cold sky. Around us the sugar pines sang lullabies to the small folk of the forest, and the stars flooded the world with distant brilliance. You have never really seen the stars until they shine upon you as you lie in a snug sleeping bag high in the mountains.

➤ **The Polished Dome of Tehipite** rises from the valley in one vast upsweep of 3600 feet. Those who are ambitious can find a way to scale it, on one side

Many of our friends, hearing of our travels in this great wilderness, have thought they might like to take a similar trip, so I shall try to describe our journey in a way that will help the reader to visualize the experience in terms of his own vacation thoughts.

Whatever else may be said about it, no other type of trip will give you so complete a change from the strain of the workaway world, from the crowded highway, and the thronging resort. At the same time, you will be wise not to embark upon this journey without mosquito netting. It seemed that every mosquito that had hatched that spring was ready to greet us the morning we climbed through Granite Pass and continued amid gathering storm clouds down the trail to Simpson Meadow. But these annoyances are forgotten as quickly as they are over. And the winding, dry trail kept us so busy that not even a tempting blue lake could lure us from pushing on toward the Middle Fork of the Kings River.

Other campers were already ahead of us at the confluence of Goddard Creek and the Middle Fork, feasting on a meal of trout. They had been there for days in a luxurious campsite, providing "private quarters" for each couple.

A veritable paradise awaited us here in the shade of the big trees, which lifted vertical lines to balance the steep walls of the peaks. On the ample bosom of the meadow the streams have spread out into many beds, and they change their courses so much from season to season that a new crossing is necessary each year.

Every summer several parties set up "housekeeping" here, bringing in their supplies by pack train from Cedar Grove and sending the animals back by packers. The season in these mountains is from June to September, and during that period you are apt to find a group of people reveling in the unhurried life that all of us at times crave. Now and then people like ourselves come through and give news of the distant outer world and provide a tenuous connection with civilization in case of need. The camaraderie of the trail is enjoyed to the fullest in conversations about near-by streams and lakes for fishing, favorite routes through the mountains, and experiences along the way.

After breakfast the next day, we found a shallow place in the Middle Fork where the burros could cross, and we carried our camera equipment over a log that bridged the stream. Through open colonnades of trees, rich with the scent of pine, the way led for 12 miles down the Middle Fork Canyon, hugging the river where the cut narrowed in places. Our goal was the great monolith, Tehipite Dome. Everywhere the Middle Fork is beautiful, but along this stretch in particular one is left with a lasting impression of tremendous

▲ TRIPLE FALLS in Cartridge Creek, whose roar beckons the traveler off the trail between Simpson Meadows and the Devil's Washbowl force. At night, the deep undertones that come from rocks being dragged along the stream bed sound like distant freight trains rumbling through the dark, and the mournful hoot of an owl completes the illusion.

Tehipite Dome rises from the valley in one vast upsweep of 3600 feet of polished granite. Its only peer in the 400 miles of the Sierra is Yosemite's Half Dome, and the perfection of Tehipite more than compensates for its smaller dimensions and its remote location. The really ambitious can find a way to scale it on one side, climbing to a height that commands a marvelous view. We satisfied ourselves with gazing at the gigantic formation from the base where streams dabble at its feet, up to its lofty, bald top.

No way has been broken through the wild terrain down the canyon from Tehipite Valley to its junction with the South Fork. So we retraced our steps, back the 12 miles to Simpson Meadow, delighting anew in the vitality of the stream and all the life that flourished along the trail. Slopes of granite that have tumbled sometimes the full 3000 feet gave way to bogs that spoke of the snow water which throughout the spring seeps down toward the river, husbanding a host of wild flowers.

▲ The Devil's Crags dominate the western rim of the canyon beyond Cartridge Creek. The pools hereabout attract sportsmen in quest of Golden, Rainbow, and Eastern Brook Trout

◄ There is always plenty of pure water in the Kings Canyon country, and the pack animals enjoy refreshing themselves during pauses along the trail

We walked through "hordes" of Leopard Lilies (*Lilium pardalinum*), so high that they completely hid David, age 8, on the back of one of the burros. Pale pink and ghostly under the pines, the strange saprophyte, Pinedrops (*Pterospora andromedea*) bends its head on sticky stems. Pine cones, sometimes as long as 14 inches, dropped at our feet as we came again into the more gently rising conntry near the big meadow.

Several miles beyond our crossing of the swift Middle Fork, we turned off to see Triple Falls in Cartridge Creek, catapulting down a narrow, black canyon. It is so hedged in that there are no open views, and one must balance precariously on the edge to see its descent. Its severe, perpendicular lines of rock are softened only by graceful ferns that cling in cracks, kept moist by the continual spray. Three segments of the falls dash down in different planes, turning like a staircase first to one side and then another. Down the shaft of the middle one, a big tree trunk has wedged, upright. Its dark, water-stained wood adds to the somber hue of the canyon.

Now the main canyon rises grandly into higher country, its voice swelling as the drop becomes more determined. Along the trail, one cataract after another chases seaward in endless variation. At

▲ THE CATCH. A fisherman "deep" in his favorite sport, about to land a gamey trout in the net. A scene along a gay Sierra stream in the heart of Kings Canyon National Park

➤ THE LESSON. The author showing his son how to fasten a bright new fly to the line. There was trout for supper that night the Devil's Washbowl, the stream projects itself about twenty feet into an almost perfectly round pool, swirling green and white in the basin. Making a complete change of direction, the water surges over a brink at one side with even madder gyrations and hastens down the gorge, as though furious at each delay. What a canyon it is!

The cliffs from Simpson Meadow to Tehipite Valley had struck us as high and impressive, but this new stretch proved beautiful beyond anything we had ever seen before.

This is no "pink tea" mountain scene but the very heart of the Sierra. Going cautiously up the granite-hewn trail, very close to the edge, we were thrilled by its power and magnificence. One can easily imagine that the devils themselves may use it at night for a playground, not to mention the bear whose tracks we saw in the dust. The river is seen not merely as a thin ribbon from some rocky rim but close at hand, in all its throbbing force. Man hugs the side of the abyss, climbing and dropping as the terrain demands, but always deep in the granite.

Above this plethora of falls spreads Grouse Meadow, loveliest of them all! The young Middle Fork dallies a while in its peaceful basin as if to gain the poise and vitality needed for the tumultuous journey ahead. In the valley, broad for this country, is spread a gracious park. Trees define its border. and a heavy mat of grass carpets the footfall. On either side, gigantic walls go up and up and still up, to culminate in the Devil's

▼ THE PEACE of the wilderness: forest-clad slopes rising to distant mountain crags along the flashing waters of Palisade Creek

▲ LANGILLE PEAK looms to the right of a gigantic cirque, the basin-shaped birthplace of an ancient glacier

Crags on the western rim. Like a jewel in the midst of this grandeur is the intensely blue water of the river, tranquil and icy cold.

Voices floated to us on the quiet air, and following the tell-tale spiral of smoke that rose from a group of trees, we found other campers making supper. The meadow itself is a breeding ground for trout, and above and below it the pools draw sportsmen in quest of the gleaming Golden Trout, the gamey Rainbow, and the Eastern Brook. Every party can find its own small brook meandering through the meadow and providing the best drink in the world.

Just below Grouse Meadow, Palisade Creek joins the Middle Fork, and a trail follows the noisy stream up to the base of the palisades. We left our burros in Deer Meadow, determined to get as close as we could to the gray pinnacles, highest points in this vast hinterland. They rise to more than 14,000 feet and support on their eastern slopes the southernmost living glaciers in the United States. Here on the western side, lakes dot the approach to Mather Pass, an aerie 12,765 feet high. The pass is reached by a thousand switchbacks, more or less, where the rare yellow columbine (*Aquilegia pubescens*) and the wild primrose (*Primula suffrutescens*), found only at high altitudes, charm even the weary. The view from the pass beggars all description. Lakes lie on their shelves like uncut gems in some vast workshop for jewelers.

A single ridge, Cirque Crest, separates the two river basins at Mather Pass; beyond, the trail enters the Upper Basin of the South Fork.

But we wanted to see the source of the Middle Fork and turned back toward it, watching the wide Palisade Basin open before us as we dropped again to spend the night in Grouse Meadow.

Not far from Little Pete Meadow it is possible to climb the eastern wall to Dusy Basin. From the switchbacks that scale the only accessible portion of the cliff, a tremendous cirque, "birthplace of a glacier," opens, with the towering Langille Peak at one side. We saw here several fine examples of the

"Billy Owl Tree." These trees, usually junipers, have twisted so that the entire trunk turns like a corkscrew. I once asked a famous naturalist how they were formed, giving him the only reason that I had ever heard. My version was that a Billy Owl sat on the top of the tree, craning his neck to follow some denizen of the forest as it circled the juniper. The trunk of the young tree turned, too, and when the bird flew away, it stayed in a continuous whorl. Said the naturalist, "Well, that is as good an explanation as I can offer."

Beyond the basin, where the Dusy Lakes in the clouds mirror the sky, the way mounts to Bishop Pass (11,989 feet). Then it drops to the eastern scarp and finds the town of Bishop in Owen's Valley.

In Le Conte Canyon we are still on the John Muir Trail, named for the man who fought and won so much for conservation in the West. This is the hiker's "highway" that follows the crest for some 78 miles in Kings Canyon National Park and links it with Yosemite to the north and Sequoia to the south. As we mount higher and higher, the Middle Fork grows ever smaller, but its bouncing waters seem eager for the strength they will gather on their way. The time comes when the baby river can be crossed on stepping stones, and its thin voice is outdone by the wind in the cliffs. The trees have given way to the tortured dwarfs of the true highlands, and only rock and snow, granite and lake, remain under the sky. Pushing on, animals and man sense the climax that comes in Muir Pass. It is 12,059 feet above sea level, in a world of its own. Often late into July it is still closed to all but foot travel, and those planning to cross it into the wonderful Evolution Country should check with the Park Rangers on the condition of the snow.

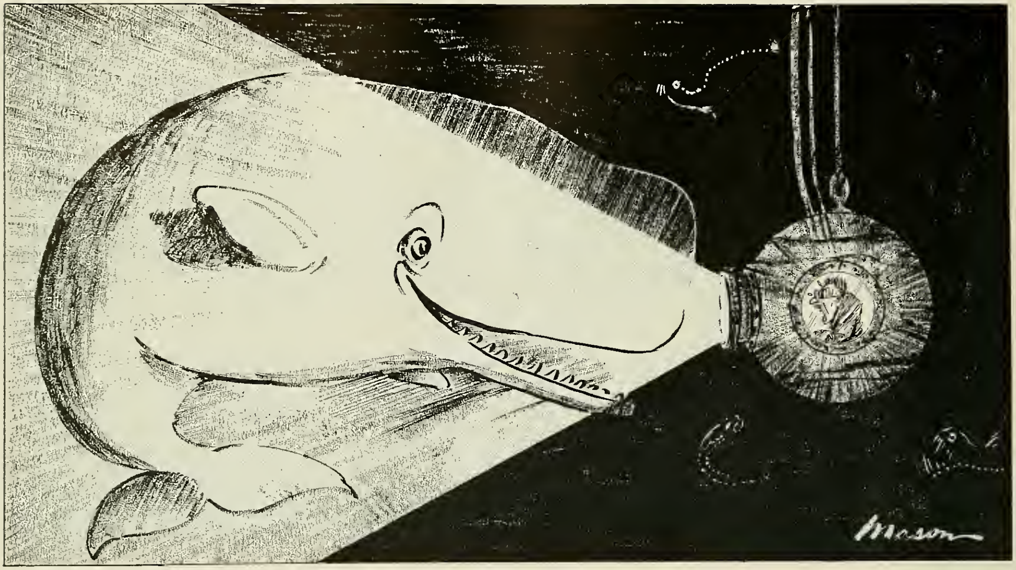
You will never forget having been there. A rock hut, giving a Tibetan aspect to the scene, is the only sign of man for many miles. Cold, bare, blue lakes lie on either side of the pass; ribbons of snow relieve the granite. Out beyond is a universe of form and shadow that stirs one strangely.

This, then, is the Middle Fork Country, from river's edge to craggy peak. It can be reached from many points, but only on foot or in the saddle. There is no room in its vastness for the mechanical speed of the auto. Thank fortune, there never will be. This is the silent inner chamber of the continent's soul from which comes a strength and calmness that remains in one's life even after resuming work. Once is never enough. Having tasted the joys of the Sierra country, you will feel each spring the urge to be off again. Within its fortress you must meet nature on her own ground and relinquish the conveniences of home for the inspiration of the heights. Now that the days are here again when we are free to take to the mountains, I, for one, want to go back into the Middle Fork Country of the Kings River.

▲ Twisted junipers, reminding one of a pair of whirling dervish dancers suddenly frozen to immobility. These trees are sometimes called Billy Owl Trees

➤ Shelter in Muir Pass: a welcome spot in the northern section of Kings Canyon National Park, where for thirteen miles the trail, lacking firewood and camping spots, looks like a Tibetan landscape

DEEP DIVE



By John Eric Hill

Drawing by

G. Frederick Mason

IN April, 1932, a 45-foot sperm whale, probably pursuing a giant squid (his normal prey) in the inky blackness of the ocean's depths, blundered into the submarine cable that connects Ecuador with Panama. There the ocean floor was over 3200 feet below the surface, more than one-half mile down. He caught his lower jaw on the cable and, struggling to get away, twisted it around his body and tail and broke it. The repair ship, sent to investigate the cause of the trouble, pulled up the cable and with it the drowned cachelot. Although it had been long suspected that this species and the smaller bottlenose whale fed at this depth, and wounded whales were known to have gone still deeper, the accident to whale and cable fully confirmed these facts.

At such a depth the pressure on every square inch of the body surface is tremendous—more than 1250 pounds to the square inch. This must compress the whale's entire body, including the lungs and the great blood vessels. The air in the lungs would be forced out if it were not for the peculiar "sacs" of sperm oil that close the nostrils tightly under the pressure of the water.

The same year that the sperm whale was caught in the cable, William Beebe and his associates descended into the depths of the Caribbean in a bathysphere. This was a round diving chamber made of inch and one-half steel plate, with fused quartz windows three inches thick. Only with these protections from underwater pressure could men descend to a depth of 2200 feet, there to see the strange creatures that dwell in perpetual night. They might well have met sperm whales returning to the surface from 1000 feet deeper.

For us landlubbers an equal marvel exists in the fact that diving mammals go for long periods without taking a breath. By breathing deeply we can hold our breath for about one minute. With much practice and by taking many deep breaths, exceptional individuals may go six minutes. A dog will die after four and one-half minutes without breathing, a cat after three minutes. Expert pearl divers stay under water about as long as this.

On the other hand, a muskrat may remain under water for twelve minutes and a seal, beaver, and manatee about fifteen minutes. A humpback or fin whale may stay down from twenty minutes to one-half hour, and the sperm whale and bottlenose may submerge for one hour or more.

It is not known exactly how these sea mammals can continue to live after such long periods without breathing. Of all the tissues of the body, those of the brain and heart are the most seriously affected by lack of oxygen, and by some mechanism the diving whales must keep these organs supplied. The heartbeat in all water animals slows down to a fraction of its usual speed during diving, and the systemic blood supply is greatly reduced.

These animals differ from land animals in another respect, too. When we get "out of breath," the accumulation of carbon dioxide in the blood automatically causes us to breathe faster. In animals that spend much of their time under water, the nervous centers that regulate heart action and breathing are not activated by this increase of carbon dioxide.


AMNH photo

▲ THE AZTEC GOD TLALOC, whom the early people of Mexico adorned with strings of popcorn

POPCORN

To many it is only a "circus treat," but to the scientist, popcorn is a key to important questions concerning early man in America

By EDGAR ANDERSON*
Missouri Botanical Garden, St. Louis, Missouri

POPCORN, trivial though it seems, is a key to various problems. Or rather, it would be a useful key if it were not for that very triviality which has led to its being generally ignored by anthropologists, travelers, and students of important crop plants. It is so closely identified with carnivals and circuses, with neighborhood movie houses and children's parties, that almost no one has taken it seriously. Though over one hundred varieties of popcorn have been introduced into the horticultural trade from time to time, there is not yet a published check list of their names. The very fact of there having been so many has had to be dug out the hard way by leafing through the yellowing pages of old seed catalogues.

In the last five years, by traveling and writing many letters and asking many questions, it has been possible to find out that popcorn is an ancient food of much importance in the two Americas and apparently in a part of the Orient as well. Rare indeed, however, is the anthropological work that lists it even without comment. Yet popcorn is theoretically of great importance for a variety of reasons. For one thing, if we only had a résumé of the facts about popcorn, we would be in a better position to discuss the origin of corn. Nearly all popcorns have very small, hard kernels. Primitive maize, or corn, probably was hard and certainly must have been small. If it has survived anywhere in the modern world, we are most apt to find it still being grown as a popcorn, the one use to which a small hard kernel is still perfectly suited. Likewise, it would seem that popping might have been one of the original uses of maize. A primitive people with no extensive machinery for preparing grains must have had a difficult time preparing maize for the table before any soft-kerneled varieties were developed. Eating it as green corn, sprouting it for beer, or popping the kernel with heat would seem to have been the most likely ways in which such a people could have used these stony little seeds.

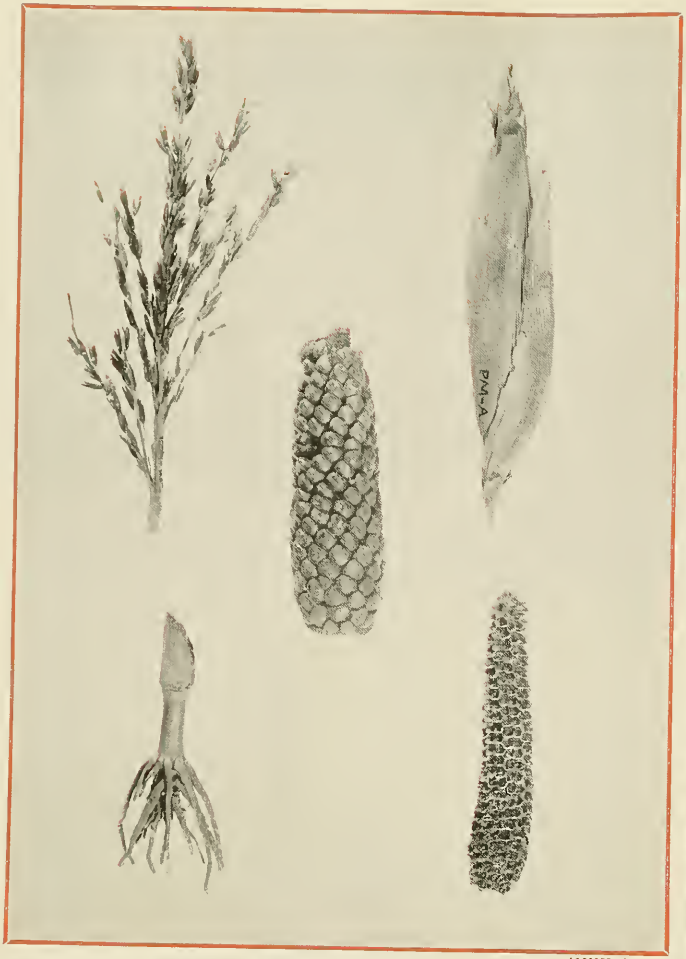
For a variety of such reasons, I set out several years ago to gather as many facts as possible about the various kinds of popcorn, where they came from, and how they were used. To be sure, they were all used as popcorn. But just exactly how were they popped—in hot ashes or sand, in front of a coal fire, on a griddle, in a clay or metal pot, or in a corn popper? The information is widely scattered, and it is going to take at least another ten years before the subject can be authoritatively discussed. Meanwhile, the evidence accumulates bit by bit in the oddest and most diverse ways. Among hundreds of unpublished colonial documents, one was found which described in detail the popcorn of Sonora, Mexico. In the storage vaults of the American Museum of Natural History there are a few glass vials containing popped kernels that were found in ancient South American graves. Among hundreds of returned travelers there were two from Ecuador who not only had seen popcorn being used in the back country, but had taken accurate notes on its uses and imported actual specimens that could be grown and studied.

There are scattered bits of evidence, which all fit together nicely, about the Aztecs and their predecessors. It is certain that these peo-

*DR. EDGAR ANDERSON, geneticist at the Missouri Botanical Garden, has taught genetics, economic botany, and field botany at Harvard and at Washington University in St. Louis, and he was a Jessup lecturer at Columbia University. Research in hybridization between species and races engaged Dr. Anderson for the first fifteen years of his professional career, and he is now concerned with this problem in cultivated plants, particularly maize.

The major kinds of corn plants, their location, and the purposes for which they are grown are the targets for Dr. Anderson's present research project. In connection with this he has done a great deal of writing and traveling.—ED.

ples had a very high quality popcorn, that it had special ceremonial uses, and that their modern descendants in central Mexico are still growing similar varieties and using them in the same ways. When Manuel Gamio excavated the great pyramids raised by the Toltecs at Teotihuacán, just north of Mexico City, he discovered charred masses of corn, husked but still attached to the ear. This find has been carefully preserved and the ears are identical in size, in the shape of the kernels, and in the number of rows per ear with a pointed-kernel popcorn still being grown in the mountains around Mexico City. In

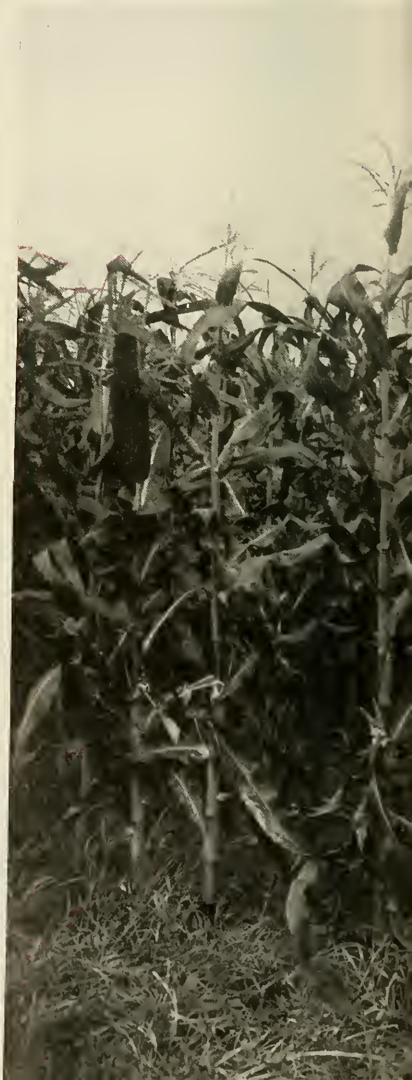


AMNH photo

▲ ANCIENT POPCORN excavated in Chile, showing tassel, ear, husk, root node, and cob

AMNH photo

▲ POPCORN expands from 18 to 27 times its original volume in popping



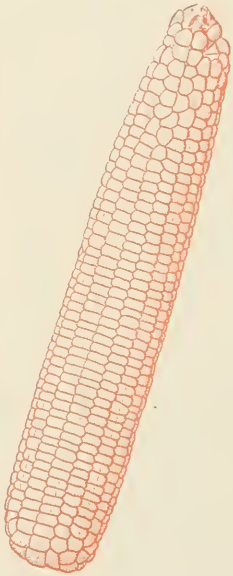
many a modern corncrib in the valley of Toluca, just west of Mexico City, exact duplicates of the Toluca ears could be found today. Nor is there the slightest possibility that the Toluca varieties have been recently introduced from popcorn growing areas in the United States. They are strange looking plants by American standards. They have wide leaves, a shallow root system, and a thick, heavy tassel. They are well adapted to the climate of the mountains where they are grown but do not do well in the corn belt of the United States.

As a matter of fact, the introduction was probably the other way around, and these ancient Mexican varieties are perhaps one of the sources of the so-called "Japanese-Hulless" popcorns, introduced a few decades ago and still outstanding for their high quality. They have most of the peculiar habits of growth of the Toluca popcorns though not to such an advanced degree, and may well have been derived from them by hybridization and selection.

From Sahagún, the scholarly monk who recorded the history and customs of the Aztecs in the early years after the Conquest, we learn a good deal about popcorn. His account can be confirmed and supplemented from other early chronicles. The Aztecs not only used popcorn as a food, they also used strings of it to decorate certain idols such as that of Tlaloc, who in one aspect or another was the God of Maize, the God of Fertility, and the God of Rain. In a similar fashion today, one may find statues of the Virgin Mary with beautiful necklaces of snowy-white popcorn in little, out-of-the-way chapels in modern Mexico.

In the west of Mexico from Sonora to Jalisco, a totally different kind of popcorn is grown, and it

Skoglund Studio, courtesy National Popcorn Co.



▲ "EXPLODER CORN," or *maiz reventador*, a type of popcorn that has apparently been grown since ancient times in western Mexico

◄ THE COMMON BELIEF that popcorn grows only on small, stunted stalks is wrong. This South American popcorn, growing in Nebraska, is eight feet tall is called by another name, *maíz reventador,* literally, "exploder corn." It is a tall, handsome plant with long, wiry tassels and tough, narrow leaves, practically the extreme opposite of the little rice popcorns of Toluca. It has a long, narrow ear and tiny kernels, and the hulls are tough when the corn is popped, though the flavor is excellent. It is an ancient variety in this region, seldom seen in the big cities, not too common in the towns, but almost universal in little villages away from the main roads. It is used for popcorn balls and for *ponteduro,* a kind of brittle made with popcorn and various other goodies such as peanuts and squash seeds. As one travels north toward Sonora, *maíz reventador* becomes increasingly important as one of the main sources of *pinole,* a meal prepared by parching or popping the kernels, grinding them to a fine powder, and mixing it with sugar and various flavorings such as anise and cinnamon.

In Jalisco the use of *pinole* is more or less incidental. There it is the kind of thing country children fill up on between meals, but in the back country of Sonora it becomes more and more important until it not only equals the famous Mexican tortilla, but may even outrival it in popularity and become the actual staff of life for the people. Apparently *pinole* made from *maíz reventador* has been the main food in this region for a very long time. In the beautiful public library of Guadalajara, among many other unpublished documents, there is an official account prepared in 1776 of a town in Sonora named San Miguel de Sahuaripa. It describes *maíz reventador,* calling it by that name, and goes on to say that it is used for *pinole,* which was made by toasting and grinding the aforesaid maize and was the common food of the land (*"para pinole que lo asen tostando dicho Maíz y mlindolo y es el Bastimento corriente de la tierra"*).

Significantly, it is in Ecuador, one of the most purely Indian of the Latin-American countries, that popcorn still takes an important place in the diet. Two members of the wartime cinchona mission, Dr. W. S. Steere and Dr. W. H. Camp, have brought back sample ears and detailed notes about its uses in the highland country around Quito. This Ecuadorean popcorn or *canguil,* to use the native name, is still quite another kind of maize than either the rice popcorn of Toluca or the *maíz reventador* of western Mexico. It has pointed kernels like the Toluca corn, but they are much bigger and are swollen at the base, tapering off abruptly to a sharp point. The ears are much longer and have fewer rows; if anything, they have more of the ear-shape of the *reventador* popcorns. The tassels of the Ecuador popcorn are different from both of the Mexican kinds. They are large and very much branched, with very small glumes. We are certain that this popcorn has been grown in Ecuador for a very long time, just as the other two kinds have in their regions. Similar ears of corn have been recovered from pre-Columbian graves in various parts of the South American highlands, and, as mentioned above, there are even some instances in which kernels of popped corn have been found with these ancient burials.

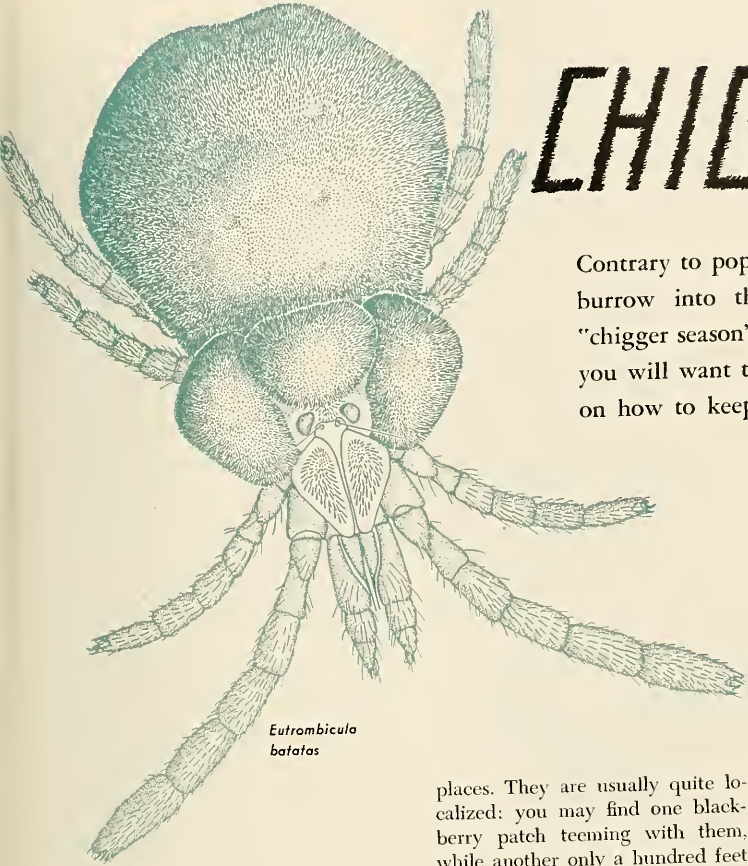
These three very different popcorns do not exhaust our catalogue of pre-Columbian varieties. The excavations of Junius Bird of the American Museum have unearthed a fourth and equally distinct type, from the coast of northern Chile. As a matter of fact, from the lowest level of his excavations at Arica, nothing but one small-kerneled variety was found. While we cannot be certain that it was popcorn, it is closely similar to popcorn types still grown at oases in that region, and it is significant that storage bags of *pinole* or some similar substance were recovered from these same levels.

For the present, such facts as these raise more questions than they answer. Instead of one primitive, small-kerneled variety, we have found at least four, three of them definitely tracing back to A.D. 1200 or earlier. The fourth variety is apparently just as old, but definite proof is not yet at hand.

The exploder corns of western Mexico accent some of the puzzles in tracing relationships between the American southwest and the civilizations of Mexico. We know these types are common in the Sonora back country and that they have been there since the time of the Spanish Conquest—probably much earlier—, yet they are almost completely lacking in Arizona and New Mexico. If all or part of the contacts between Mexico and our Southwest took place up the narrow Sonoran Corridor between the Sierra Madre Occidental and the Gulf of Mexico, why were none of these distinctive popcorns carried on into Arizona and New Mexico? They are very rare there today and completely absent in most areas, nor have they as yet been found at any of the various archaeological sites in that dry country. The contacts therefore must have been mainly through the mountains or by some very indirect route.

The popcorns of the Orient raise an even larger question—that of contacts between the Old World and the New. Various popcorns are grown in the Orient, mostly among very primitive peoples. How and when did they get there, and by what route? Professor H. H. Bartlett, of the University of Michigan, has brought back from Sumatra herbarium specimens of a small pearl popcorn that is grown by the peoples of Sumatra. It even has a ceremonial name, which would ordinarily indicate considerable antiquity. In northern Burma and south China, small-kerneled, flinty varieties are grown by primitive, pre-Chinese peoples; and in northern India there are accounts of such varieties being used in the preparation of a meal that sounds suspiciously like *pinole.* Can it be possible that corn, like the sweet potato, crossed the Pacific in primitive times, and if so in which direction did it travel? Our first survey of the facts about popcorn has brought together enough information to raise these questions. When a careful survey of the world's popcorns has been completed, we shall be able to answer some of them.

THE END


Eutrombicula batatas

CHIGGERS!

Contrary to popular belief, they do not burrow into the skin, but with the "chigger season" just around the corner, you will want to know these latest tips on how to keep them from biting you

By
MARY H. MICHENER
and
CHARLES D. MICHENER*

HAVE you ever gone blackberry picking and come home with more chiggers than blackberries? For days those viciously itching bites around your ankles, knees, and waist reminded you of the outing. The chigger mites, or red bugs, are familiar to people throughout the southern states. They also occur in large areas of the North Atlantic and central states and in scattered localities elsewhere in this country.

They are most common in grass and low, open growth of all kinds, but are often plentiful around stumps and rotting logs. Their abundance in blackberry patches and pastures is probably due to the number of animals, such as birds, rabbits, and livestock, in these places. They are usually quite localized: you may find one blackberry patch teeming with them, while another only a hundred feet away, and apparently similar, will have few or none.

It is small comfort to learn that only a few of the hundred or more known species of chiggers in the Americas attack man and that no species uses man as its chief host. The chigger would prefer that you were a chicken, for example, or a box turtle, or even a toad. The commonest species in this country, called *Eutrombicula alfreddugèsi* (after Alfred Dugès who studied this species in Mexico over 50 years ago), has been found on amphibians, reptiles, birds, and mammals. Some species are found only on snakes and lizards, others only on birds. In their larval stage all chiggers attack vertebrates. They belong to the subfamily Trombiculinae of the family Trombidiidae. All the mites, with their cousins the ticks, form the order Acarina and are more closely related to spiders than to true insects.

The Attack

What is the nature of this annoying little beast? You may chance

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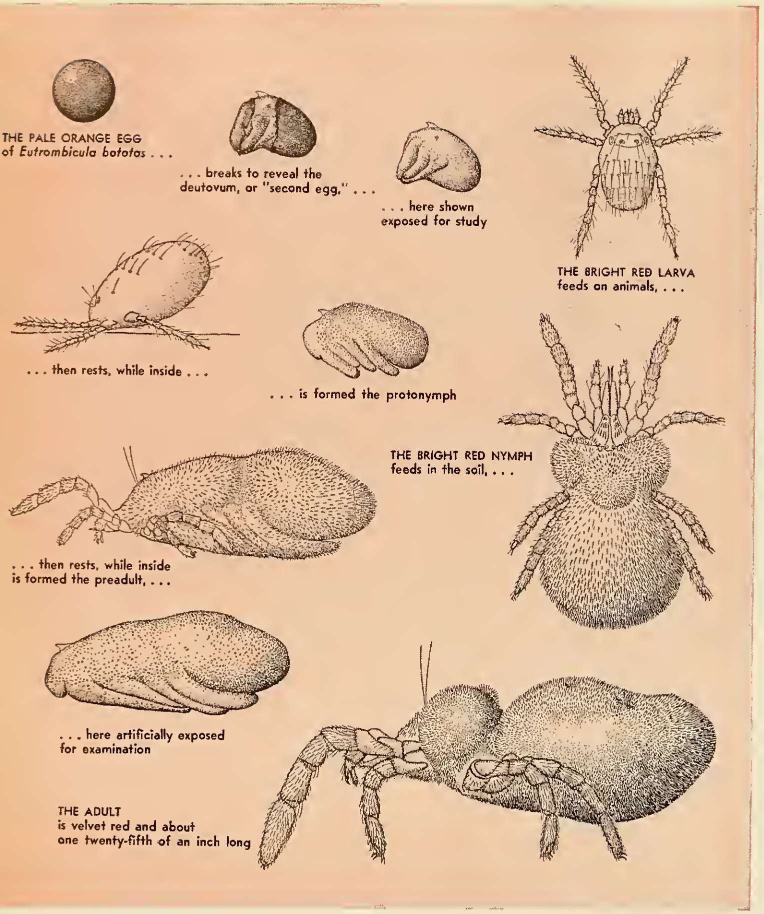
Much of the information contained in this article was gathered or verified during the many months that the Micheners spent in Panama, where Dr. Michener served as a Captain in the Army Sanitary Corps. He was sent there to obtain basic information on the habits and life histories of chiggers in connection with studies concerning scrub typhus, an Oriental chigger-borne disease.—ED.



to see one as it crosses a dark shoe, yet even against contrasting color the brilliant red mite is so small as to be barely visible. It is actually only 0.2 millimeter in length at the biting stage. This means that if you were sufficiently deft to line up 125 larval chiggers, they would form a line just one inch long.

From your shoe the chigger wanders upward to areas where the skin is moist and to places where the clothing fits tightly against the skin. Particularly favored places are under the belt, around the tops of the socks, and in the groin and armpits. It often chooses to bite at the mouth of a hair follicle. Having found a cosy dining nook, it inserts its minute mouth parts, or chelicerae, into your skin.

Most persons who have ever heard of chiggers have one definite idea about them,—that they "burrow into the skin." This common belief is even supported by many authorities, but it happens to be wrong. We must not confuse the chigger with the jigger or chigoe, a small flea which does burrow, especially under toenails, and later extrudes its eggs through an opening in the skin. An attached chigger may be partially surrounded by the swelling of your skin, but it does not burrow in. It has no equipment for burrowing and is much too large to enter a pore. Furthermore, if you look very carefully before scratching at all, you will see chiggers attached on the outside of your skin. One reason that you don't usually see a chigger at a chigger bite is that you have scratched it off before realizing that there was a chigger there.

The chigger does not suck blood. This little gourmet brings his own sauce to tenderize the meat. An injection of a digestive fluid (no doubt containing a proteolytic enzyme) dissolves the tissues so that it can suck them up. Your skin reacts to this abuse by hardening the cells on all sides of the path of the potent juice. There is formed a tubule or sort of miniature well, often as deep as the chigger is long. The liquefied tissue, which the chigger drinks, is contained within the hardened walls. When replete, your uninvited guests drops off, if you have not already scratched him off. Presumably it is the action of that digestive fluid which makes the bite itch so. The insertion of the mouth parts, or chelicerae, is not ordinarily perceptible. It is after a few hours, when the digestive juices have begun their work, that the itching begins. The itching becomes even worse after a day or two, and you may still be absent-mindedly strumming the spot two weeks later.

Your contribution to the development of the chigger is an important one, for in all its life cycle it feeds but once on an animal or human host. The life cycle, in itself, is an amazing series of events. The details of development are unknown for many species and they may vary in many ways. The life story of *Eutrombicula batatas*, a common tropical species which we have studied in Panama, will serve as a good example. The accompanying illustrations of this species are all drawn to the same scale. From all the available evidence, the various chiggers in the United States have similar life histories.

Nature of the Enemy

The eggs are laid singly on the surface of moist soil. They are so small (about 0.15 millimeter or 0.006 inch in diameter) and so pale an orange hue that they can best be discovered by searching the soil in chigger-rearing jars with a binocular microscope. Sometimes an egg is seen within the body of a slide-mounted and cleared adult female chigger. Four or five days after the egg is laid, the shell cracks. At this point you might expect a larval chigger to burst out. But no, chiggers continue to be different at every turn. The two halves of the eggshell are pushed apart, but between them lies an odd lumpish form with a spine on its back. It has burst the shell by becoming larger (perhaps by absorbing water) until it is half again as large as the spherical egg. The creature at this stage remains motionless within the broken eggshell for six or seven days and is called the deutovum or "second egg."

Within the deutovum the larva forms. Its legs can be seen moving about inside as it prepares to emerge. It takes several hours to work its way free. This little fellow is all red, the six legs somewhat lighter, the eyes a particularly deep red. Under a microscope you would be able to see the definite patterns of bristles with which it is decorated or, perhaps, armed.

This is where you come in. It is the larva that bites. As soon as it is free of the eggshell, it starts to crawl around and upward. Larvae climb onto blades of grass, sticks, and leaves of plants or bushes, indeed onto anything rising above the general level of the ground. Some Panamanian species which are bird parasites even climb trees. Unlike young ticks, which patiently and quietly wait in such places for host animals to walk past, the larval chiggers run about constantly. They are particularly active when the sun is shining. When you, or better hosts, pass by, brushing against the places infested with chiggers, they quickly catch a ride, and after finding a good spot, they bite. We have seen small areas of short grass in Panama so heavily infested that 40 or 50 chiggers could be found on each shoe any time we were walking about.

The engorgement on the digested tissue of a host may take several days. We have seen chiggers satisfied with two days' feeding on a chicken, while other individuals of the same species, on the same chicken, will remain for as long as ten days. On a lizard another Panamanian species of chigger may remain as long as three weeks before dropping off. Why the duration of feeding varies so widely is still a mystery. The unlucky chigger that depends on a human being for his once-in-a-lifetime feast is almost sure to be scratched off or smashed before it has fully engorged. There is some evidence that even if the chigger is undisturbed, it does not find man a very satisfactory host.

When the meal is finished, the chigger larva drops off onto the soil. It may crawl around for a day or so, then it stops in a protecting crevice, straightens its legs, raises its abdomen, and apparently anchors its mouth parts in the ground, in the position shown in the first drawing in the second row at left. Thus it remains motionless while inside a melting down and reassembling of materials takes place that is more spectacular than the reconversion of a war plant to peacetime industry.

The developing protonymph or "before nymph" can be seen through the bloated larval skin. Its eight legs are folded and not associated with the now empty shells of the six larval legs. The protonymph never emerges from the larval covering, although it has a spine on its back which breaks the larval skin. It in turn houses a reincarnation of itself. Within its saclike unjointed legs grow the jointed legs of the nymph. About a week after the larva makes its last stand, the nymph makes its debut, breaking out through the larval integument. An active, bright red, eight-legged creature about one-half millimeter (one-fiftieth of an inch) long, it might be considered the adolescent chigger. It resembles the adult in most ways except in the capacities for parenthood.

When the nymph is ready to become an adult, it does not simply split its skin and step out, as would a grasshopper. Again this extreme introvert withdraws inside its own drying skin to change. First there is a pupa-like preadult, much like the protonymph, having a thin bumpy skin and a horn on its back. The preadult does not move from the old nymphal covering. Inside of it the true adult is formed. After a week of preparation the adult emerges from the two layers of integument.

We can look on the nymphs and adults dispassionately, for they cannot bite, and we must grant that they are very handsome little animals. Like the nymph, the adult is brilliant red, with the eight legs a little paler and the eyes a little darker. A dense coat of plumed or feathery hairs gives it a rich velvety appearance, enhanced by the lobed body form.

From the shape of the adult you can easily tell the general group to which any red mites you may find in the soil or under stones or logs belong. If there is a stylish constriction between the front and rear parts of the body, as in *E. batatas*, the species is a true chigger, which in the larval period at-attacks vertebrates. Incidentally, the two parts of the body are not thorax and abdomen as might be expected from analogy with insects, for the two posterior pairs of legs in the chiggers come from the rear portion of the body. The front part is called the prosoma, the rear the metasoma.

The adult chigger is almost a re-

➤ AN ADULT North American chigger, *Eutrombicula alfreddugèsi*, on a bit of soil spectable size, nearly one millimeter long. In walking an inch it would be measuring its length only about 25 times. After it has fed, it is slightly larger. Females average a little larger than males. Just what the nymphs and adults normally eat is not certainly known. In the laboratory, nymphs and adults of *E. batatas* were most successfully reared on the eggs of various insects. A few developed on soil mixed with chicken manure. These are probably good clues to their feeding habits in nature. It is interesting to watch the adults with a binocular microscope as they feed on insect eggs. They use the chelae, or pinchers, of the pedipalps (short leglike structures between the front legs) to adjust the egg and hold it while they puncture it with the sharp chelicerae, which can be seen between the pedipalps in the illustration.

In Panama we found nymphs and adults of *E. batatas* on and just beneath the surface of moist soil in areas of dense, short grass. They were very abundant only around villages or in other places where chickens or other animals provided a good food supply for the larvae. As many as two thousand chigger larvae were sometimes found on a single small chicken, many of them clumped together to form large, bright red masses. Young chickens were found to be much better hosts than old ones; the dense feathers on mature birds apparently discourages the larval chiggers, many of which dropped off without ever reaching the skin.

In the United States, while chiggers are sometimes chicken pests, the ones that attack man are mostly inhabitants of woodlands and brushy areas. The adults of these are usually found in leaf mold, under logs, in rotten stumps, and similar situations, although they also occur in the ground.

Secret Weapon

Quite apart from their nuisance value, the chigger mites are of great concern to us. In the Far East and Pacific areas, from Queensland, Australia, through the East Indies to India and Burma and north to southern Japan, they are carriers of scrub typhus. This serious disease is also known as Japanese River Fever or Tsutsugamushi Disease. Because of its importance in Japan, the chiggers there were extensively studied by Japanese students, and until the war the Japanese chiggers were better known than those in any other part of the world. When Allied troops were operating in scrub-typhus areas, the disease was a problem sufficiently grave to warrant immediate research on its transmission and possible prevention.

We know how a mosquito carries malaria from one person to another in successive bites. But, you will say, if a chigger bites only once in its lifetime, how can it transmit a disease? Amazing as it seems, the microscopic organism causing scrub typhus (a *Rickettsia*) survives in the chigger through all the mite's transformations and is carried through the eggs to the larvae of the next generation.[1]

We are often asked whether there is a danger of scrub typhus being introduced into parts of the United States where chiggers abound. The danger is not so great as it might appear. Man is a very poor host for chiggers, and the chance that an infected person could return to this country and infect our native chigger population is negligible. So also is the chance that he would bring, attached to him, oriental chigger larvae in a sufficiently healthy state that they could go on through their life history and produce offspring to infect persons or animals in this country. A greater danger is that infected rodents might be introduced. Because of the habits of the chiggers, however, the disease is primarily rural, and rural rodents are not ordinarily carried on ships. Another possibility is the introduction of infected nymphal or adult chiggers in soil.

Field Maneuvers

Panama proved ideal for the investigation of the life histories of chiggers, as we have described, and for field experiments under tropical conditions with repellents and killing agents.

A few miles up the Chagres River from Gamboa, in the village of Santa Rosa, a dozen little native boys, dark-skinned and Spanish-speaking, began working for the U. S. Army. First they had a bath, which according to their custom consisted of a swim in the river. Then they were inspected with a reading glass, and any chiggers still on them were removed. After this preparation they were provided with special small-sized uniforms. These had been carefully impregnated with various substances that had appeared promising in preventing chigger attacks, in experiments by the U. S. Bureau of Entomology and Plant Quarantine. A few wore untreated suits as controls.

The boys were turned out to play in a grassy field which we knew to be heavily infested with chiggers. This was no real hardship, for they were accustomed to chiggers as a part of their daily lives, sharing them freely with the chickens, pigs, and goats. Perhaps the greater hardship lay in having to wear so many clothes! After three hours of play in the grass (we took this fine opportunity to have the boys collect spiders for the American Museum of Natural History), the boys were kept in an uninfested area for two hours. This period was to let any chiggers drop off that were merely strolling. Only the real hangers-on interested us. The number of chiggers attached to each boy was then counted.

After many such experiments using various materials, the best available material was found to be benzyl benzoate. It killed chiggers after several light washings of the impregnated clothes. Benzyl benzoate had been found best also by other workers studying different

[1] Transmission of disease organisms from one generation to the next is also known to occur in various tick-borne diseases, such as Rocky Mountain Spotted Fever and Relapsing Fever. Since each tick bites more than once during its life, however, such transmission is not necessary to perpetuate these diseases.

species of chiggers. Other substances were effective for varying lengths of time.

The Repulse

The most practical killing agent, from the standpoint of availability, is dimethyl phthalate. It kills chiggers quickly and is found in some of the newer commercial brands of mosquito repellents. Dimethyl phthalate applied to your skin will prevent many bites, but its effectiveness wears off after four or five hours. A better way is to apply the dimethyl phthalate to your clothing, where it will be effective until the clothes are washed. You will get reasonably good protection by drawing the mouth of a small bottle of dimethyl phthalate around the tops of your boots or socks and the edges of all the openings in your clothing, such as fly or placket, waistband, shirt front, and cuffs, so that a chigger has to cross a treated band in order to get inside your clothes (unless, of course, he chooses to work his way through the mesh of the cloth). You will get better protection by spraying the dimethyl phthalate onto your clothes; and nearly complete protection is gained by dipping your clothes into a water emulsion (made with a commercial emulsifier) of dimethyl phthalate. Benzyl benzoate, if you can get it, can be applied to your clothing in the same way, with even better results. These materials, as well as certain others, are not mere repellents; they kill chiggers that touch them. Incidentally, DDT is not particularly effective in controlling chiggers.

The old custom of dusting sulphur on yourself does help a lot in keeping chiggers at a distance—and your friends as well. Benzyl benzoate and dimethyl phthalate have light, not unpleasant, odors. If used as an emulsified dip, they will not mark your clothing. If used in full strength, an oily mark may remain until the garment is washed.

Now that you have learned to thwart the chiggers, you can go out and enjoy your blackberries and let the dead chiggers fall where they may.

Brown Pelican Trio

By Hugo H. Schroder

THE municipal pier at St. Petersburg, Florida, is visited daily by numbers of brown pelicans who have discovered that kindhearted visitors are willing to toss out helpings of fish to them. They have found that it is much simpler to wait for handouts than it is to go out and catch their own dinners. One can even buy fish on the pier to feed to the big-beaked birds.

A number of pelicans usually perch on each group of pilings beside the pier, all waiting for handouts. When a fish is thrown to one of these groups, each bird tries to grab the morsel when it comes within reach. Sometimes there is a bit of squabbling over the fish if the lucky bird does not swallow it promptly.

Co-operation on the part of a fellow wildlife photographer resulted in this photograph, showing a trio of pelicans, all anxiously waiting for the fish to come within reach. It was only a small fish, yet each bird was eager to grab it. Bills were extended, and wings were slightly elevated to be brought into play if necessary. Note that each of the trio is wearing a band on its leg, which will enable scientists to study their movements.

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ured by the changes of electrical resistance caused by temperature changes in certain mixtures of chemicals. Humidity is measured on the same principle: certain chemicals change their electrical resistance when their moisture content is changed. The building of meteorological instruments was once mostly the job of a good mechanic; now chemists hang over the mechanic's shoulders, and his blueprints are drawn up by engineers skilled in the science of electronics.

The *radio sonde* has taken over where the original recording *ballon sonde* left off, and while it can be further refined, it probably will stay essentially the same for some time.

Everybody knows by now that far up in the sky there is something called the stratosphere. Meteorologists and aviators say that it begins above the troposphere, which embraces the atmospheric layers near the ground—roughly the first 7 miles. Weather takes place in the troposphere, which is where the various air masses are in motion. The temperature in the troposphere is extremely variable, but in general it drops about one degree Fahrenheit for every 300 feet rise, until it reaches a low of about −67° F. It then stays the same for a while and later even shows a tendency to rise again. The imaginary dividing line between the troposphere and the stratosphere is called the tropopause. It varies from about 5 to 12 miles above sea level, depending on latitude and season. The stratosphere extends to an altitude of about 50 miles, above which is the ionosphere, so named because these higher layers are more or less strongly ionized.

Radio sondes and balloons have penetrated only into the very lowest layers of the stratosphere. Yes, there have been some exceptional ascents to 130,000 feet (about 25 miles), but the average *radio sonde* does not go nearly so high. The reason is that the balloon bursts, and even if it does not, it comes to rest at a point where the envelope has reached maximum expansion and can no longer give added buoyancy in the extremely rare air. With present equipment, that point is usually around 19 miles.

Beyond that only rockets will carry instruments.

The idea of a rocket that could carry weather instruments is by no means novel. The late Professor Robert H. Goddard began to think about the problem in 1914. Several years earlier a German engineer named Maul, whose chief work was in the development of camera-carrying rockets for military use, had applied for and been granted a patent for instrument-carrying rockets for meteorological work. While Maul did build a considerable number of camera-carrying rockets, it is doubtful whether he ever actually attempted a meteorological rocket. Nor did Professor Goddard progress beyond preliminary work. Quite extensive work along these lines was done by the German Rocket Society during the years from 1930 to 1933. But after Hitler's rise to power, the Society was disbanded.

Later the German army began to scrape together the experts of the old German Rocket Society that were still available and founded a rocket research station for military purposes near the small seashore resort of Peenemünde on the island of Usedom in the Baltic. The result of this work was V-2, a 46-foot rocket weighing 12½ tons at the take-off. Warhead and empty rocket together weighed about 4½ tons. The remaining weight was about equally distributed between the two fuels, liquid oxygen, and grain alcohol with an admixture of about 25 per cent water. The rocket rose to 60 miles at the peak of its trajectory when traveling in operational use over a horizontal range of 200 miles in five minutes.

As soon as the existence of this weapon became known inside Germany, German meteorologists began to approach the German army for a few V-2 rockets for meteorological purposes. As far as captured documents tell, they failed to get any rockets. Meteorologists elsewhere cast eager, longing eyes at V-2 rockets for the same purpose, and while they had to wait longer than the Germans expected to wait, they at least got their wish.

The first rocket to rise from the White Sands Proving Ground was not a captured V-2 but the homegrown "WAC Corporal." It had been built by Douglas Aircraft with a propulsion unit furnished by Aerojet, Inc., the same firm that supplied the JATO units, take-off rockets for Navy flying boats. The "WAC Corporal" was 16 feet long, with an average diameter of 12 inches. Launched with the aid of booster rockets, it reached an altitude of 230,000 feet, or about 44 miles.

In April, 1946, the first captured V-2 took off from White Sands. It was a test very much in the nature of a dress rehearsal, without any visitors or spectators. The first test before invited guests and representatives of the press was made on May 10, 1946, with a resulting altitude of about 80 miles. This seems to be the average altitude of V-2 firings, but it was proved twice what a V-2 can do when fired nearly vertically: the rocket fired on July 30, 1946, climbed to an altitude of 104 miles, and a rocket fired in December 1946 even went to 114 miles.

World War I furnished meteorology with the theoretical tool of air mass analysis and with the beginnings of the *radio sonde*. World War II provided the ultimate carrier for the meteorologist's instruments, the liquid fuel rocket, which can reach any altitude and even penetrate to any desired distance into interplanetary space. Fuel capacity is now the only limit to the altitude that a rocket can reach.

Of course V-2 is not ideally suited for such research, and the supply is limited. V-2 was built to be used as long range artillery, not as a meteorological instrument. It is far too large and, consequently, too expensive. The meteorological rocket of the future will be designed to carry light and compact instruments and will be comparatively small and light itself. Most important of all, it will be designed for mass production. What meteorologists want is not one high altitude observation a week but scores of them each day from many different stations. And because that wish is reasonable and logical, it will be granted in the not far distant future.

THE MYSTERIOUS MARKINGS OF NAZCA

Continued from page 207

agriculture and the transformation of tribal society into the early period of civilization brought about the growth of a more complex and organized social life. This resulted in an increasing realization that there was likewise an extremely complex organization among the heavenly bodies above. When they learned that the annual movements of most of the heavenly bodies could be correlated with the progress of the seasons, around which the whole productive and social process revolved, a fuller understanding of astronomy became imperative. Increasingly systematic attempts were therefore made to understand, predict, and control the various fluctuating social and natural events of earth. With this purpose, a rising priesthood built up an extensive system of observations and calculations and established involved rituals of supplication addressed to the heavenly bodies, which, with their relentless and unfluctuating periodicity, seemed completely to dominate life on earth. Thus the first science, astronomy, was born.

The control that the heavenly bodies apparently exercised over earthly affairs led to the development of an accurate and well-organized calendar for determining "holy" and "lucky" dates for planting and harvesting crops and for a host of other events both practical and ceremonial. In an irrigated economy the rise and fall of the life-giving water in the rivers, around which the whole productive and ceremonial processes revolve, becomes one of the chief problems around which astronomical predictions and activities are centered.

Moreover, as the development of an agricultural economy led to a growth of social differentiations, the astronomer-priests probably found that the more complex were their astronomical knowledge and ceremonial forms, the more they could impress the populace with their mysterious supernatural powers. Thereby they strengthened their privileged position. Thus, a whole system of interacting forces evolved which, once established, developed through its own internal momentum and probably went far beyond the actual practical needs.

Our lack of knowledge of this development is due partly to the absence of native records and partly to the fact that the Spanish chroniclers were not especially interested in recording the astronomical or astrological knowledge of the "heathen" priests. And even if the interest had been present, it is doubtful that these priests would have yielded the most sacred secrets of their profession to the foreign conquerors. When the Nazca markings have been deciphered, an effort should be made to correlate the findings with Baron Erland Nordenskiöld's tentative analysis of the ancient Peruvian knotted cords, or quipus, as well as with the more elaborate calendrical studies of Fritz Buck and with similar work of Stansbury Hagar and Zelia Nuttall. When that is done, we should have new insight into a phase of ancient Peruvian culture that still rests in obscurity. We will then be able to understand concretely what underlies a statement of one of the old chroniclers, Cieza de Leon, who wrote: "These Indians watched the heavens and the signs very constantly, which made them such great soothsayers."

But the question remains: Why should such a poor region as Nazca have produced such elaborate and peculiar forms? A general explanation may lie in the fact that in Nazca, as among the Mayans of Yucatán, the early appearance and continued existence of a certain level of culture, together with the absence of restraining influences of a centralized secular state, permitted the powerful priesthood to develop its astronomical investigations and practices to the fullest extent possible.

At the same time, we must not exaggerate the complexity of observations made by the ancients and the labor required in the construction of the markings. Actually, building slightly elevated structures of this sort is one of the simplest and cheapest ways of creating sight lines, ceremonial "roads" and enclosures. The still poorer valleys between Nazca and the Chilean border also contain similar markings, though naturally they are smaller in size and number. Furthermore, the valleys of the region have been inhabited for a long time, and each generation and century was forced to carry on its activities in the same place—with the resulting chaotic maze of superimposed lines, figures, and centers. Add to this the fact that this region is practically a perfect desert with no further economic value, and the persistence of these complex markings down to the present becomes less surprising.

In the richer regions of the northwest coast of Peru, as well as in other more advanced parts of the rest of the world, these simpler forms apparently also once existed. Remains of "roads" and rectangles have been reported from the Lurin and Viru valleys in Peru. In the Zaña and Lambayeque valleys I found "roads" similar to those of Nazca. But gradually, with the accumulation of greater wealth, it was possible to build much more elaborate and expensive roads, walls, pyramids, and temples for similar astronomical-religious purposes. It is true that in these more advanced areas as the secular power grew at the expense of the priesthood and the people, only such forms of astronomy came to be supported as were concerned with the interests of the state. Nevertheless, the attempt to obtain the aid of the heavenly bodies to rule the world continued as an important endeavor of the state-directed priesthood.

Thus as we pursue our study, we must bear in mind the close and continuous relationship between ancient Peruvian astronomy and the whole life of the people. Only then can we obtain results that will be a step forward in understanding both. At the same time, by correlating our results with what we know of the astronomy and culture of other prehistoric peoples, we should be able to broaden our knowledge of this early stage of human development, the remains of which now present us with such a host of perplexing questions.

▼ **Any idea** that the mysterious lines could have been used either as roads or irrigation canals is dispelled by this view, showing them high above any available water supply and connecting no strategic or useful points

 Continued from page 193

Snakes would not select such a place in which to deposit eggs (and more than one is always laid), and the chances of the egg's hatching under such conditions are nil. It is unlikely but not impossible that a snake chanced to enter some furrier's establishment and lodged itself inside an incompleted fur piece. Moreover, it might have survived for several weeks or even months under such conditions.

We have one snake in the collections of the American Museum with a note attached saying that the snake was found between the saddle and a blanket when they were being taken from a horse after a day's journey in Ethiopia. Supposedly it had crawled in during the previous night, and the snake, together with the blanket and the saddle, had been unsuspectingly thrown on the horse. The fur piece yarn is a little more incredible, but such things can happen.

° ° °

Sirs:

As a natural science teacher, I have developed considerable interest in your well-written magazine, Natural History.

Your highly selective articles, together with your well-informed pages devoted to "Your New Books," are a real treat to any person who is interested in science, either as a hobby or as a profession. I always consult your pages before buying new books, and I also make it a point to mention your valuable magazine every time I place an order. . . .

Brother Claude Côté, F. S. C.
Montreal, Canada

Alert Readers

Sirs:

In the April Natural History there are many wonderful stories and articles, one of the best being the one on "Fiddlers." For years I lived in Florida near Estero Bay and have seen many thousands of fiddlers. . . . Evidently the picture at the top of page 188 was printed upside-down. . . .

I am curious to know whether anyone else noticed this error.

New York, N. Y. W. E. Hazard.

Yes, one other person had the keen eyes to notice that the photograph of the claw got in the press upside-down—Mr. Wolfgang F. Pauli of Bradford, Massachusetts.—Ed.

° ° °

Sirs:

Your Magazine covers the field so thoroughly that in my opinion it should be adopted in high schools, particularly where botany and zoology are taught.

In "The Saga of the Earth Nut" (March issue) it is said that "no Indians in North America were growing potatoes when Sir Walter Raleigh arrived." I don't think Raleigh ever put foot on North America, much as he wanted to. If I'm wrong, I would appreciate your putting me straight on this.

E. W. "Rip" Summerell.
New Bern, N. C.

Mr. Summerell's historical eye is sharp and accurate. The sentence should have read: " . . . when Sir Walter Raleigh's colony arrived at Jamestown." Raleigh made two expeditions to South America, but any claim to his having visited North America is denied on historical evidence. —Ed.

Morden African Expedition

Lieutenant Colonel William J. Morden, veteran explorer and honorary fellow of The American Museum of Natural History, sailed from New York on April 9, in company with his wife, on an expedition to eastern and central Africa. Their purpose is to make extensive collections of ethnological material among some of the rapidly changing African tribes. Mr. Kepler Lewis, Field Associate of the American Museum's Department of Anthropology, accompanied them. Some zoological collecting will also be done.

The party will secure supplies and motor transport at Capetown and will then depart on a journey that will take them through the Union of South Africa, Southern and Northern Rhodesia, Tanganyika Territory, Kenya Colony, Uganda, the Sudan, and Egypt.

Mrs. Morden plans to specialize in studies of the life of women—their customs, characteristics, ceremonials, and habits. In preparation for the expedition, Mr. and Mrs. Morden studied Swahili for more than a year.

Art from the Solomon Islands

A group of rare, native carvings collected in the Solomons by the late Lieutenant Commander John Burke, U.S.N.R., can be viewed by the public at The American Museum of Natural History. For two years prior to his death in a plane crash, Lieutenant Commander Burke was attached to the Pacific Fleet and used his opportunities in little known islands to rescue for posterity examples of ancient carvings that will never be made again. Many of the objects in the collection are not represented in the records of other museums or in the published works on the Solomons. Whether their use or meaning will ever be determined will depend partly upon whether related objects have been photographed or collected by other American servicemen during the war.

YOUR NEW BOOKS

Continued from page 199

earthed fossils or collected reptiles. He talked with the natives and lived in their houses. When he found a spring that contained fresh-water crabs, he sketched the creatures in life, and he experimented with the jumping bean to find out what made it jump. He met good Mexicans and bad ones, but mostly he found the Sonorans proud of their beautiful country and nearly always congenial, helpful and friendly.

In short, Mr. Hilton came to know a great deal about the country south of the Arizona border, including the people, the animals, and the plants. He writes honestly, with humor, modesty, and sympathy. He is an observing artist, who enjoyed his travels and remembered facts as well as yarns. His "experiment in sharing these memories" is eminently successful; he skillfully accomplishes his avowed purpose—to give the reader a better understanding and appreciation of the people and the land south of our border.

C. M. BOGERT.

MIKE THE MYNAH

- - - - by Louisa Clark Williams and Francis X. Williams

Privately printed at H. S. P. A. Experiment Station, Honolulu, T. H. 139 pp., 25 drawings

VARIOUS starlings of India are called mynahs, and Mike was not of the species that can so readily be taught to imitate human speech. He had naught to do with microphones. His kind is widespread, for this common Indian mynah has been carried by man to many distant islands and there thrives only too well. Its introduction into the United State has wisely been forbidden.

On the island of Oahu, mynahs were liberated as early as 1865, and they now form a very abundant and noisy part of the bird population. Cardinals, house finches, sparrows, and doves have likewise been introduced. One is apt to like almost any bird that frequents one's garden; many mynahs were kept as pets by members of the Armed Forces. They develop distinctive personalities and are excellent subjects for behavior study.

Thus did Mrs. Williams and her entomologist husband adopt Mike as a fledgling and study him closely from May until late December. His moods, foods, and other peculiarities are all discussed in diary form, which keeps the dates and development clear. At the same time the neighbor mynahs were watched; and another of their young, nicknamed Butch, was kept for nine days in company with Mike.

The Bullies, Tiddly, her mates, and others round out the picture. During a second year another young bird, Moki, was sheltered for six days until it was able to fly away safely with its parents. Mynahs are bumptious birds, their singing really pleasant if not heard too constantly. We are assured that they fight more among themselves than they do with other birds. This is the book to read if you take a human interest in mynahs, and you probably will if you live in Hawaii or some other place where these birds dwell.

JAMES P. CHAPIN.

SANTA EULALIA. *The Religion of a Cuchumatán Indian Town*

- - - - - - - by Oliver La Farge

The University of Chicago Press, $4.00, 211 pp., 24 illust.

ALTHOUGH the literary works of Mr. La Farge are familiar to most readers, it is not so generally known that he is also an ethnologist of no small merit. In this semi-technical report he deals primarily with the religion of the Maya of Santa Eulalia, a primitive and isolated town in the Cuchumatán region of highland Guatemala. Other aspects of the culture are discussed briefly.

The orientation throughout is frankly historical, one of the principal aims being to gain through a study of the modern Indians a more comprehensive insight into the complex religion of the pre-Columbian Maya. Little systematic attempt has been made to sort the surviving Christian and Mayan elements, although rites and ceremonies are so grouped into chapters as to indicate a predominantly Spanish or native origin. In Santa Eulalia, as in the ancient Maya city-states, religion pervades the whole fabric of life. Elements and beliefs of Christianity have been reinterpreted to fit into an essentially Indian system. As the author puts it, the people "accepted God and the saints and then proceeded to convert them to the older religion."

It is regrettable that the social and economic aspects of the culture were not more fully treated, but, on the other hand, one might say that this book embodies one of the most important collections of myths and legends yet reported for the Maya. In a lively final chapter he recounts how, because of continued bad weather during his stay in the town and the theft of an important idol from a near-by Mayan ruin, the tribal curse was invoked against him and his party. Using counter magic, which he was believed to possess, La Farge effectively combatted the hostile native priesthood. This reviewer found *Santa Eulalia* entertaining reading as well as a significant ethnological record.

HARRY TSCHOPIK, JR.

AMERICAN INDIAN EDUCATION

- - - - - - by Evelyn C. Adams

King's Crown Press, $2.25, 122 pp.

THE introduction of this little volume was written by John Collier, who was Commissioner of Indian Affairs from 1933 to 1945. In this foreword, Mr. Collier states that the author "has attempted with modesty, great industry, factual scrupulousness, and real breadth of mind, the substantial beginnings of . . . a needed study, mainly in terms of the United States."

In a brief story, as presented in this book, no attempt has been made to exhaust the subject. While it is true that Indian education is as old as Indian life (as Mr. Collier points out), Mrs. Adams deals with the subject from the advent of the white man, beginning with the Spanish Colonial Period. The right of the Indians to speak their native tongue and to preserve their aboriginal culture was a significant condition of the Jesuit Missions of California. The French policy grew out of the fur trade. From the English Colonial Period we have the interesting stories of the Rev. Eleazer Wheelock and Dartmouth College, the Rev. John Eliot and his Indian Bible, and Indian education in the College of William and Mary.

The author designates the period from 1776 to 1870 as that of Partial Government Responsibility. This period included three giant steps in land manipulation, namely, the Louisiana Purchase in 1803, the Indian Removal Act in 1830, and the rapid acquisition of national territory from 1845 to 1865, accompanied by western white settlement. The Period of Full Federal Responsibility (1870-1921), during which Indian culture was denounced, began in 1870 with Congressional authorization of the first annual appropriation for Indian education. The romantic story of the famous Carlisle Indian School, opened in 1879 by General (then Captain) Richard H. Pratt, comes in this period.

The history is carried through logically and carefully to the present time. A rather extensive bibliography and an analytical index are valuable features of the book.

TE ATA and CLYDE FISHER.

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June **NATURAL HISTORY** 1947

Brains and the Beast · Thunderbolt Belief · Sea Otter

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Man In Whale

SIRS:

I was greatly interested in the letter, appearing in your April publication, concerning the incredible incident of the unfortunate seaman, Jas. Bartley, who was swallowed by a sperm whale and lived to tell the tale. My interest is in a sense personal because of my small part in a similar though not so fortunate accident. Incidentally, I am inclined to agree with Dr. Murphy's remarks concerning the dubiousness of the tale quoted.

It was in February or March of '93 or '94 when, as a young surgeon, I was attached for the season to the sealing fleet out of St. Johns, Newfoundland, as much for the adventure as for my "sealers' share" of the trip. We sailed on the schooner "Toulinguet," one of a considerable fleet of wooden ships bent on the winter's take of seal pups.

One of the lads on another ship had the misfortune, in full view of his comrades, to become isolated from the others on an ice pan, from which he fell into the icy waters in the proximity of a huge sperm whale. The whale was apparently as lost and out of season in those Arctic waters as he was confused and angered by the sudden appearance of a fleet of ships and men.

Somehow the poor fellow was swallowed by the whale, which then made straight for one of the smaller sealers. A lucky shot from the small cannon mounted on her stern mortally wounded the huge mammal and served to change his course, though he traveled a full three miles out to sea before his final death thrashing. The next day he was found floating belly-up by one of the longboats as it was searching for seals; and though it was impossible under those conditions to bring him in, the men, by a valiant effort and many hours of hard labor, were able to hack their way through his abdomen below the diaphragm and isolate his huge gas-filled "upper stomach," which apparently contained their comrade. This was severed with some difficulty at the cardia and in the first portion of the duodenum. They brought it to me for inspection and also for preservation of the man's body, as it was hoped he could be returned to his native Argentia [Newfoundland] for burial.

At first I attempted the dissection with my scalpel but quickly gave it up in favor of one of the sharpest galley knives. The stomach was finally opened and gave off an overpowering stench. A fearsome sight met our eyes. The young man had apparently been badly crushed in the region of his chest, which may have been enough to kill him outright. (In any event an examination of his lungs revealed a general atelectasia with marked hemorrhage throughout.) The most striking findings were external, however; the whale's gastric mucosa had encased his body (particularly the exposed parts) like the foot of a huge snail. His face, hands, and one of his legs, where a trouser leg had been pulled up or torn, were badly macerated and partially digested . . . It was my opinion that he had no consciousness of what happened to him. Curiously enough some lice on his head appeared still to be alive.

The appearance and odor were so bad that all save I were forced to turn away, and we were obliged to consign him to the briny deep—the last resting place of many a good sealer—rather than to carry him back to his rocky homeland.

I believe this tends to corroborate Dr. Murphy's remarks.

EGERTON Y. DAVIS, JR.
Boston, Mass.

Important Notice

Readers are reminded that NATURAL HISTORY is not published during July and August. Those who expect to be away after September 1, however, and wish to have their September issue sent to a temporary summer address are requested to notify the Membership Secretary. Please give also the date of expected return to permanent address.

Ursula Meyer from Three Lions

Diving Animals

In response to Dr. John Eric Hill's 550-word article, "Deep Dive," in the May issue, NATURAL HISTORY Magazine received a 1700-word letter from Dr. T. McKean Downs of Bryn Mawr, Pa. This letter asks a number of extremely interesting questions concerning the ability of animals to dive to great depths and hold their breath for long periods. Space forbids publication of the whole letter; possibly some of the questions Dr. Downs asks about diving birds can be answered in a future issue of NATURAL HISTORY. The abridgment of the letter printed below is interrupted at intervals to give Dr. Hill's answers.—ED.

SIRS:

Dr. Hill informs us that the air would be forced from the lungs of a whale at great depths but for a special valvular mechanism in the nostril. What is this valve, and how does it work?

Answer:

In the sperm whale the spermaceti organ, a large saclike mass of alveolar tissue containing oil, fits like a plug into the bony nasal passage. Less elaborate plugs, also operating under pressure, are to be found in the "nose" of several other whales. Most other toothed whales have a complicated series of pockets, between

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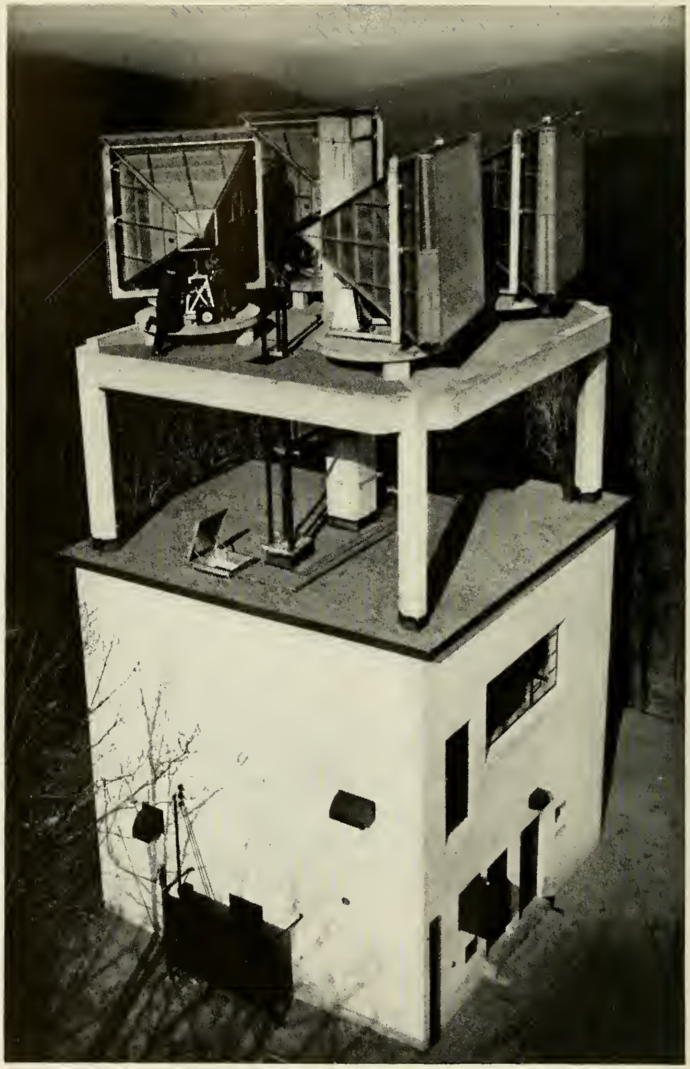

Airplane photograph of one of seven relay stations — to test use of radio "microwaves" for Long Distance services

NATURAL HISTORY

The Magazine of the American Museum of Natural History

FREDERICK TRUBEE DAVISON, President — ALBERT E. PARR, Director

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THE COVER THIS MONTH

The Amarraboyo is perhaps the most beautiful representative of a family of very showy plants, the Melastomaceae, that are as common and as typical of warm regions as roses are of our temperate clime. Its flowers measure about three inches across; and the petals, which are brilliantly colored when fresh, fade with age, so that the flowering tree shows a wide range of hues. This picture illustrates two characteristics of the family—the palmately veined leaves and the curious structure of the stamens.

The Amarraboyo is common locally as a small tree on the forested ridges of the central cordillera of the Colombian Andes. Dr. Walter Henricks Hodge took this picture at an elevation of 8000 feet near Rio Negro (Antióquia), where the species was first discovered. The botanist Triana named the plant *Meriania nobilis* in honor of Maria Merian, a German traveler-naturalist.

Other showy melastomes are conspicuous near timber line in the Andes, from Venezuela south to Bolivia. A single herbaceous genus, the pink-flowered Deer Grass or Meadow Beauty (*Rhexia*), is found in the United States on sandy, peaty swamps of the Atlantic coastal plain.

PUBLICATION OFFICE: American Museum of Natural History, Seventy-ninth St. at Central Park West, New York 24, N. Y.

EDITOR: Edward M. Weyer, Jr., Ph.D.
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ART AND PRODUCTION: Robert E. Williamson.
Sarah Lasersohn, *Assistant in Art and Production.*

Magazine subscriptions, Membership applications, and Advertising inquiries should be sent to Charles J. O'Connor.

NATURAL HISTORY is published monthly (except July and August) at New York 24, N. Y. by the American Museum of Natural History, Seventy-ninth Street and Central Park West. Subscription price $4.00 a year, single copies fifty cents. Subscriptions to Canada, Newfoundland, and all foreign countries $4.50. Entered as second class matter March 9, 1936, at the Post Office at New York, under the Act of August 24, 1912. Manuscripts and illustrations submitted to the Editorial Office will be handled with care, but the publisher cannot assume responsibility for their safety.

The American Museum is open to the public every day in the year without charge

YOUR NEW BOOKS

LOGBOOK FOR GRACE • PANFISH • ATOM
YOSEMITE • MOUNTAINEERING • SEA

LOGBOOK FOR GRACE
- - by Robert Cushman Murphy

The Macmillan Co., $4.00, 290 pp.

THE chance to comment on Robert Cushman Murphy's *Logbook for Grace* is, for this reviewer, a chance to reminisce. For Bob Murphy and I have grown up together beneath the sheltering roof of the American Museum of Natural History, fortress of science, home of learning, hearth of friendships. His luck was better than mine; for while I had the advantage of joining up in 1907, as against his 1912, I drifted away from the anthropologists of the Museum in 1913 to become a geographer, while Bob remained with the biologists to develop into a leader in various branches of that science, honored not merely at home but also through world-wide recognition. Knowing Bob has been a continuing pleasure and a fortifying experience. For, as I watched him grow in stature and influence, I saw no lessening of that endearing charm of being ready to lend a friendly hand. I was instinctively aware of this characteristic when we first met, and I have had multiple proof of it through the decades.

But no one, even of the Museum Staff, can know Bob Murphy from every side except by following his distinguished writings, none of which has been quite so revealing as the *Logbook* now proves to be.

Not being the first to review this journal of a year's voyage south from our latitudes through the tropics to the Antarctic and back again, I cannot have the good fortune of being the first to draw the obvious comparison between Murphy's *Logbook for Grace* and Darwin's *Voyage of the Beagle.* There is analogy but no parallel. Darwin, though he wrote clearly and with enlightenment to the reader, and though he was one of the greatest pioneers, did not have Murphy's literary grace.

To each of these writers, his first long voyage, though adventurous physically, was at its core an adventure of the spirit. Their keen eyes saw not merely with discrimination but also with an understanding which their pens have been able to convey. To each the voyage turned out to be the foundation of a career. That Darwin's travel observations became also the foundation of a revolutionary theory was made possible through a chronological priority which left to Murphy what has proved to be more the improvement and beautifying of the superstructure.

Our comment on the *Logbook for Grace* strives to be a characterization and not a synopsis. The most revealing characterization may well be a series of comparisons.

You cannot think of comparing the *Logbook* with anything but a masterpiece. None comes to mind from our century that is worthy or, at least, none where the comparison seems enlightening. Because of my own long association with New Bedford whalers in the Arctic, I must discard the one readily suggested comparison with a piece of fiction—*Moby Dick.* For my New Bedford whaler friends used to go purple in the face at Melville's inaccuracies and lack of understanding which, I feel sure, will not be the case for the few remaining patriarchs who have a chance to read the *Logbook.* In the domain of fact, Doughty's famous *Arabia Deserta* suffers through grandiloquence and overstatement. Darwin, as we have said, is nearest, for if he is ahead of Murphy in some things, he is also behind him in others.

The *Logbook for Grace* need not even shrink from comparison with what Theodore Roosevelt used to say was the greatest travel book ever written, David Livingstone's *Missionary Travels.*

VILHJALMUR STEFANSSON.

ONE HUNDRED YEARS IN THE YOSEMITE
- - - - by Carl Parcher Russell

University of California Press, $3.75, 226 pp., 52 illust.

MUCH has been written about the older, more important National Parks. For the most part these have been pamphlets dealing with the geology or natural history; a few have been essentially guide books. The few popular books have sought to make the text interesting by padding it with human-interest stories, with talk of "sagebrushers" (campers), "pearl divers" (hotel waitresses), or "bug hunters" (the ranger-naturalists). Brief accounts of matters of historical interest in connection with individual parks have been printed, but heretofore no serious effort has been devoted to the history of any one region.

Dr. Carl Russell was for many years the Park Naturalist in Yosemite, and as such he probably contributed more than any single individual to the success and growth of an educational program in the National Parks. The value of such adjuncts in the parks was apparently first realized by Professor Loye Miller; and the man largely responsible for the modern park system, Stephen T. Mather, urged Professor Miller to come to the Yosemite Valley to begin such work in 1919. The museum that was eventually set up in that park has been one of the outstanding institutions of the park system. Within a few years educational programs were organized in Glacier, Zion, Grand Canyon (with a museum designed by Dr. J. C. Merriam that is a model for small institutions), and Rocky Mountain.

Dr. Russell's exhaustive and scholarly treatment goes beyond the evolution of the educational program, however. He has delved into the past, beginning with the now famed Padre Garces, who entered Tulare Valley near the Yosemite in 1776.The accounts of the Moraga Expedition of 1806 Jedidiah Smith 20 years later, and the Walker party in 1833 (probably the first Americans to see

Yosemite Valley) read like a novel as pieced together by Dr. Russell. The book is among the most informative and certainly the most readable of those dealing with the National Parks.

C. M. BOGERT.

THE WORLD GROWS ROUND MY DOOR

- - - - - - - by David Fairchild

Charles Scribner's Sons, $5.00,
347 pp., 124 illust.

ALL those who have read *The World Was My Garden* or *Garden Islands of the Great East* by the same author will want to read this story of the Kampong, Mr. Fairchild's home on the edge of the tropics, located near Coconut Grove, Florida. In preparing this place for plant experiments there came to be so many buildings that it suggested a little village—a Javanese Kampong. And "The Kampong" it became.

Here we find enthralling descriptions of the introduction and development of forms of plants new to the American tropics, many of which have proved to be of great commercial value. These included mangoes, avocados, loquats, various relatives of the cherimoya, many kinds of citrus fruits, and others too numerous to mention.

Mr. Fairchild introduced the "Sausage Tree" from Africa, and he writes about one thriving specimen near his home: "No one could possibly have predicted that it would have thousands of photographs taken of it by all sorts of people, that it would appear in movies all over the country, and that in a single year 40,000 picture postcards of it would be bought by visitors. It has probably made more money for its owner than any other single planted tree."

The age of fallen trees in the North can be determined with a good deal of accuracy by counting the annual rings, but in the tropics trees do not form annual rings, and one can imagine the fun our tropical plant explorer had when a visiting forester from the North showed interest in the enormous stump of a sycamore fig which had been a casualty of the 1935 hurricane. Mr. Fairchild asked him how old he thought the tree had been. The forester looked at its cut surface carefully and said: "About a hundred and fifty years, I think." "Precisely," said Mr. Fairchild. "We planted it in 1917."

This is another fascinating book by this indefatigable plant explorer, who has succeeded in an unusual way in putting himself in his book. Eighty full pages of photographs add to the attractiveness and interest of the volume.

CLYDE FISHER.

THIS GREAT AND WIDE SEA

- - - - - - - - - by R. E. Coker

University of North Carolina Press, $5.00,
325 pp., 91 plates, 23 figs.

THE influence of the sea upon climate, commerce, food, and other aspects of our lives has in recent years become increasingly apparent and increasingly important. It is Dr. Coker's belief that we should all develop a greater "sea consciousness" to these "mute but powerful forces" which control our lives. Those who have been attracted at all to the subject will find in *This Great and Wide Sea* sufficient material to hold and broaden their interests.

This book may be adequately called an introduction to the dynamics of the ocean and the physical, chemical, and biological roles which it plays. The author avoids technicality and redundancy. He reviews the enormous oceanographic knowledge in a generalized form, suitable for either the intelligent layman or the uninitiated. In this respect, the book meets the demand for a more popular and simplified account of a complex and diverse field of science.

The book employs the usual method of selecting the broader categories of marine science for the various chapters. The book is divided into three sections, covering "History and Geography," "Chemistry and Physics," and "Life in the Sea," and includes informative discussions on the more important methods, knowledge, and history of each. Although each section with its respective chapters deals with a certain aspect of the sea, the reader will find that the close relationship within and between the living and the inorganic is continually presented. This has been one of the author's goals and represents probably the most important point of view expressed in the book.

PLATO TELAPORUS.

ANIMALS OF WEST AFRICA

- - - - - - - - by G. S. Cansdale

Longmans, Green and Co., 2/9 shillings
144 pp., 45 photographs, 1 map

TO fill the growing need for nature books in the schools of the Gold Colony, a series of government radio broadcasts has been published in this informative little book. The author is a forestry officer, known already to NATURAL HISTORY readers by his article on Bush Babies, published in January, 1946.

Mr. Cansdale now discusses briefly the many mammals, birds, serpents, and antlike insects that inhabit the Gold Coast. His subjects range in size from the elephant and manatee down to the lowly but destructive termite. The sections dealing with the mammals and the more conspicuous birds are naturally more complete than the remarks on the smaller, more elusive species. The fauna is far too varied to be treated in detail in such a handbook, yet it will serve as an excellent introduction, and the photographs aid most efficiently. Mr. Cansdale is to be congratulated and encouraged to write more.

JAMES P. CHAPIN.

NOT BY BREAD ALONE

- - - - by Vilhjalmur Stefansson

The Macmillan Co., $3.50, 339 pp.

NOT By Bread Alone is a kind of dietetic bombshell, for the facts that Stefansson has marshalled constitute a refutation of much of the food propaganda with which Americans have been bombarded in recent years.

Beginning with the desperate struggles of early man to find food, Stefansson pictures the varying conditions that changed primitive man from an anthropoidal type of forest scavenger into an upright hunter of meat.

From this point onward his theme concerns the salutary effects of meat on the human frame, backed by such irrefutable proof as the teeth and bones of ancient man.

When discussing the primitive Indians and Eskimos, as well as the frontier whites who lived for long periods on the meat and fat of wild animals, Stefansson speaks with the knowledge he has acquired from the years he spent in the Arctic. Later, under the eyes of a skeptical world and the strict supervision of a group of eminent scientists, he and Karsten Anderson lived for a year in perfect health on an all-meat diet.

In the chapters dealing with scurvy, the reader is amazed at the inefficiency with which man has combatted this dread disease and the stubbornness with which he has failed to recognize in meat a food that was both preventive and cure.

The history of pemmican, as Stefansson gives it, makes interesting reading. Known to man since Coronado found it among the Indians of our Southwest in 1541, it has been the chief mainstay of wilderness travelers up to the present time.

His explanation of why our army dietitians failed to furnish pemmican as an emergency ration to our armed forces during the last war is ample evidence of the need for Stefansson's valuable book.

BELMORE BROWNE.

APRIL IN THE BRANCHES
------ by Gulielma F. Alsop

E. P. Dutton & Co., Inc., $3.50, 257 pp.

THIS book begins with a search for a house and land where the author and a companion could take charge of the environment and make it over "nearer to the heart's desire." The abandoned cottage and few acres of land are situated in Connecticut. Twenty years of occupation, using holidays and vacations, form the background upon which the text is based. The chapters are written about months of the year, and the style is essay bordering on diary.

There was a great deal of planning and hard work to bring out of the overgrown location, part of which was a community dump, the order and accomplishment that justified the optimistic purchase. The reader is not given all of this story which must have been of considerable interest, but the highlights are brought out now and again, and the reader must draw on his imagination to fill in the gaps. These two women, in leisure moments extracted from busy professional lives, apparently performed a major face-lifting operation on their country property.

But most of the book is occupied in passive communion with the aesthetic qualities of the house and grounds, the satisfaction in a task well done as respects the dwelling, and the exaltation of the spirit when looking upon the out-of-doors. Possessed of a broad knowledge of their plant and animal life, well-grounded in the literature of natural history, they found beauty all the way from the grass tips to the clouds in the sky. Gardeners will recall a kindred feeling in reading these pages, for the deepest response to the garden environment comes at such intervals as the stroll at the end of the day or the intervals when the hands are quiet. There is fun in the doing, but the ultimate reward comes in these moments of relaxation.

This is not a book to be read at a sitting or to steam through under forced draft. It requires introspective leisure to get the full value of the imagery the author packs into her pages. The reflections of two decades are here.

H. E. ANTHONY.

EXPLAINING THE ATOM
--------- by Selig Hecht

The Viking Press, $2.75, 205 pp.

THE explosion of the first atomic bombs brought in their wake a rather large crop of books on atomic energy, generally of mediocre quality. That the second crop, of which the first signs are already evident, promises to be much better is by no means due to the fact that more information has been released in the meantime. Certainly, some more facts have been made known, but the lack of quality of the first crop was not due to secrecy but mostly to lack of thought, which, it may be presumed, was caused by lack of time.

One of the first books of the new crop, and a good indication if it can be taken as representative, is Selig Hecht's *Explaining the Atom*. The author of this volume is Professor of Biophysics at Columbia University and also Honorary Vice Chairman of the Emergency Committee of Atomic Scientists. He is well qualified for the job he has undertaken, and he has done it well.

The first sentence in the book reads: "This is a book for the complete layman." Strange to say, that statement is correct. Any layman who can read and is willing to read this book slowly and carefully will close it with a quite complete understanding of the nature of atoms and the forces involved. Most important, perhaps, he no longer will be in doubt as to the difference between chemical and nuclear (so-called atomic) energy. Professor Selig Hecht has accomplished this feat in the only manner in which it can be accomplished, by following the historical development. Only by following the reasoning as it grew through the decades, from experiment to experiment (eliminating blind alleys), can the student grow to understand the results. And when he does, he will also understand why we cannot "keep" the secret of the atomic bomb. The reason is quite simple: there is no basic secret, and whatever secret there may have been was given away in a spectacular demonstration over Hiroshima. All that scientists all over the world needed to know was that it worked at all.

The only adverse criticism the reviewer has to make against this book can be

Continued on page 287

l MARGERY J. MILNE

›y the authors

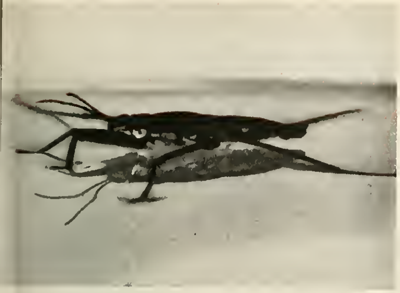
face film of ponds, streams, lakes, and even oceans. Theirs is an almost two-dimensional realm, a special niche in nature for use of which certain requirements must be met.

When a substance attracts water molecules more strongly than water molecules attract each other, the water wets the surface. The liquid creeps along, invading every crevice, clinging tightly to each irregularity. But some materials, such as waxes and oils, attract water molecules so little that the water draws away, pulling back into itself and leaving the surfaces dry. Aquatic birds take advantage of this principle by regularly adding oil to their outer plumage, thereby keeping their feathers from becoming water-soaked. The many creatures that walk on water do so by means of well-waxed, hair- the water does not run around and let the foot fall through the surface film as it would if the waxy hairs were absent. Instead the insect's weight is supported partly by the buoyant force of the water displaced from the dimples and partly by the surface tension which tends to erase the depressions and bring all the water film to the same level. The strider uses chiefly its hind- and foremost legs to hold its body well above the smooth and slippery surface of the pond, while working the middle pair as oars to scull itself along. Mirrored in the water film below the bug is its image,—a reflected "double" seldom seen except by small creatures close to the water surface. Below the strider, on the bottom, are dark shadows cast not only by the insect, but also by the dimples in the surface film where its feet press downward. Sometimes, on sunny days, these shadows on a sandy bottom are more conspicuous than the insects themselves. They drift along and follow every movement of the rowing striders on the film above.

A considerable *length* of surface must be called upon to support an insect as heavy as a full-grown water strider. If its hair-booted feet pressed on the film at only six small points, the bug would penetrate into the water and sink at once. But the strider's legs are spread so widely that its feet make elongated dimples or furrows in the water film. So secure is the insect on a quiet pond or stream that it can shift its weight freely among its feet. Most spectacular are the demonstrations of this when a strider cleans itself. Drawing its rowing legs far back, it stands with its head almost in the water, while its hind legs are raised well above the surface and rubbed one against the other much as the housefly does. Then the insect rests on forefeet and one hind foot, with the rowing leg on that side as an outrigger, while the middle and rear feet of the opposite side are raised into the air and rubbed free of clinging particles by a similar fiddling movement. To accomplish this contortion, the bug practically lies down on its side. The water film stands the strain, but the shadows cast on the bottom shift and spread as the pressures on the fewer surface furrows are increased. Finally the strider stands on rowing feet and rear pontoons while its body and forelegs are raised high above the water. The insect washes itself much as a kitten does, transferring dust particles from feelers, beak, and body to the forefeet, then rubbing these together until they are satisfactorily clean. The bug seems to give great care to every detail, and if uninterrupted, such a complete toilet operation may take ten minutes.

The Quest for Food

Other animals that spread their weight on outstretched feet can rest with safety on the water film. Small gnats and midges flit from place to place on ponds, alighting with equal equanimity on film or foliage. Even large crane flies settle with surprising grace upon the water surface, and rise again with their long legs trailing behind. Each foot combines the advantages of waxed hair covering and slender length which can distribute the insect's weight along the surface film. Sometimes the water striders catch small flies that fail to take flight in time. Occasionally, too, a crane fly dies of unknown causes while resting on the water surface. Without muscle action to hold its body well above the water, the insect sags into the pond and sinks in or barely stays afloat. Water striders gather around it to salvage such nourishing juices as remain. It is but one of the many types of food the striders seek as they push their way along the transparent but rubbery surface film. Some of their sustenance floats up to them from below; each dead fish attracts a crowd of striders. But most of the food of these insects falls into the water from the air above. Ants tumble from leaves overhanging the water. Beetles close their wings and drop or blunder into ponds and streams where the water wets them and renders them helpless prey to the predaceous bugs. The striders investigate every particle, often making great leaps over the water to reach some newly fallen object. Small particles such as drowning ants are picked out of the surface film and held on a slender black beak while



⮝ Each strider has a "double," mirrored by the surface of the water

⮜ Two striders approaching the cast skin of a *Dolomedes* spider. One strider carries an ant around on its slender beak while removing the nourishing juices. Only the under surfaces of the ant and the spider's "ghost" are wet

the life juices are drained away. Often a strider is seen carrying with it a gnat or other carcass as it glides along the water surface. Occasionally other striders chase the food-bearing relative across the pond, just as chickens pursue a hen fortunate enough to have found a large grub.

On ponds and streams the striders stay close to shore or hurry to reach it if a breeze springs up and the water's surface becomes ruffled. In rain and in winter, the striders leave the water and crawl out upon the bank. In spite of these precautions, the insects do get wet at times. Although they show great ability in navigating streams, and can spring ahead to make progress against the current, an occasional bug is swept through a riffle and fails to stay afloat. In such situations, striders may be found below the surface film, rowing to shore where they can crawl out again to dry and clean themselves.

Seagoing Striders

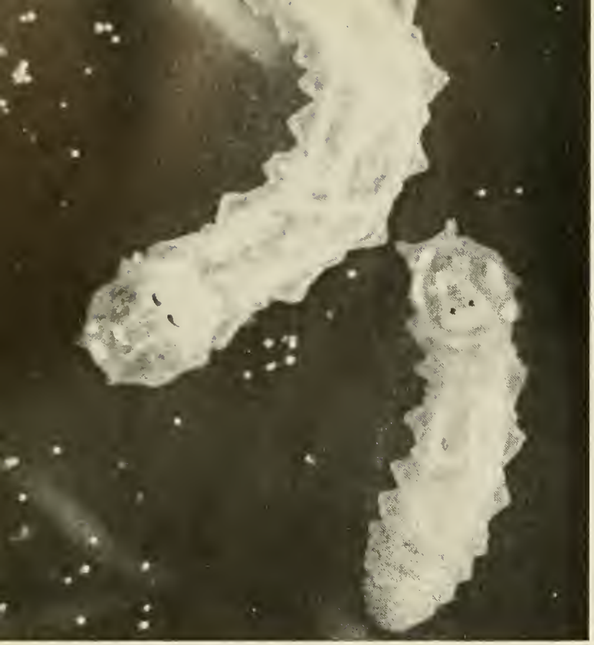
There is also a seagoing water strider,—a small gray form common in tropical and subtropical lagoons and mangrove swamps, where it congregates in large groups. These same water striders are found at great distances from land, riding the waves like the best sailors. No one knows what they do during a storm at sea or when it rains. They must get wet, and what is there to crawl out upon to dry? To add to the problem, these seagoing striders often crawl down into the water during calm weather, and row along to feed there, upside down, on the underside of the water film. Many of them live out their lives hundreds of miles from shore and raise their families at sea. The eggs are laid on seaweed at the surface of the ocean or on the infrequent feathers dropped by sea gulls.

Spiders and mites of several kinds frequent the water film in pursuit of the insects there. They have the same means of staying dry as do the striders, and they scamper about on ponds picking up food wherever they can find it. Most of the water spiders are tan with dark stripes. Many of the females lay their eggs in a creamy sphere of silk, and drag this precious ball after them wherever they go, even out upon the water film. One of these ball-making spiders is a giant called *Dolomedes.* A full-grown mother may measure two inches or more between the tips of outstretched legs; her egg sphere may be half an inch in diameter and contain hundreds of potential spiders. Even after they hatch, the spiderlets stay with their parent, and the adult is often seen with a fuzzy covering which can scurry off, like goslings from a mother goose. Such a family group is quite a prize for a hungry fish, and those spiders that hesitate while running on the water film may lose their lives. However, spiders seldom stop on the surface; they run from shore to plant or from leaf to lily pad, carrying their prey with them to a safe spot. But fish in ponds and streams follow walkers on the water to profit from their occasional unwariness. Sometimes a fish makes a mistake and seizes a spider's ghost,—the empty, castoff skin. Often these skins float downstream, casting on the bottom a shadow much like that of the spider itself. But the skin rests on the water like a dead crane fly, while the living spider walks well above the surface with only its eight feet furrowing the film and making sharp silhouettes on the sand below.

Most conspicuous of the water mites is a common one with a ball-like body of brilliant, velvety red. The full-grown mites reach a diameter of a quarter of an inch. They run so smoothly on their very short legs that they seem to glide over the surface film rather than move on distinct feet. The females leave solitary brown eggs on floating vegetation, to hatch into immature mites with six legs instead of the characteristic eight. These larval mites spend a few weeks as parasites on some insect. They lie in wait for water striders or diving beetles,—anything that comes their way. Sometimes they ride on damsel flies; more often they catch the striders. One strider may carry several of these clinging mites, each sucking nourishment yet seeming to do little harm to its host. Eventually they drop off, molt to gain another pair of legs and the spherical form of the adult body, and forage for themselves as their parents do. The mites not only run along the surface, but frequently climb down plant stems into the water and swim about. Their eight short legs give them an even motion by which they may be distinguished easily from all other aquatic animals.

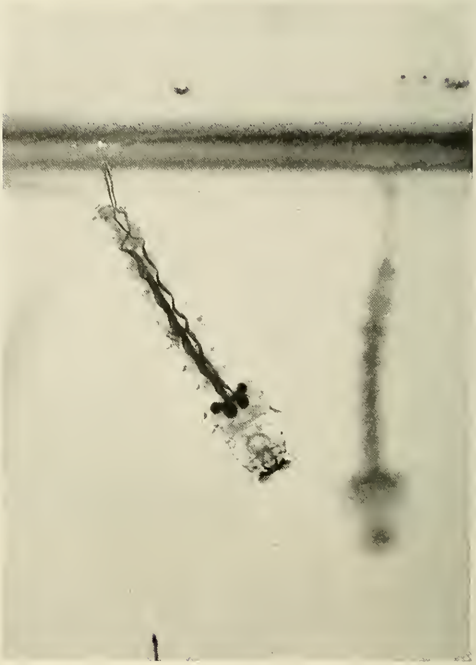
Catapult Take-off

Very small insects with waxy feet can stand upon the water film without the additional precaution of spreading their legs widely. The smallest mites have this advantage. So do the several kinds of springtails and the many leaf hoppers which jump over the surface. These animals are so very light that even when they press down sharply on the water film to throw themselves into the air and escape some danger, they do not produce any sizable dimple in the surface. The leaf hoppers have leaping legs like a locust's or a katydid's, but the springtails have a much more ingenious way of catapulting them-



▲ THESE WHITE, TRANSLUCENT AQUATIC LARVAE of a fly can continue to breathe while the front end works through the bottom ooze of a shallow pond for food. Each has a cup-shaped cavity at the posterior end open to the air, exposing spiracles (black paired marks). Through these, gas is admitted to white tubes which extend through the body. The creatures are less than half an inch long

▼ THIS MOSQUITO WRIGGLER hangs from the surface film by a whorl of waxy hairs around the opening of its breathing tube



selves into the air. They are grotesque insects, with an extended tail. Some merely keep this tail curved under them, almost resting on the water film between their six short legs. To jump they simply straighten out, but do so suddenly. Others carry the tip of the underturned tail in a special catch, like the notched trigger of a mousetrap. The tail is strained against the catch just as is the mousetrap spring. When the insect is frightened (or sometimes seemingly just for fun) the catch is slipped, the tail whacks the water film, and the springtail is thrown high into the air, to land somewhere else. For a creature so minute, air has an excellent cushioning effect, so that the springtail settles without damage, usually on its feet.

Two types of springtails are common on fresh water and one on quiet bays of the ocean. The more abundant of the lake and pond forms is bluish black, about an eighth of an inch long. It congregates in such enormous numbers as to appear as a conspicuous blue-black band along the water's edge. The individuals walk about among their fellows, but at the slightest disturbance, the group flings itself into the air like tiny corn kernels popping on a hot griddle. They alight many inches away, no longer in association with each other. To all intents and purposes they have vanished. Like other springtails, these have a tubular extension from the underside near the catch for the springing organ. With this "ventral tube" they are able to hold themselves to the water surface. The tube can be wet by the water and forms a sort of anchor for the insect. The seagoing springtail and the seagoing strider are among the relatively few insects that are not bound to a land or fresh-water existence. The seagoing springtail is found all over the world along sandy and muddy coasts and on tidal pools in rocky shore lines. No one knows what happens to them during storms and showers at sea. Not all of them can come ashore for such occasions.

Beneath the Film

The underside of the water surface is also used by a surprising number of aquatic creatures. Every now and again a pond snail crawls up a plant stem as far as the water surface, there to roll over and glide out under the water film, its flat foot pulsing with slow waves of movement from aft to fore along its length. In this position, many of the snails apply to the water surface a part of the body between foot and shell, and there open up the single hole that leads into the lung, so they can breathe in a load of air to take below. In very shallow water, a flat sole similar to that of the pond snail, but much smaller, shorter, and narrower, turns out to belong to a worm which is all sole, with almost no thickness. This flat-worm, a free-living scavenger related to the liver flukes and tape-worms, is commonly called a "planarian" and seemingly has crossed eyes spotted on its speckled back. It is a source of never-ending delight to all biology students, and a laboratory pet with a firm grip on life. The animal is so elementally constructed that pieces cut from a single planarian can reorganize to form a whole. Biologists have worried out the philosophies of "self" in terms of many-headed, several-tailed planarians, which creep along the sides and water surface in laboratory jars to mock their captors.

Hydra

Another animal capable of remarkable regeneration is *Hydra,* named two centuries ago by a man who, discovering that it could multiply heads if mutilated, thought of the Greek mythical monster of that name. *Hydra* looks like a discarded umbrella without any cloth covering,—merely a stalk with long arms from one end. The arms are tentacles with nettling cells for catching microscopic life, and between the arms is an opening into the animal's interior, through which the prey is thrust for digestion. The opposite end of the stalk is armed with a sticky disk, the stickiness of which is under the creature's control. Often *Hydra* reaches a few of its tentacles upward and attaches them to some plant stem, then lets go with the sticky disk, to somersault in slow motion and glue its body to a higher point. Repetition of this process or a gradual gliding of the sticky disk may bring the animal almost to the water's surface. There *Hydra* often hangs, foot stuck to the underside of the water film, body pendant, tentacles outstretched for an inch or two beyond, waiting for unwary water animals to bump into its battery of stinging cells. *Hydra's* weight upon the water surface forms a dimple there, but the depression is not like the furrow under the water strider's foot. It is more similar to that around the snail or flatworm, and *Hydra* can creep along the water as they do, although with no visible waves of movement. These submerged creatures produce a water-repelling material from the flat area applied to the surface film. The water draws away, clinging wetly

▼ POND SNAILS in a shallow puddle. The one with the black spotted shell is on the bottom of the puddle, while the other crawls under the surface film. This photograph, like others in the article, was taken with a Bausch and Lomb Tessar lens treated with Balcote to reduce the flare

only to the rim of *Hydra's* disk or of the soles of snail or worm.

Two types of minute crustaceans upon which *Hydra* feeds have odd relationships to the underside of the water film. One of these, *Scapholeberis*, by name, has special waxy bristles with which to puncture the water film from below and lay hold upon it. Since these bristles are on the underside of the crustacean, the creature rests back downward, supported by the film. For purposes of camouflage its body coloring is related obviously to its upside-down position, for instead of being dark-backed and light-bellied like fish and most other animals, *Scapholeberis* is the opposite. In this position, the crustacean rows itself about with its long antennae, browsing on algae that float upward from below, and upon pollen and other flotsam accumulated on the water surface from the air above. A gust of wind tows the surface water and *Scapholeberis* attached to it,—a "sort of submarine sailing" some have aptly called it.

The other type of crustacean is typified by *Bosmina*, a tiny creature which is often trapped by accidently breaking through the water film as it swims along below the surface. Unless a wave or similar disturbance knocks the helpless creature below the film again, it must wait in this position—partly in and partly out of the water—until it can molt its skin and slip out of the old covering into the lake below. The difficulties encountered when a small underwater animal is caught by the "dry" surface of water are similar to those experienced by animals of similar bulk and strength when they fall into the water from the air. Unless a branch is near by upon which they can crawl out, they usually drown or are picked up by water striders and other carnivorous creatures that make this two-dimensional world their home. Even water striders have difficulties; readers of Frank E. Lutz' fieldbook are cautioned to carry home their striders in a dry pail, not in water, lest they drown.

The many insects that live in ponds and streams must have atmospheric air to breathe, and remarkable provisions have been made for reaching through the surface film.

Back swimmers, mosquito wrigglers, diving beetles, and other water beetles come to the surface from time to time to thrust through the water film some tubular mechanism in order to replace the air stored beneath their wings or in their breathing tubes. Only by such frequent restocking can they carry on their precarious submarine existence. Some of the fly young, shaped like maggots and other peculiar things, have telescoping segments at their hinder ends, which they can extend to and through the surface film for gathering air continually while the creatures burrow busily to find food in the mire. Some of the water beetle larvae not only come up to get their air but also drag living or freshly killed prey to the surface and thrust it out into the air, where it can give less resistance to being swallowed and where gravity can be of more help.

Whirligig Beetle

One of the water beetles has a greasy back which repels all moisture like the feathers of a duck. This is the whirligig beetle, which passes much of its life at the surface of ponds and streams. Actually, it is a double animal—dry above and wet below, with paddle-like feet to propel it rapidly through the water. Even its eyes are divided into an upper portion for vision into the air and a lower part with which to watch the water's depths. These beetles are very vigorous swimmers, familiar to most people as they zig and zag along the water surface, commonly in groups, leaving behind them little V's of waves like tiny speedboats.

Egg-laying

The water film forms a definite barrier for insects that must lay their eggs in the water itself, and an almost endless variety of solutions to the problem can be observed. Perhaps the simplest is that of the water lily leaf beetle, which cuts a small, circular hole in the dry top of its lily pad, pushes its abdominal tip through the hole into the water below, and while standing high and dry on a familiar surface, lays two rows of eggs on the undersurface of the lily leaf in close concentric arcs. Many dragonflies, caddis flies, May flies, and others extrude a single egg or a group of eggs from the abdominal tip while soaring over the water. They fly down close and suddenly flick the abdomen through the surface film and liberate the egg. Pulling quickly out, they zoom away to repeat the process when the next egg is ready. The insect's momentum insures it against being caught in the surface film and dragged in to drown. Much more careful are the ordinary biting mosquitoes, which literally lay a raft of eggs. The raft floats upon the water film with only its lower surface wet. The eggs hatch through their lower ends and the young wrigglers emerge into the water directly, many to be eaten at once by hungry beetle larvae and fish. The malaria mosquito, in contrast, lays her eggs singly on the surface of the water.

Another little fly, the *Dixa* midge, stands on the surface like a water strider while she deposits an extruded wet mass of eggs suspended by a strand of gelatine. As the egg mass is let down into the water, the fly adds to the supporting filament a circular, transparent disk which repels water. The disk catches on the surface film and pulls down a dimple as the strand below lengthens out and the suspended eggs sink farther into the water. The fly leaves, but the eggs with their little float drift around as the water surface is blown or as currents move the water itself. The eggs may become stuck to some vegetation or break their mooring and sink to the bottom, there to hatch.

Some other insects, when ready to lay their eggs in the water, wrap their wings around their bodies like a cloak, enclosing a bubble of air, and then crawl down stones or stems through the surface film and into the depths below. Those that succeed in laying their eggs and escaping capture in the water may later crawl back out into the air, dry off, and fly away. Male and female damsel flies co-operate in this.

Continued on page 283

▲ THE OWL'S EYES are in the front of the head instead of at the side where most other birds have them. This is a good position for seeing straight ahead while hunting and alighting at night

Flight Secrets OF THE OWL

The superspeed camera demonstrates that the Great Horned Owl closes its transparent, protective eyelid at the moment of alighting

By LYNWOOD M. CHACE

NIGHTLY for some time I have been studying the owl shown in these photographs, in an enclosure I have constructed that contains tree branches to give him a natural environment. He is a most interesting subject, obviously well worth investigation with the superspeed photographic equipment at my disposal.

When I began to develop the pictures, I found that they gave a rare opportunity to study the wing action, the rapid movement being frozen in sharp detail by the stroboscopic flash, which operates at about 1/10,000 second. But something of which I had not been aware was taking place at the same time, and this proved to be the most interesting thing of all. This was the action of the owl's extra eyelid, a transparent membrane that is put into use at the moment the owl alights, to protect the eye from twigs and branches.

◂ THE TAKE-OFF. Note how intensely the owl seems to be concentrating on visual mastery of the problem he is undertaking

▾ WITH VIGOROUS WING STROKES, the Great Horned Owl gets up speed

▲ AGAIN we note the bird's visual concentration as he gets under way. The unequal dilation of the pupils is probably caused by the dim secondary illumination at one side. The flash is almost certainly too rapid to record this reaction and is so brilliant that the pupil would be contracted nearly to the size of the lead in a pencil

➤ FULL SPEED AHEAD: a graphic view of the nocturnal marauder as he approaches level flight. This photograph reveals that the primary feathers of the wing can be overlapped in reverse, something not previously realized

▲ LOWERING HIS LANDING GEAR and putting on his wing brakes, the owl prepares to alight on a birch branch. The alert attitude of the bird makes it fairly obvious that he is operating in much less illumination than the instantaneous flash would make it appear

➤ THE TRANSPARENT LID of the eye is now being brought into position as protection. This is probably the first photograph ever to reveal this extraordinary equipment in action

▲ THE LANDING IS COMPLETE, and the protective eyelid is still down. This lid is a thin, transparent, rubber-like membrane through which the owl can see. Its opaque appearance here is caused by halation. A polar screen over the lens would have made the eye clearly visible, but the protective eyelid would then have been invisible

➤ AS SOON AS the owl perches upright on the branch, the protective eyelid slides back into position beneath the outer lid. So ends a cycle of flight activity impossible to observe before the invention of the superspeed camera

THE THUNDERBOLT BELIEF

Early in history, someone started the idea that stone implements were created by the thunder god to kill his enemies. Centuries passed before primitive man was accredited with having made them, and even today the thunderbolt belief is defended in widely separate places

By Nels C. Nelson
Curator Emeritus of Prehistoric Archaeology, American Museum of Natural History

After Montelius, from Folklore

▲ An Assyrian god holding an ax and a bundle of lightning: an early indication of the belief that stone tools were created by lightning. From Nineveh

A FEW weeks ago a young man called at the American Museum to offer for sale a primitive stone implement of peculiar interest, sent to him by his father, a farmer near Rome, Italy. The father was represented as attaching great value to the object because he himself had seen it fall from the sky during a thunderstorm!

Fortunately, the specimen was a fine example of the so-called Mousterian point, typical of the Middle Paleolithic culture of southwest Europe and North Africa. It was, in other words, simply a subtriangular flake of brown, flintlike material with traces of marginal chipping—a type of implement common to many archaeological sites, particularly in France, and dating from some 25,000 years ago.

The writer showed the visitor a number of similar specimens, intimating that many were on exhibit, as well as in storage, and explained how they were made. The young man's face fell noticeably. Finally, on being told that one dollar was the most that any public museum would be likely to offer him for his treasure, he departed saying he would send it back to his father, who would otherwise accuse him of having appropriated the bulk of the money received.

This routine incident, startling perhaps to most native-born Americans, will evoke little more than an indulgent smile from those who have lived for some time in rural Europe. Born in Denmark, the writer was himself barely eight years old when his village schoolmaster explained to him and his ABC class the real nature of the schoolroom collection of stone hammers, axes, and the like. But long before that event, he had been repeatedly told by the home folk that such things were "thunderbolts," the possession of which brought "good luck." He is still wondering whether those practical, literate, and, for the most part, well-informed country people really believed what they said. Who can tell? To a listening child they appeared to believe in witches, in fortune tellers, in death warnings, and, above all, in hair-raising ghost stories. Perhaps these surviving beliefs were rehearsed with only mock seriousness—like our Santa Claus stories—but even now it is just as easy to suspect that the raconteurs were taking no chances, for "there might be something in it." As if to clinch matters, one grandfather told us that he kept a stone ax hidden in his cow barn; and when, 26 years ago, the well on the other grandfather's place was cleaned out, a large, finely polished flint ax was found on the muddy bottom, dropped there, no doubt, long ago to purify the water.

Lest the uninitiated reader at once conclude that only isolated, perhaps aberrant, instances have been cited, it seems necessary to lay bare the traditional foundations upon which this belief in celestial origin actually rests and, perhaps, to offer an explanation. Conceived, apparently, by the white man, this slowly fading human trait—of great interest to every culture historian as a diffusion phenomenon—is still to be found all over Europe, as well as in parts of Asia and Africa, and it has a secure foothold in the West Indies. Only in mainland America, Australia, and the far Pacific Islands, where stone implements were in common use when the Europeans first arrived, has the idea failed to be adopted generally, but it is present here and there, for example, in Brazil and southeastern United States.

This superstitious regard for stone implements as thunderbolts has a long history. When it began is not definitely ascertainable, but in its most primitive form the notion unquestionably originated far back in prehistoric times. Since then, like other forms of beliefs, it has undergone many changes and sublimations. However, the late aspect with which we are acquainted presumably arose in, and spread from, some ancient center of civilization where the use of stone implements had been forgotten, say in Mesopotamia, some five thousand years ago. The first historic references usually cited occur in the classical writings of Greece and Rome. The Roman naturalist Pliny (who lived from 23 B.C. to A.D. 79) quotes an older Greek writer, Sotacus, who described different types of stone implements, called *ceraunia*, or thunderstones. He gave their various magical properties and indicated how they were sought (specifically in Parthia) and found in places where the lightning had struck. Incidentally, places and persons so struck were taboo, as is still the case with our Navaho Indians.

From other early and late sources, we learn how the various forms of stone implements were worn, not merely as ornaments but primarily as charms, amulets, talismans, or "big medicine"; also how, disposed in other ways, they served to ward off disease and every other kind of private and public calamity. Over and above this passive, protective function, they were regarded as active fetishes or idols and, as such, were placed at tombs (observed by the writer in Mongolia), on open-air altars, and, naturally, also in shrines and temples where they were, and still are, worshiped with prayers and sacrifices. Some devotees look upon them as mysterious, heaven-sent "powers," others simply as the thunder weapons hurled through the air by one of the numerous, localized sky gods named in Old World mythologies—Thor, Zeus, Indra, etc. This means that to some believers the implements were visible, impersonal potencies for good or ill; to others they were the symbols of invisible, personal rulers at home in the sky. As thunderbolts, the ax and the hammer, in particular, served this high office in the West. Other conventionalizations of lightning still function in the East, but Western art alone furnishes many proofs that the "cult of the ax" flourished as a religion for a long time.

The history of this religious development, and of the origin of the thunderbolt belief on which it rests, can as yet be only vaguely inferred, in part from modern analogies. This much seems clear, however: the thunderbolt as a physical phenomenon was *objectified lightning*. Whatever its form, and whether it was explained as the *cause* or the *effect* of the lightning, it was identified with celestial fire of the same nature as the sun and other astral bodies. These sky-fire transformations were probably first revered as concentrations of nameless physical forces; only later, when the notion of personal gods arose, were they regarded as weapons capriciously wielded by spiritual powers and ultimately personified or anthropomorphized as thunder gods. In mythological terms this transition marks the "Titans" as dethroned by Zeus. The last step came when the two, god and weapon, were reproduced in metal and other media to serve as symbols for sacred and secular ceremonial purposes. One point more seems clear; almost all the thunder gods and sky gods (Yaweh perhaps excepted) were sun gods. In brief, therefore, what we are really dealing with could properly be called a modified form of sun worship.

This traditional attitude, recorded as having existed as much as 2500 years ago, prevailed to some extent in Europe until less than 150 years ago. Thus, throughout the seventeenth and eighteenth centuries learned book scholars argued against the rising opinions of scientific observers and vied among themselves in explaining how, when lightning flashed, the air was congealed to form the variously shaped stones. Compelled to admit that some of these stones duplicated current forms of iron implements, one champion of the old school, in desperation perhaps, ventured the opinion that they were petrified metallic implements. Any mystical explanation was preferred to the one that is obvious to us. As late as 1802, a distinguished professor declared that the stone implements found in the old burial mounds "are nothing but the religious symbols of the thunder god's weapons with which he is believed to have driven away and destroyed trolls, i.e., evil spirits and dangerous giants." The last feeble effort to evade the idea of human manufacture came in 1820; but, as we have seen, faint echoes are still being heard.

Difficult as it may be for us to appreciate the importance of this prolonged controversy, it was serious enough at the time. On its outcome hinged a fundamental change in world outlook—specifically, a radically new and inspiring conception of human cultural history. At bottom, it was clearly a dispute over the relative merits of the deductive and inductive methods for arriving at new knowledge. In other words, it was an appeal to

After Montelius, from Folklore

▲ IN GAUL one god controlled both the thunder and the sun, as shown here. The wheel symbolized the sun fiction as opposed to fact. The fictionists, or traditionalists, represented by theologians and book scholars in general, took their stand on the sacred Hebrew Scriptures and on the almost equally sacred writings of Aristotle. These compendiums were regarded as authoritative on all mundane matters. Neither, unfortunately, had anything to say about a Stone Age having preceded the Metal Ages. Indeed, quite the contrary. Hebrew and Greek origin myths and early legends, as found in the Pentateuch and in Hesiod (both dating from around 850 B.C.), agree in representing human life as beginning under ideal circumstances, the former in a "Garden of Eden" and the latter in a "Golden Age," and as ending respectively in a "Fall" and a "Decline." But that is another story.

Now, what of the history of the opposing school, whose views finally won out? A detailed account would be too long, but a few leading facts must be indicated. Commencing at the known beginnings, it can be said that from the approximate time of Sotacus himself, and for several succeeding centuries, there are on record a number of observant Greek and Roman travelers who reported having seen stone and bone implements in actual use by the "barbarians" in widely separated foreign lands. The first of these is Herodotus (484-425 B.C.), the reputed father of anthropology, who tells of stone-tipped arrows, etc., employed by Ethiopians to the south of Egypt. Others follow with similar reports from named and recognized tribes, for example, those in Baluchistan, Sardinia, south Russia, and even faraway Finland. These observations did not immediately result in a basic theory of cultural evolution; but the Greek tragedian Aeschylus (525-455 B.C.), in his *Prometheus Bound*, and the Roman poet Ovid (43 B.C.-A.D. 17), in his *Metamorphoses*, clearly indicate their awareness that material culture had changed and improved from time to time. It seems to have been left for the Roman poet Lucretius (97-53 B.C.) to sum up for us the available facts, as well as the more or less fantastic opinions of his day, in his celebrated work, *The Nature of Things*, which anticipates in several essential respects the modern view of human progress. This document was presumably known to medieval and later scholars, but it was completely ignored by most of them.

Meanwhile, America was discovered, and by the year 1550 the manufacture and general use of stone implements had been observed from Kansas to Chile and doubtless elsewhere. Doubtless, too, examples had been taken back to Europe, and in time comparison of these with local forms brought illuminating results. Whatever the precise facts, shortly before 1600 we find Michael Mercati, an Italian physician, supporting his disbelief in thunderbolts by explaining how such things were made and used as tools and weapons in the days before the employment of metals; and he quotes Lucretius in support of his views. From that day, little by little, the idea gained ground that if the American aborigines were then living in a Stone Age, perhaps our European ancestors had also passed through such a culture stage long ago, and by 1836 this surmise was generally accepted as an established fact.

Looking at the problem for a moment from another angle, we may well be astonished at the long delayed acceptance of the idea of a Stone Age. But my own experience both with Chinese farmers and with artisans here at home has revealed, beyond the merely skeptical attitude, something like an aversion to the suggestion that a flint ax, for instance, was once made by man and even used by him as an actual tool. Their reluctance is backed by arguments essentially the same as some of those used by the book scholar only four or five generations ago. And yet, while stone no longer serves as a major raw material for implements and utensils among civilized peoples, we still do employ whetstones, grindstones, and millstones; and only a few years ago the market supplied us with soapstone discs for the so-called "fireless cooker." The word "potstone" appears in the dictionary, indicating that soapstone or steatite was once used for culinary vessels in England as well as in aboriginal America. Moreover, perforated stone hammers are said to be still used in Iceland for pounding fish, and we are told by competent authorities that other forms of stone devices—anvils, lamps, spindlewhorls, etc.—survive in use in Ireland, Scotland, and the offshore islands. Going back a little in time, the same authorities claim that flint arrowpoints were used at the battle of Hastings in 1066 and that, in fact, stone tools were in common use in England down to about the year 1100. Accepting these reports, we are bound to ask how it came about that the memory of so late a general use of stone tools was totally lost. Could it be that it was the old, fascinating thunderbolt idea that effectually erased it?

And that brings us to the final question. How, in the first place, did man arrive at his deeply ingrained notion of thunderbolts? Why the celestial origin? And why did he single out artifacts and certain fossils resembling artifacts as heaven-sent when other equally mysterious things found on earth were accepted as parts of the normal creation? The answer, it seems to the writer, is not far to seek: early historic man simply confused artifacts with meteorites. This, as it turns out, is not a new idea, inasmuch as the Romans evidently regarded meteorites as one form of the thunderbolts. But, disregarding this lapse of memory on the part of recent writers, it can hardly be denied that mankind must have known for untold ages that meteorites were connected with "falling stars"; and it was not unreasonable for him in later times to conclude that lightning, in some similar way, also brought solid objects to earth. We ourselves have come to recognize fulgurites as solids produced by lightning, not out of air, to be sure, but out of sand. As for the modern student of nature, it may serve to remind him that meteors, and especially meteoric showers,

A Plea for our Native Wild Orchids

By Julian Burroughs

FOR the botanist and nature lover there is no greater pleasure in the woods than finding an orchid in bloom. There are 57 native wild orchids in the northeastern part of our country, I am told, all of them in more or less danger of extinction: first, because of the clearing of woods and draining of swamps; second, because so many people cannot resist the temptation to pick them.

When I was a boy the big, showy lady's-slipper grew in abundance on the edges of the near-by swamps; today not one is to be found where once they raised their gorgeous bloom. Continued gathering has exterminated them. I remember my father telling of a young woman who, longing to see lady's-slippers blooming in their dark swamps, coaxed him to take her to their beds. Although she promised faithfully not to pick any, my father later discovered that she had returned the next day to pick every last one.

So often our wild orchids are gathered innocently by people who, fascinated by them, do not realize that picking exterminates them. Other people sometimes dig them up, planning to transplant them to their own flower beds. Seldom, unfortunately, can this be done; transplanted they soon die, and that is their end.

In New York State picking wild orchids is against the law, subject to a heavy fine. Also some wildlife sanctuaries have been established where orchids, as well as other rare flowers, can carry on undisturbed, to be enjoyed and appreciated by our descendants. It is a most worthy cause to save some of our orchids, at least, for our children's children, so that they may experience the thrill of seeing them in bloom in their native woods.

Photo by Frederick H. Pough

▲ Yellow fringed orchis (*Habenaria ciliaris*), now becoming rare because of the excessive elimination of swamps and other changes caused by man. It blooms in July and August, in suitable areas from Ontario to the Gulf, and is the largest and showiest of the orange-yellow orchids

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were until quite recently regarded, as in Greek and Roman times, as having portentous significance. If this is not enough, there is an abundance of evidence from nearly all parts of the world that man has long sought meteorites, worn them as amulets, probably carried them in his medicine bundle, apparently buried them in his mounds, and positively placed them in his shrines and temples to worship them, precisely as he did with the stone ax in more limited areas. Confirming this reverential aspect, we have the statement by a professional writer on meteors that meteorites "certainly were considered holy by the Aztecs and preserved in their temples"; and, as visible proof, it is generally accepted that the venerated "black stone" in the sacred Kaaba at Mecca is an aerolite.

In conclusion, let us return to our starting point to bring the subject up-to-date. This is easily done because, while we may no longer consciously believe in the magical powers of thunderbolts, we do actually, perhaps unconsciously, practice several inherited ritual and ceremonial customs once connected with the ancient symbols. A few examples must suffice. Thus, as a proper beginning, petitions are still addressed, literally and figuratively, to "God in Heaven." Respect is paid to crowns, scepters, maces, and batons which, as symbols of authority, may be suspected as being modified descendants of the old thunderbolt. Our Mazda lightbulb, named after Zoroaster's god of light, recalls astrology and brings in the Parsees, who today worship fire as the symbol of purity; it reminds us of Christmas candles, of lighted churches and sanctuaries the world over, and of the "eternal

Continued on page 284

➤ A silver pendant in the form of a hammer made by the Vikings to symbolize their thunder god, Thor. Even in the nineteenth century, Thursday ("Thor's Day") was sacred

After Montelius, from Folklore

Insect Portraits

AN EXTRAORDINARY SERIES OF CANDID CAMERA SHOTS OF THE INSECT WORLD

Photographs by Richard L. Cassell
Descriptive text by Mont A. Cazier

Many thousands of candid camera shots have been taken of men, women, and children going about their usual or unusual business. But have you ever had the insect world that abounds about you exposed for your close scrutiny? For instance, have you ever seen . . .

▼ . . . the Praying Mantis waiting with forelegs poised to capture unwary insects that come within reach? As you approach, he extends his wings and looks in your direction, preparing to flee in fright. Or have you, by chance, happened upon . . .

▲ . . . a group of moths and male Rhinoceros beetles amiably engaged in taking sustenance from a "bleeding" tree trunk? They pay little or no attention to your approach because the meal at hand is apparently more important. Two quite different forms of "table etiquette" are shown in this gathering: the moths unroll their long, tubelike mouth parts through which they suck the delicacies at hand, whereas the "rhinos" dip their small, chewing mouth parts and, occasionally, their legs into the attractive plant exudate. No noise is audible!

➤ THOUGH DANGEROUS LOOKING, a closer view of the "rhino" shows him to be quite the contrary. The large, erect, double forked horn is an immovable projection of the head, while the shorter, single forked horn is a projection of the thorax. Neither are instruments by which you can be injured, but another male "rhino" may have to contend with them if he happens along. The mouth parts, which are barely visible beneath the head, are used only in feeding

▲ IMAGINE MEETING this alert, seemingly begoggled specimen on some dead or fallen log! Perhaps your first inclination would be to retreat, if you did not know him to be a Longhorn Beetle, whose interests are more in the log and in others of his kind than in your presence or welfare. He is an expert in wood chewing, for which he possesses strong, sharp mandibles. The sensory organs on his long antennae enable him to seek out suitable food and, in the case of the females, suitable wood in which to lay eggs. Since he is quite harmless, let's approach cautiously so as not frighten him away and . . .

➤. . . look him in the eyes! Thus you see that the "goggles" are in reality large, granulate, compound eyes composed of hundreds of small, eyelike facets. To him you probably appear as a mosaic image. Perhaps you have already noticed that not only can he look at you from the front but, without so much as a turn of the head, from the sides and top as well. Those "teeth" are not stationary but can be brought together with great force

◄ UPON FIRST SIGHT, you might mistake this resting creature for a Scorpion, especially if you are familiar with the characteristic posture of the true Scorpion's abdomen. Unlike the Scorpion, however, this individual has long wings. The curved structure is his abdomen, which terminates in a stingless, pincer-like male sex organ. His Scorpion-like appearance and his wings have earned him the name of Scorpionfly. One might see him feeding on small animal life or, with equal adroitness, upon fruits and flowers, for his feeding habits are variable

▲ THE FANTASTIC CREATURE approaching with the leaflike plates of his antennae (feelers) spread like half open books is known as a June Beetle. His body is ornamented with patches of scales and hairs, and the front of his head ends in an upturned scoop. In this position thousands of sensory pits on the leaves of his antennae are exposed, and any odors from near-by food, or the odors and sounds of near-by females of his kind, would bring a quick change in his otherwise lethargic behavior

▼ THIS PASSER-BY is known as a Weevil, or perhaps more appropriately as a Snout Beetle. He might also be introduced as the Durante of the Insect World, except for the fact that he is a destructive pest and carries his small, chewing mouth parts far out on the end of his snout. His elbowed feelers are inserted on the sides of the snout, and his tough, rough body makes him a difficult character with which to contend

▲ ENCOUNTERS with this denizen of fresh-water pond and marsh are not easily forgotten, in spite of his rather innocuous title of Giant Water Bug. You may consider it fortunate that he can, at most, grab you firmly with his long, clawlike front legs and give you a painful bite by inserting his needle-like mouth parts and irritating saliva into any exposed flesh. Aquatic animals, such as other insects, small fish, frogs, and salamanders, are not so lucky, for they are overcome by the voracious attacks of this demon, which feeds on their body fluids

▼ THIS FELLOW is commonly called a Slant Faced Locust and, although he may have a long face, he should not be unhappy since he still has quite a bit of life before him. His short wings indicate that he has not yet reached adulthood and so cannot fly; but his long hind legs, amply developed for jumping, enable him to go about his business

▲ SINCE you have probably been the unfortunate recipient of a hornet's wrath at one time or another, you might like to know what the other end of the critter looks like. Here you see a bald, light colored face with five eyes, a pair of antennae, and two mandibles protruding below. The numerous, small facets in the large compound eyes are again making a mosaic image of you, while the three simple eyes on the top of the head, with their single lenses, are serving to increase the wasp's sensitivity to light stimuli received through the compound eyes

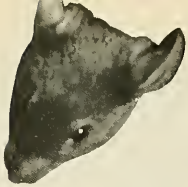
◀ LOOKING DOWN UPON YOU is a majestic Stag Beetle. With antennae erect, antlerlike mandibles spread, and legs braced, he stands ready to ward off any attackers or to attack if the affections of a female are contested. The males of these beetles will often battle to the death but, while ferocious in appearance, are capable of giving you but a mild pinch

▲ RABBIT? No, this innocent looking fellow is just a large male moth with branched antennae extended to intercept any odor emanating from the opposite sex that might be wafted his way. A strong flier, he travels for long distances in response to favorable stimuli

If you trouble to examine insects closely, you will see many wonderful things like these; and remember, there are over a million different kinds, most of which have not been observed thoroughly

Brains and the Beast


Acme



Experimental animal psychology applies scientific methods to determine the learning ability of animals and gives promise of a fuller understanding of the lives and behavior of living creatures other than ourselves

By Frank A. Beach

IF you have ever taught a dog to perform a trick or even house-broken a puppy, you know several important things about the process of learning in animals. You know that it is possible to inhibit an instinctive response by punishment and to establish a new or learned response by reward. If you have been acquainted with more than one dog, you are well aware that no two are exactly alike, that each has his own unique "personality" and that dogs differ from one another in their ability to learn.

Before the beginnings of recorded history, mankind had amassed a great fund of practical information about the relative educability of different animals, the limitations of learning ability in each, and the most effective methods of training various domesticated species to perform certain tasks.

A New Science

When the new science of experimental animal psychology came into being less than fifty years ago, the results of its early attempts to study animal learning must have seemed futile and almost ridiculous in comparison with the vast store of practical knowledge that represented the accumulated experience of more than a hundred human generations. But the comparative psychologist was, and still is, seeking to answer questions that the animal breeder or pet owner has never seriously studied. How far down the animal scale does ability to learn extend? What about the learning powers of species that man has never bothered or been able to domesticate? Of course, a poodle can be taught to dance on his hind legs or jump through a hoop, and this tells us something about his learning ability; but do such tricks represent the upper limit of the dog's capacity? Could he, perhaps, without special training, solve new problems by a process of reasoning? How do animals learn, anyway? Is it by a mechanical, trial-and-error procedure, or do they have sudden flashes of "insight" in which the correct solution suddenly becomes clear?

There is only one way to attack such problems: the method of experimentation. Animal psychology has barely begun to answer its own questions, but the story of its successes and failures is an exciting one, for it gives promise of future rewards in the form of a fuller understanding and appreciation of the lives and behavior of living creatures other than ourselves.

Searching for "The Foot of the Class"

One winter afternoon more than 40 years ago, in the laboratory of zoology at the Johns Hopkins University, a scientist sat hunched over his microscope. He was observing the behavior of a one-celled animal so small that it appeared as a speck of dust to the naked eye. The animal was a paramecium, which moved rapidly about in the single drop of water on the microscope slide. A tiny fragment of filter paper floated in the water drop, and as the animal swam against this obstacle, it reacted violently, backing away as swiftly as possible. The next time the paper was encountered the paramecium responded less vigorously; and after a number of such collisions, the animal's only response was to turn slowly and swim away in another direction.

After studying hundreds of individual paramecia, this scientist, Professor H. S. Jennings, was convinced that behavior of this type is characteristic of the species. He then began to wonder whether certain influential German zoologists had been correct in concluding that very simple animals that lack a complex, highly specialized nervous system are nothing but protoplasmic machines. Is their behavior, he asked, completely controlled by the action of external forces in the same manner as inanimate objects are moved about by air currents, chemical attraction, or magnetic forces? Jennings believed that even the one-celled paramecium shows some ability to control its own behavior and seems to discriminate between various substances in its environment, approaching some and avoiding others.

Dr. Jennings was not prepared to assert that a paramecium can learn, but two other investigators working in the same laboratory about two decades later described experiments with another type of unicellular animal which led to a real controversy on this question. Biologists who study the amoeba usually rear dozens of the minute animals in a single glass dish. If the dish happens to be kept in a place where about half of it is struck by rays of direct light and the remainder is shaded, nearly all of the animals will usually be found to congregate in the darker portions of the dish.

Interested in learning more about this light-avoiding tendency, the Hopkins zoologists placed one amoeba on a microscope slide and focused a narrow beam of intense light across the center of the water droplet in which the animal was moving about. As the amoeba flowed along, it entered the illuminated area; and when this occurred the forward movement slowed, and finally the animal came to a dead stop. Then, sluggishly, it began to move backward into the shaded region of its minuscule lake. In its progression about the slide, the amoeba encountered the light beam again and again, and the depth of its penetrations into the band of illumination steadily decreased. After a number of such experiences the amoeba began to reverse its direction of movement as soon as the forward edge of its body entered the region of bright light.

Before these experiments were reported, most psychologists and zoologists had agreed that learning consists of changes in behavior occurring as a result of experience. Did the results described by Drs. S. O. Mast and L. C. Pusch represent true learning? Contemporary opinion was divided. Some authorities insisted that these alterations in the amoeba's behavior were too transient and limited to be classified as examples of learning, while other scientists declared just as stoutly that this was a clear-cut illustration of very primitive learning by practice. The entire debate hinged, of course, on a matter of definition, and the dispute has never been fully resolved; but the facts in the case are not questioned.

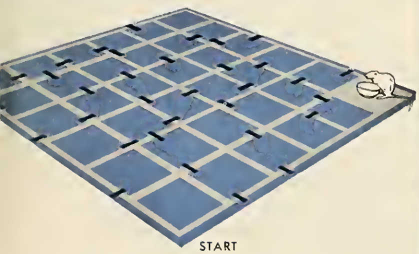
Although experimentalists are divided on the question of learning in one-celled creatures, they are practically unanimous in agreeing that the higher invertebrates can modify their behavior as a result of personal experience.

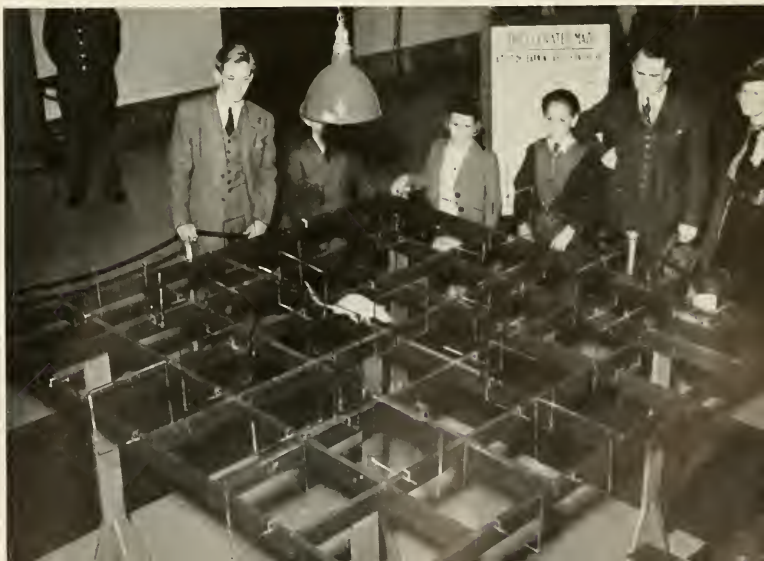
One of the common methods of showing that an animal can learn has been to produce, by training, a reversal in some inherited or unlearned behavior tendency. Like the amoeba, the cockroach avoids light by staying in the dark when possible, but experiments conducted at the Institute of Experimental Biology in Vienna proved that this native behavior tendency can be completely reversed. Dr. J. S. Szymanski put cockroaches in a box with one lighted and one darkened compartment connected by a small doorway. At first, when the roaches were placed in the lighted side, they ran directly through the doorway into the dark section; but each time they did so, the insects were given a weak electric shock. After a number of such experiences the animals not only ceased to go to the dark but resisted being pushed toward the doorway leading to that compartment. Moreover, they hurried into the light even if the experimenter placed them in the dark when the electric current was not turned on.

Threading the Labyrinth

Four thousand years ago the mummified bodies of Egyptian Pharaohs, together with the carcasses of their sacred crocodiles, were sometimes hidden within the innermost recesses of elaborately constructed temples, in chambers that could only be reached by passing through a bewildering series of connecting rooms and passageways. The pathway was made as confusing as possible without ac-

➤ A **RAT MAZE** exhibited a few years ago at the American Museum, in which the animal had to make 25 decisions before reaching his reward of food. Panes of glass barred further progress after each wrong turn. The error curve for rats in this type of maze closely resembles that for human beings, but the rats sometimes learn faster





tually preventing the mourners from visiting the shrine, the purpose being to mislead potential despoilers or to bewilder the ghost if it attempted to escape to haunt the living. Some of the earliest Italian kings were buried in the center of cunningly devised labyrinths from which it was exceedingly difficult to find an exit without a clew of thread thoughtfully laid down from the entrance. The use of labyrinths in one form or another has persisted ever since. In seventeenth and eighteenth century England, no lord or noble considered his formal garden complete unless it included a maze of pathways enclosed by high, dense hedges.

At the turn of the present century Dr. W. S. Small, Professor of Psychology at Clark University, was searching for some convenient method of studying the learning ability of white rats. Remembering the famous maze in the gardens of Hampton Court Palace, and thinking about the natural habits of the rat, he came to the conclusion that a miniature labyrinth might be well fitted for measuring learning in this animal. Since Small's time the maze has become a favorite tool of the comparative psychologist. It varies in complexity from the simple, single-T design, in which the animal is called upon to make only one turn, either to the right or to the left, to much more elaborate patterns involving as many as 25 "choice points." But all mazes are based upon the same principle. The animal or human subject enters at one point and leaves at another. In order to get from the entrance to the exit he must walk, hop, swim, or crawl through a series of passageways or over elevated runways that branch or divide at regular intervals. At each fork in the road a choice of routes is imperative; if the wrong pathway is selected, it ends in a blind alley and the subject must go back to the fork to take the alternative path leading to the next division of the ways. To learn a maze the animal makes repeated journeys through it, gradually eliminating the tendency to enter the various blind alleys, until finally he can go from beginning to end without once departing from the correct pathway.

As he leaves the maze the animal is given a bite of his favorite food or provided with some other reward, and in some experiments each choice of a blind alley is punished with a mild electric shock. One of the great practical advantages of this experimental tool is that it can be adapted to any animal capable of locomotion, and its complexity or difficulty can be adjusted to the learning capacities of the particular species under investigation.

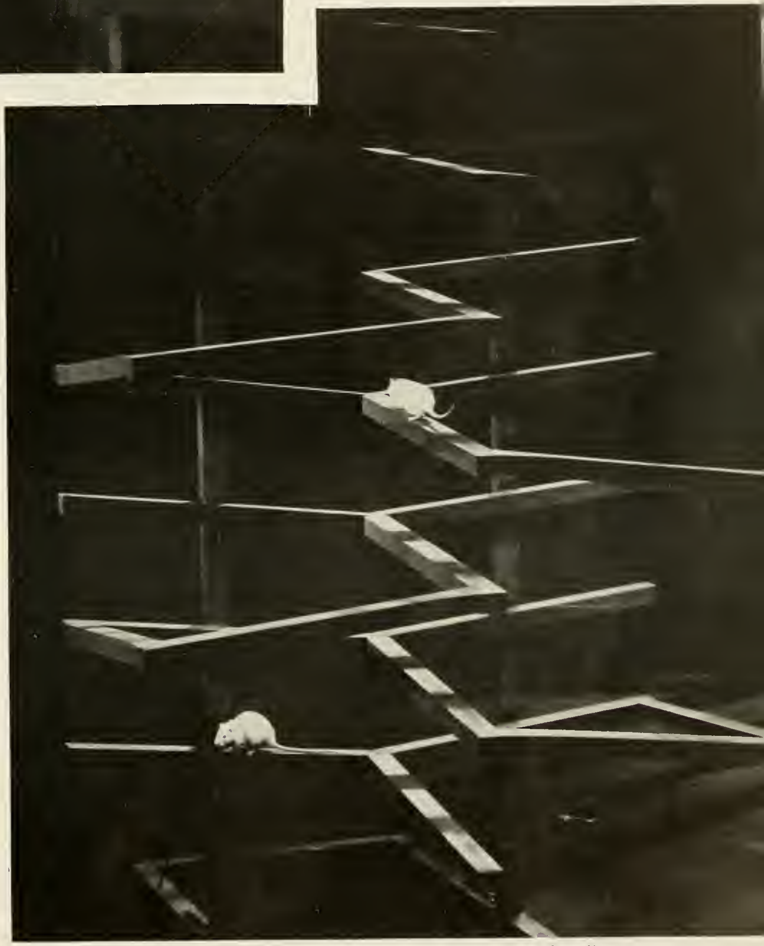
In 1912, Professor R. M. Yerkes, then a young psychologist at Harvard University, discovered that *Allobophra foetida*, whose unlovely common name is "manure worm," could learn after many trials to choose the right-hand turn and avoid the left in a single-T maze. Turns to the left were punished with an electric shock, and turns to the right were rewarded by allowing the worm to crawl into a dark box filled with moist earth. Dr. Yerkes' experiment must have called for a great deal of patience, but the man who really deserves an award for perseverance was the one who proved that *snails* of land or fresh-water varieties are capable of learning a right- or left-hand turn.

The list of animals that have mastered relatively simple mazes includes cockroaches, crayfish, toads, frogs, goldfish, snakes, turtles,

LIFE photograph by Fritz Goro. Copyright TIME, Inc.

◄ ANTS pass most of their lives traveling between nest and source of food. This maze, designed by Dr. T. C. Schneirla, demonstrated that they learn a path more quickly when traveling back to the nest laden with food. Apparatus at lower left controls gates in maze

THE RAT at the bottom of the lower picture is a beginner who has not yet learned this unusual maze. While he explores a blind alley, the other animal, who has learned the true path, forges ahead toward the goal, where food is waiting



International News photos

chickens, cowbirds, pigeons, and bluebirds. Some insects can cope with comparatively complicated mazes such as the one used by Dr. T. C. Schneirla of the American Museum of Natural History in his studies of learning in the ant. The best maze students of all are mammals, and laboratory rats can learn mazes with as many as 25 blind alleys. Monkeys do little better than rats in spite of the fact that primates are supposed to be much more intelligent than rodents.

As soon as mazes were introduced into the experimental laboratory, psychologists naturally thought of comparing the ability of men and other animals on this all-purpose test. Of course, human subjects had no trouble topping the invertebrates, the fish, the amphibia and reptiles, and the birds; but when man and rat were matched, the score was less uneven. The earliest attempts to compare humans and rodents in maze performance were made in about 1911, and the results suggested, but did not prove, that rats might do nearly as well as human subjects. More recent and carefully controlled experiments have proved the point. At a southern college two psychologists constructed an elevated maze consisting of narrow pathways supported by pillars. Rats were required to run along the elevated pathway, and blindfolded college students followed it by running their hands along the path, as on a guard rail. All conditions were held as nearly the same as possible for the rats and humans, although the animals were not blindfolded, and the students were not required to go hungry and then accept a food reward.

When all the scores were in, it became clear that the 27 white rats had made a much better showing than the 19 girl and 19 boy college students. The rodents could run through the maze without a single error after fewer trips than the humans required. Before making three successive perfect runs, the students committed nearly twice as many errors (entering blind alleys) as the rats, and they took more than three times as long to do it.

Continued on page 283

Photo by Tad Nichols

Where the ANTELOPE Play

Our graceful pronghorn is a rewarding subject of observation in some of the treeless sections of the West. When wild, it won't let you get close; when tame—try to keep away from it!

By WILLIAM H. CARR

THE antelope streamed along, gaining speed as they put their hearts into it. We glanced at the car's speedometer while the needle advanced rapidly from 25 to 30 and then to 35 miles an hour. There were 28 animals in the gracefully undulating group running before us, several frightened little ones among them. The actions of all were marvelously rhythmical as their slender legs flashed across the mile-high prairie. Presently we slowed down, and the antelope followed suit. Shortly after we stopped, they also halted. Binoculars revealed them to be breathing very rapidly as they turned and stared in our direction, apparently wondering what our next move would be. We knew they were capable of greater bursts of speed, but it seemed cruel to pursue them farther just to satisfy our curiosity. After a brief period the winded creatures walked slowly away and disappeared beyond a small, shrub-covered hill.

In the background were the rugged, green Cimarron Mountains of northeastern New Mexico, and in the opposite direction a vast expanse of brown, yellow, and golden plains swept on to the horizon. It was a region of magnificent vistas and incomparable color, where the towering Rockies descended to meet the endless Great Plains. The animals were prevented from vanishing altogether by means of an inconspicuous fence enclosing hundreds of acres. This huge pasture was a relatively small section of the 200-square-mile territory maintained by the National Council of the Boy Scouts of America and is known far and wide as the Philmont Scout Ranch. It is the world's largest boys' reservation and, to a growing extent, is also considered a wilderness wildlife sanctuary.

Young men from virtually every

Graceful forms in the wintry wilderness: a group of pronghorn antelope on Anderson Mesa, near Flagstaff, Arizona. They had been gathered in a mid-winter roundup for moving to better pasture

state in the Union visit the Ranch each summer and are presented with the opportunity of viewing a varied and abundant animal population including two antelope herds, elk, many deer, numerous black bears, mountain lions, wildcats, beaver, and a fine group of buffalo. I had been fortunate enough to be included among the Ranch guests, and my initial experience with the antelope herd had aroused a determination to continue my observations of these highly interesting plains dwellers.

The American Antelope, which once inhabited the grasslands of the West in tremendous numbers, has "come back" in many places under adequate protection and rigid hunting control. Despite this fact, opportunities to see this animal are largely restricted to game preserves and ranches owned by conservation-minded persons. Ruthless slaughter and overgrazing of their range by cattle have reduced the original herds to a pitiful remnant. Today poaching and increasing competition with added cattle and sheep, even on Federal land, are ever-present threats to their continued existence. Constant vigilance is still the watchword for all who would preserve this wonderful American animal.

One August morning before daylight I walked into the area where the animals wandered. After going slowly for a mile or so, I sat down upon the ground, feeling certain that the antelope were near. Soon a faint, lilac light showed over the near-by 10,000-foot mountains, and with powerful field glasses I quickly discovered the herd. They were browsing at the edge of the Gamble Oak woods. As the light increased, the animals continued their feeding and commenced to walk in my direction, cropping the grass and moving gradually ahead. The young ones strayed some distance from the main group. They appeared to be eating more avidly than the adults. On several occasions two small bucks would "square off" and engage in a brief skirmish, striking their horns together in a rather half-hearted fashion, presumably more in play than in actual combat. The rutting season was at hand, and possibly these short-lived clashes were preliminaries to the future, main event.

As the animals advanced they would often look up and about. A large buck stalked before the others and fed very little, spending most of his time gazing about. On later occasions I invariably saw this same animal behaving in this fashion, usually walking or standing in front of the others and scanning the landscape in all directions as though he were the watchdog of the herd. He seemed fully as well fed as his companions. In fact, all of the antelope were in excellent condition.

I sat very still and am certain the animals had no idea of my presence until they were less than 75 yards away. Then the leader saw me. He stiffened instantly, and a moment later the entire herd centered their attention on me. Several of the animals trotted away, only to stop and look at me again. The youngsters especially were very curious and peered at me from time to time, craning their necks and sometimes taking several side steps the better to view me. The buck held his ground at first, then walked away in leisurely fashion with many backward glances.

I remained where I was, keeping as still as I possibly could. The antelope were by no means tame; yet they stayed near by and commenced to graze again. One female lay down, and presently several of the others did likewise. The old buck never forgot me, though he grazed from time to time and frequently surveyed the surroundings in other directions.

The sun arose above the mountains and warmed the prairie. The buck, with his wary eye still on me, drew nearer, looked at me

Photo by Ralph Childs

Antelope are almost as free as the wind on the Cimarron range of New Mexico, where the southwestern Rockies meet the Great Plains

THE WHITE RUMP of the antelope is covered with brittle hairs that may be raised whenever the animal is alarmed. This display of snowy white, visible for long distances, is believed to serve as a warning to other antelope

PLAYING PUSH: a tame, young antelope that took delight in pitting its strength against the author in this way. Unlike its human adversary, it never seemed to tire of this sport

Photos by Marvin H. Frost

carefully for minutes at a time, then gradually circled to my rear, followed by several smaller animals. The muscular coordination of the antelope, even when they traveled slowly, was a thing of perfection. Quick motions of the feet as they stamped to shake off flies were as smoothly executed as were their actions when running. On one occasion a small female engaged in what seemed to be a race with a young one. Here I saw a new pace or gait that differed radically from other forms of antelope locomotion. Both animals loped, somewhat as horses do, before breaking into the effortless run that marks the antelope as one of the world's swiftest speedsters. At the conclusion of the race the little one obtained a breakfast of milk from his mother as she stood patiently by.

It was breakfast time for me, too, and I was hungry. When I stood up, the animals simply "exploded." They sped off in every direction but quickly formed into two groups and flew toward the shelter of the oak woods, not pausing to look back until they had at least quadrupled the distance between us. I walked toward the ranch and a welcome morning meal. The animals eyed my departure for a while and then resumed feeding.

On many successive mornings I returned to the antelope, feeling that I had really made their acquaintance. Once, while keeping my early morning vigil, I decided to try an experiment that had been suggested by a painting by Frederic Remington. The artist had depicted an antelope hunt in the last century. His painting showed a hunter concealed behind a hill waving a flag on the end of a pole in an attempt to arouse the antelope's curiosity and thus encourage them to come within range of the waiting rifle. It is well known that the animals are extremely interested in any unusual sight upon their domain. Not having a pole, I resorted to a much simpler expedient. I merely lay on my back, tied a white handkerchief to my boot, and raised it in the air, moving it up and down for a time. The calisthenics were a bit tiring but had the desired result.

The buck first saw my foot and,

Photo by Marvin H. Frost

SEVEN-MONTH ANTELOPE TWINS, which were bottle-fed after their wild mother had been killed. They were perfectly tame, full of curiosity, and always ready to play

as on previous occasions, he stood perfectly still and watched the strange phenomenon. Then the others saw the object and gazed steadily. After a time the entire herd moved cautiously in my direction, pausing now and then to peer at the "flag." I grew tired of the game long before they did, and at one point it seemed I could not keep my foot in the air for another moment; but I persisted anyway, regretting that I had not thought to bring a pole.

I shall never know just how close the animals would have come, for when they were not more than fifty yards away, a collie dog appeared upon the scene, and the antelope were off like a flash, with the dog in hot pursuit. I jumped up and shouted, trying to attract the dog's attention, but to no avail. He dashed after the animals and continued the chase until both he and the antelope had disappeared. I ran toward the woods, but they were a long way off, and I soon realized the futility of attempting to catch up. I went back to the ranch, and we set out in a car, driving rapidly over the prairie in the direction taken by the herd. No one knew anything about the dog. Presumably he was a stray. We did not locate him, although we did find the antelope unharmed and feeding once more.

The habits of the herd were more or less routine. Each morning they would drift down from the woods and feed upon the plain, pausing now and then to lie down and rest, yet advancing into the center of the open space. About mid-morning all but one would recline upon a hillside. The old buck usually maintained his watchfulness and stayed on his feet. When he did lie down, some other animal would be walking about. Whether there was any design in this seeming sentry duty I could not say.

Toward late afternoon the group would move slowly toward the woods once more. On several moonlight nights I saw them feeding as late as midnight. It was my impression that they were rather active at all hours, resting frequently but not often spending many hours in any restricted locality.

I had become very much attached to the antelope herd on those quiet early mornings when I sat alone in the midst of tremendous space. The scene was exceedingly peaceful, with only the occasional call of a distant quail to break the silence. Vagrant winds sighed through the fragrant grasses, carrying the sweet scent of late summer. In imagination it was very easy to travel backward through time to days not so long ago when these same prairies knew the tread of countless antelope and buffalo; days before the near-by Sante Fe Trail was ever heard of, when only the Utes and Apaches roamed this region, and the rumble of covered wagons had not yet echoed through mountain passes. The warm season was rapidly waning and the distant desert was beckoning. I knew I would miss my association with the animals and the plains very much indeed.

On my arrival home, more than 600 miles away, I was greatly pleased to learn that there were some antelope practically at my doorstep. It seemed that two little animals had been rescued by the local Game Warden several months before. They were twins whose mother had been accidentally killed. The warden had delivered his charges to the custodian of the Tucson Mountain Park in Southern Arizona, and the man had confined the creatures in a safe enclosure and had successfully raised them. Now they were perfectly tame and very well developed.

I lost little time becoming familiar with the twins. They were a beautiful little pair and reminded me strongly of happy experiences in the past when I had raised many Virginia Deer fawns in the Northeast. There is scarcely a more delightful creature in all the world with which to become intimately acquainted than a deer fawn; at least that was the way I felt until a young antelope walked up to me and proceeded to take my necktie

UNUSUAL DIFFICULTIES for a photographer: the two young antelope shown in these pictures often refused to stay far enough from Marvin H. Frost to let him press the shutter release

ONE OF THE TWINS busied himself examining the cameraman's kit. Choosing the paper cover of a flash bulb, it proceeded to munch on it like a small goat

Photos by Marvin H. Frost

in his mouth and give it a good healthy tug. Then my opinions were shaken, and to this day I don't know which I would rather raise, a deer or an antelope. The decision would be very difficult.

The transformation that marks the difference in behavior between a wild animal and a tame one is often amazing. The offspring of the fleet, wary antelope become incredibly tame when bottle-raised. One marvels at the contrast between creatures that practically run themselves to death to escape and others of the same type that will follow a human friend so closely that they may actually trip him up if he fails to watch out! No immediate descendants of wild animals could possibly have been more trusting than were these carefully reared young antelope that strolled to meet me when I first entered their enclosure.

While I had secured excellent views of individual antelope in the semi-wild herd at Cimarron, my real opportunity for close observation came with these little pets, for, of course, I could handle them. Their eyes were their most striking features. They were very large, perhaps the size of a half dollar, and were a beautiful black-brown color with long, fairly stiff eyelashes on the upper lid and shorter ones on the lower. Their tongues were black and so were their inner lips, the tips of their ears, and the end of their moist noses—all as black as could be. The under surfaces of their bodies and chests were white, and there were also white patches along the cheek, under the chin, and across the neck front. A russet-color covered their backs and most of the head. A brownish strip of raised hair lay between the ears and ran down the back of the head and neck, somewhat like a mane. To say that they were attractively patterned and colored is to put it mildly.

When I sat on a box in their roomy enclosure, the alert young antelope investigated my person thoroughly, tasting my jacket sleeve, nosing my side pockets, and even placing their feet upon my lap the better to sniff my hat. They followed me wherever I moved and were quick to resume their sniffing and tasting whenever I stopped. Once one of them grasped the black focusing cloth as my photographer friend, Marvin H. Frost, was endeavoring to arrange for a picture at a fixed spot. The animal pulled the cloth from the camera and from Frost's head, too, and walked away with it. It would have been difficult for a lone man to snap their pictures, for they would not stray far enough away from the camera unless an assistant enticed them!

After some time, one of the little explorers grew tired and lay down, folding its front legs first and doubling up the hind legs afterwards. The animals would permit us to take practically any liberties while they were reclining or walking about. On one occasion when Frost sat down, a young antelope placed its front feet upon his shoulders and nosed about his ears, as shown in one of the photographs. The result was a tickling sensation that caused him to get up promptly. It is not every day that one can have an antelope breathe down one's neck!

There was a fair-sized bale of alfalfa in one corner of the enclosure, upon which the young animals fed from time to time. They would take a few nibbles and then return to us. They were not at all backward about lowering their heads and pushing one another out of the way during feeding operations. Sometimes they would really butt each other, too. It was this last action that gave me an idea.

It seemed that if the animals would play "butt the leader" among themselves, they might also play the game with me. I placed my fist gently between the small "prongs" or little pointed horns projecting from the animal's forehead and then, very carefully, commenced to push. The youngster responded immediately. He put his head down and butted away with a vengeance. The harder he strained against my fist, the harder I pressed. After a while the animal began to push in earnest, placing his hind feet firmly against the ground and leaning far forward as he struggled to topple me over. I honestly believe that if I had suddenly removed my fist, the animal would have fallen forward on its head.

The antelope pushed, and I pushed. After a time I grew tired of the strenuous game, but the antelope had just begun to get into the spirit of things. The moment I drew away, my antagonist reared suddenly to his hind feet and took several quick steps toward me, feinting with his head somewhat as a boxer would do. Then he charged and succeeded in delivering a blow like a billy goat, which caught me in the nether regions and really hurt. He was playing and wished to continue the contest, but the whole thing had lost a bit of its initial novelty for me, so I retired from the field, defeated but wiser. I had definitely started something that I could not finish, for the resilient little animal was tireless and surprisingly strong considering its size.

Once when I was playing "push" with the antelope, my hand slipped and I placed it against one of the little horns or nubbins. I realized then that the antelope's weapons are sharp-tipped, even at a tender age. It is this peculiar forehead apparatus that gives the American antelope a unique position in the world of mammals. The creature is the only antelope known to science that has branching or "pronged" hollow horns—hence its name, Pronghorn Antelope. The outer covering of these appendages is shed each year. Both males and females possess horns, and new ones develop annually upon a permanent, bony center or core.

The antelope has another characteristic that is also noteworthy: the remarkable patch of long, brittle, white hairs upon its rump. When the animal is frightened or otherwise excited, the hairs are raised to form a large showy surface, visible for great distances upon the prairie. Skin muscles are brought into play to make the hairs stand up in this way. When the animals are running away, the white rumps are by far the most conspicuous objects one sees. If their function is that of a warning signal for others in the herd, it is certainly effective.

The manner in which the young antelope stepped about was something that could scarcely be equaled for absolute poetry of motion. Their sharp-hoofed little feet and slender legs seemed almost too delicate to support them, yet they were as sure-footed as one could imagine. I stayed with them as long as I could and returned frequently, never tiring of playing with them. Some day I am going to raise an orphaned antelope of my own!

Photo by Marvin H. Frost

➤ Personification of gentleness: a creature that would harm no other living thing. Two nubbins above the eyes show where the "prongs" will appear. Both sexes have them, and they are shed annually

LOVE *Song* OF A TOAD

By Karl H. Maslowski

◄ One warm night late in April, this warty-skinned Fowler's Toad pushed his way out of his winter shelter beneath an overhanging pond bank near Amelia, Ohio. The entrance to the retreat was draped with roots that hung like a portiere

➤ Several moments later the toad hopped a few inches away, and abruptly his throat sac bulged like a dark, frothy soap bubble. This action was accompanied by a sweet, droning call which, when heard at a distance, sounded almost like the soft bleat of a sheep. This was his first love song of the season

◄ Later in the night the toad stationed himself along the muddy pond bank and continued his calling. The calls were about 3 to 5 seconds in duration and were repeated almost constantly. This species ranges west from New England and New York to Michigan and eastern Texas, and south to northern Georgia. It averages about $2\frac{1}{2}$ inches in length from snout to vent, the females being slightly larger than the males

THE LIFE OF THE WATER FILM

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The male uses a pair of claspers at the end of his long abdomen to hold the female by her slender neck. After her eggs are fertilized and seem ready for laying, the pair alight at the water's edge and the female backs into the water down some stem. The male holds on to her and remains above the surface at least as far as his wings. When the eggs have been deposited, the female starts upward and the male pulls, fluttering his wings, so that between their combined efforts, the female is brought out of the water again, to dry off and fly away.

These many special abilities and difficulties related to the water film are based on the very high surface tension which is so characteristic of this commonest liquid. Each adaptation in form or behavior is a means of using or of circumventing the strong surface forces involved. None of these methods do anything to change the surface tension itself. Yet this is possible, and is the basis of a familiar parlor trick. If a chip of gum camphor is dropped into a dish of water, the chip spins around and sails in erratic courses, propelled by a mysterious force. Actually the camphor is dissolving faster along some parts of the water line than in others, and since camphor greatly reduces the surface tension of water, the surface forces are weakest where the gum is dissolving most rapidly. The chip moves because of the inequality of surface forces pulling it from all sides. The weakest forces are behind the moving chip and show where the camphor is dissolving fastest.

One of the rove beetles makes use of this trick. Like its relatives, *Stenus* is an active little beetle, running or flying around much of its time in search of carrion or prey small enough to overcome and eat. Sometimes *Stenus* falls into a puddle or a pond. It has no waxed hair to keep its feet dry and therefore sinks well into the surface film, its legs and underparts thoroughly wetted by the water. But *Stenus* merely expels from its anal glands a substance that makes the water wetter—reducing the surface tension at its posterior end. Undiminished surface forces in front of the beetle promptly draw it forward. As long as the insect continues to emit this magic substance, it sails along with no apparent effort. Often the beetle reaches some dry object upon which it can crawl to dry off and again take to flight. This rove beetle can keep up its speedboating for many minutes, but if it is deprived of the abdominal tip with the anal glands, the insect is quite helpless in the water.

The leaves of some of our pond plants are like the whirligig beetles, with a water-shedding top and a lower surface that rests in and is wet by the water. Lily pads are of this sort, anchored to their loglike roots by long slender ropy stems. Their two surfaces support two different types of clinging life, one wet, one dry, while in between the water lily gathers up the sunshine energy to make it grow. The duckweeds too, small flakes of green, are always at the water surface. The larger kinds rest on the surface with rootlets dangling into the pond below. One of these duckweeds is our smallest flowering plant, floating freely just below the water film among the lily pads. Contrast with this the largest water leaf of the Victoria lily, whose six-foot disk with turned up rim will float a human child of medium size, all safe and dry.

When spring comes to the lake or pond surrounded by pine clad hills, the water film takes on a golden yellow cast with squandered pollen grains. The wind makes patterns of the driven dust, while the whirligigs cruise through it and raise a wake like tiny boats, rocking all the water bugs and giving rise to quiet lappings on the near-by shore. Spent and useless to the trees around, this pollen dies and sinks below. Throughout the years it may build up a layered record of the past. From just such fossil pollen we know many of the plants which lived and passed away but left no other mark. Pollen, wind, and water film combined to make a fossil trail of bygone trees.

BRAINS AND THE BEAST

Continued from page 275

After the dullest subject had learned to traverse the maze perfectly, all the humans and animals were given a 30-day rest and then tested to see how much they remembered. (Neither the rats nor the students were informed in advance that they were supposed to remember the habit!) The amount of forgetting was measured by comparing the number of trials or errors involved in reaching perfection during the original learning with those needed to regain this level of performance 30 days later; and it turned out that the humans excelled the rats in this regard. Students relearned with less difficulty than rodents, but the differences were relatively small.

If you have followed the story so far without devoting much thought to the question of how learning takes place, you may be a little nonplussed by the outcome of the tale. Do I mean to say that men are no more intelligent than rats? Of course not! Well then, doesn't learning ability bear any relation to intelligence? Certainly! The resolution of this paradox becomes apparent when we realize that *for some types of learning superior intelligence is of little or no value.* (In fact, it may even be a handicap, but we can't go into that just now.)

Consider for a moment exactly what learning a maze involves. Imagine that you are led to the entrance of a narrow alley and told to keep moving until you come to the exit. Very soon you arrive at a point where the alley divides, one passage going to the right and the other to the left. Which should you enter? There is no way in the world for you to "reason this problem out"; you simply must make a blind guess. If your guess is wrong—and it probably will be about one time out of every two—you soon find yourself at the end of a cul-de-sac and have to retrace your steps to the division point to take the alternative road, which leads to another fork in the ways. Another guess is called for; and so it goes. All through the entire maze you make one gamble after another. Finally you come to the end, and the experimenter insists that you start through again for a second trip. Here is the first choice point. Was it the right or the left passage that ended in a blind alley when you came through before? Perhaps you remember; maybe you don't. But unless the maze is a cinch, you're going to make at least a few mistakes on this second trip. In fact, you will only learn the maze to perfection by walking through time after time, making errors and then eliminating them, until you have finally memorized the correct turn at every point of choice.

This is what is usually called trial-and-error learning, or rote learning. It offers no opportunity for the use of reasoning or insight but forces the learner to rely on simple memory. The maze, therefore, is not a good device for exploring the upper limits of intelligent behavior in mammals or other highly developed animals, although it does seem to tax the ability of lower forms. It is, however, an extremely useful means of studying the way in which rote learning takes place.

The role of rote learning in human life is greater than you might suspect. At one time this method of learning was heavily stressed in the elementary schools. Many of us can remember how we had to memorize our A, B, C's, the capitals of the 48 states, and the names of all the presidents. A few decades ago such material was committed to memory by a constant repetition that had no appeal to any higher mental powers. Educational techniques have changed, but much of the learning that occurs in everyday life is of this same sort. Telephone numbers, street addresses, the names of acquaintances—we usually say that we learn such things "by heart," which seems to suggest that our heads are not involved. This isn't quite the case, but it is true that a lot of our own mental activity seems to be of the same sort as that of the rat in the maze, which does not involve any high degree of intellectual ability.

Natural History Magazine will soon publish another article by Dr. Beach, carrying the discussion to the ability of various animals to escape from puzzle boxes by lifting latches, pressing pedals, etc. Do not miss this illuminating sequel. —Ed.

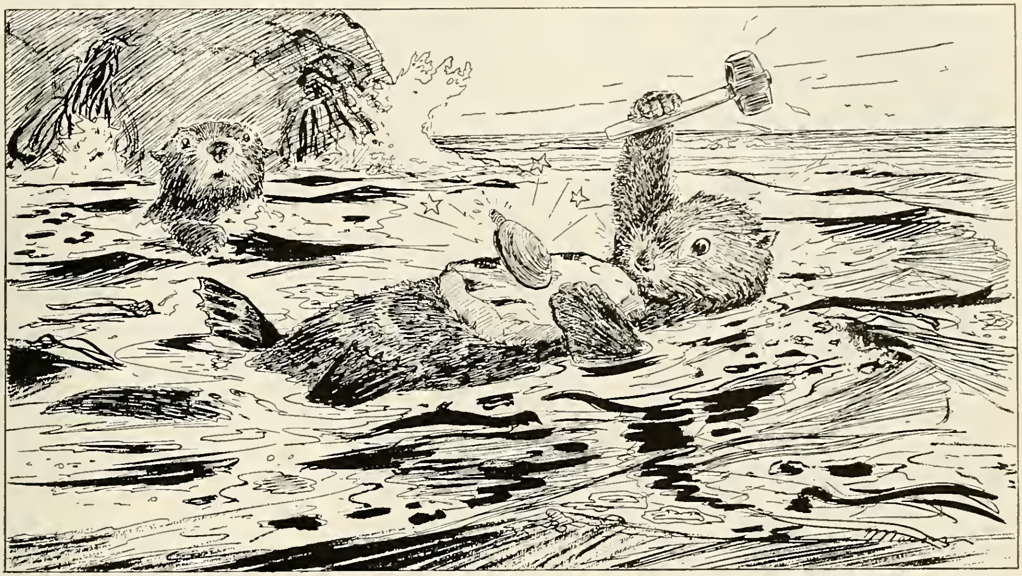
THE THUNDERBOLT BELIEF

Continued from page 263

flames" in Paris over the grave of the unknown soldier and in the Lincoln Courthouse at Dearborn, Michigan. We sometimes take oath on the Bible; but long ago equally solemn affirmations were validated by the stone ax and later by Thor's hammer. By such sacred symbols foreign treaties were ratified, compacts sealed, and commercial bargains struck. And so today when the auctioneer with his hammer "knocks down a sale" or the chairman pounds his gavel, some beholders must surely fancy seeing the old thunder god nodding in the background.

There remains, perhaps, to emphasize what may already be apparent to the reader. It is that contemplation of the illuminating facts presented here all too briefly, yields, not only a sense of the gradual liberation from stultifying beliefs, but glimpses of the hidden threads that bind progressive humanity together. And, however regarded, it would be hard to find a more perfect example of the diffusion of an idea over a large part of the world than is afforded by the concept, "thunderbolt."

SEA OTTER



THE sea otter, which is found along the shores of the Northern Pacific from the Kurile Islands to Lower California, wears perhaps the finest fur of any animal. This four-foot long cousin of the river otters is a dark chocolate-brown frosted with white, the pallid overlay coming to predominance on the head. The fur is soft, thick, and lustrous, and its richness almost led to the extinction of this interesting animal.

The first Europeans to see the sea otter were the Russians, who reached the Pacific shores of Kamchatka around 1700. In the following years, they moved northward and eastward in pursuit of the animal to Alaska and even to California.

At first the otters were fearless, and in two centuries about a million of them were killed. As late as 1891, as many as 5000 were taken in a year. Then the catch dropped rapidly, for only a pitiful remnant remained. Fortunately, international agreements for the protection of the sea otter were then reached, and the animals have again become fairly common in the Aleutians, the Pribilofs, and along the coast of central California.

By JOHN ERIC HILL

Drawing by

G. FREDERICK MASON

Sea otters have many unusual habits. Ever since they were hunted so intensively, it has been the habit of the California animals to pass most of their lives in the ocean, floating on their backs among the kelp and seldom landing even on isolated rocks. They even give birth to their offspring at sea. The mother carries the young on her chest while she rests and leaves them floating in a kelp patch while she hunts for food. The sea otter sleeps on the waves, often holding fast to a large seaweed to keep from drifting.

When hunger moves the sea otter, it usually leaves its school; indeed, at mealtimes—which correspond approximately with our breakfast, lunch, and dinner—a whole school of the animals may scatter. On the California coast their chief food is the abalone, a flattened sea snail six to ten inches in diameter. The hungry otter swims to a good feeding ground and dives obliquely to a depth of 60 to 150 feet. The abalone, when disturbed, can hold so tightly to its rocky home that a person has to use a crowbar to dislodge it; but the otter must manage to pull the mollusk loose with a quick jerk of the paw or teeth.

The purple, spine-covered sea urchin is also attacked, especially in the more northern regions. The sea otter punctures the sea urchin's calcareous shell with its sharp, canine teeth and sucks out the soft insides, as a fox sucks an egg. Sometimes it captures crabs of various sorts, too. It crushes the shell easily between its massive, round cheek teeth and swallows the shell and meat alike!

While studying the school of sea otters near Carmel, California, Miss Edna Fisher* heard a strange clicking sound. High-powered binoculars disclosed that the sea otters were making this sound by pounding a small, hard-shelled object, probably a bivalve, on a flat stone balanced on the chest! Each time an otter brought up this shellfish, it also brought an "anvil" upon which to crack it—a most unusual use of a tool by a mammal.

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*E. M. Fisher, *Journal of Mammalogy*, XX, (1939) 21-36.

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which are plugs controlled by muscles. The whalebone whales have a spiral valve whose folds fit into each other and effectively close the nostril when external pressure is exerted.

Question:

Can a whale get the bends?

Answer:

The bends, or caisson disease, is a serious affliction of divers caused by nitrogen bubbles in the blood. A whale does not get the bends simply because it does not keep on breathing below the surface as a diver does in a diving suit. The only nitrogen the whale gets into its blood is the nitrogen it carried down in its last breath.

Question:

Do whales swallow water or do they, as I have heard, depend on water formed by metabolic processes, as many desert animals do? If so, how? The desert animals live largely on carbohydrates, which in their ultimate metabolism produce considerable water. Whales live exclusively, I suppose, on proteins, which, if memory serves, do not form much water in metabolism. If they do swallow sea water, as many sea birds can be seen to do, what amazing kidneys they must have . . .

Answer:

Whales undoubtedly swallow some sea water. Their food, too, contains a lot of water, whether it be shrimps, fish, or squids. Unlike ourselves, they are apparently adapted fully to salt water and "protoplasmic" water.

Question:

Dr. Hill says that when submerged, the heartbeat of all water animals slows down to a fraction of its usual speed. How can the heart rate be counted in a whale?

Answer:

Electrocardiac readings have been made by attaching wires to submerged mammals in tanks. Dolphins were used, but the larger whales probably react similarly.

Question:

Regarding the statement that the systemic blood supply is greatly reduced during diving, I can understand that this could be true so far as the visceral blood flow is concerned, for that is diminished in all animals during muscular activity. But the blood supply to the muscles can hardly be decreased. One would think rather that it must be increased, as in other animals. When diving, an animal must keep itself down against its own buoyancy. Also, propulsion under water requires expenditure of considerable energy. I am wondering how the muscles can supply this energy if their blood supply is much cut down.

I once made an observation when cruising at 16 knots (say 18 land miles an hour) in the southern Bering Sea. We were overtaken by a school of about 100 porpoises, of unidentified species. On reaching us, they "slowed down" and kept us company for over half an hour, most of them very close by. Sixteen knots is quite a good speed for a boat, yet the porpoises showed no signs of fatigue, and they appeared almost to be loafing along. They seemed to be feeding on fishes or other organisms stirred up by the ship, though we could not see this food from the ship's bridge. A porpoise that would stop or turn aside, apparently to investigate or devour something, instantly caught up with us again. Finally the ship apparently emerged from the school of small creatures, for the porpoises turned and left us, seemingly at undiminished speed.

The amazing thing to me was not only the speed and endurance of these little whales but their apparent lack of breathlessness. I am not sure I know of any land animal that could travel over half an hour at 18 miles an hour; but if any could, they would surely be in great distress for air, and their breathing would be as rapid as possible. These porpoises were submerged most of the time. Several individuals that I timed came to the surface only every minute or two. Sometimes they leaped clear of the water, during which there would be time for two breaths, not more. Usually they just rolled the blow hole to the surface, expelled a lungful of air with a short, quick, audible puff, and filled the lungs again before submerging. More than once it looked as though the nostril was still open and inhaling as the porpoise went under, but this was, of course, an erroneous impression.

How could air taken in at the rate of only one breath every minute or two provide enough oxygen for such an expenditure of energy? We, ourselves, breathe about sixteen times a minute while resting. These porpoises must, it seems to me, either have been drawing on oxygen stored in large amounts somewhere in the body, or have been getting it by the chemical breakdown of compounds of oxygen.

Answer:

During long dives muscular energy is secured through the breakdown of glycogen in the muscle tissue. This supply suffices for some time; but oxygen is later required to restore the glycogen. Porpoises and whales are not known to have any special means of actually storing oxygen. They do make efficient use of what they breathe, however, and their lungs are well ventilated at each breath. Porpoises never breathe much more frequently than you observed them.

"Chiggers"

SIRS:

The article, "Chiggers!" by Mary H. and Charles D. Michener, in the May issue of NATURAL HISTORY, suggests no methods of curing chigger bite. Is there any treatment that will stop the itching?

NAN WOOD.

New York, N. Y.

A drop of fingernail polish (colorless, if preferred), applied to each bite, allowed to dry, and left on the irritation is quite an effective means of arresting the itch.

CHARLES D. MICHENER,
The American Museum of Natural History.

New York, N. Y.

Frog Migration

SIRS:

Last night, while driving home from Manchester, I was astonished to see what appeared to be a mass migration of thousands of frogs, leaping across the concrete highway for a distance covering about five miles. Their course seemed to be westerly, away from the partly flooded flat meadows and toward higher ground. Many of them, of course, had not escaped the numerous autos.

As it was a chilly night with a dense fog, I did not stop to investigate; the poor visibility would have invited a rear-end collision. But as they leaped into the glare of the headlights, they seemed slender, with notably long hind legs and bodies a bit under three inches in length.

Why was the migration away from inviting breeding spots to high and presumably dry ground? Is this a usual custom?

HERBERT WHEATON CONGDON.

Arlington, Vt.

The following answer is offered by James A. Oliver, Assistant Curator of the Department of Amphibians and Reptiles at the American Museum:

The migration of amphibians in large numbers is not an uncommon occurrence in rural areas on warm, rainy nights in early spring. These migrations are associated with the same events as those of fishes and birds and are influenced by similar controlling factors. They represent periodic journeys performed for the purpose of reproduction.

The movements involving large numbers of individuals are usually directed *toward* the breeding site; so the interesting point about Mr. Congdon's observation is that the frogs appeared to be moving *away* from "inviting breeding spots to high and presumably dry ground."

If the frogs were not moving to a breeding pool situated out of sight on higher ground (unlikely also because the night was chilly), two possibilities remain.

The date, location, and size indicate that these frogs were either the Wood Frog (*Rana sylvatica sylvatica*) or the Leopard Frog (*Rana pipiens*). In the northeastern states, these two species breed earlier than any of our other frogs, with the exception of the small Spring Peeper (*Hyla crucifer*). But it seems unlikely that so many would have been seen if breeding had been completed, because the return occurs over a longer interval, and fewer individuals are to be seen at any one time. The fact that the night was chilly also bears evidence against this possibility, but it lends support to what I consider the most probable explanation. This is that the breeding activity had been interrupted by cool weather and that the frogs were returning to higher ground.

This does happen with frogs that breed before the onset of continual warm weather. Dr. Charles Walker, one of the foremost students of amphibians, recorded a similar observation for the Wood Frog in Ohio. In this instance, presumably in response to falling temperature, the Wood Frogs moved up a steep slope from a pond, with unmated individuals of both sexes included in the movement. Dr. Walker concluded that the breeding activities of this frog are probably often interrupted by unfavorable weather.

YOUR NEW BOOKS

Continued from page 247

found on page 194, where industrial uses of atomic energy are dismissed with the sentence, "It is best not to speculate about this." It has been made known that one group of engineers is studying the problem of an atomic-powered locomotive; the Navy has stated that atomic energy drive for ships is under study and looks promising; and Project NEPA (Nuclear Energy for Propulsion of Aircraft) has been set up at Oak Ridge. It does not make the reader of a book on atomic energy feel too happy if he is left with the impression that this new and tremendous discovery has no other value than destruction by the square mile.

WILLY LEY.

THE ILLUSTRATED ENCYCLOPEDIA OF AMERICAN WILD FLOWERS

- - - - - - - by Ethel Hausman

Garden City Publishing Co., $2.49, 584 pp., over 500 illust., 16 color plates

THIS book, nation-wide in scope, is a good source of information on 1200 of our more common wild flowers, nearly half of which are illustrated with drawings. An illustrated section on the family characteristics is followed by the alphabetically arranged families and an illustrated glossary.

Two very worth-while approaches to the study of wild flowers have been used in this encyclopedic manual, which distinguish it from many of the other popular books on plants.

The author has had the courage to assemble the flowers in their natural botanical families rather than in artificial groupings such as season of bloom or flower color. The flower lover can here learn to recognize and use these family affiliations in identifying plants and in so doing can add much to the pleasure of botanizing.

There has been an ingenious use of the natural associations of plants in their environments that also aids in identifications. Scientists know this phase of botany as ecology, but seldom is the layman given the chance to have it pointed out for him in color, as the artist, Tabea Hofmann, has done in sixteen color plates.

Simple keys would have been a welcome addition, obviating the necessity for "leafing through" the book to find the name of an unidentified plant. This page-by-page searching must be used even when the name is known, because the order in which the genera are arranged within the families is not of any help in locating a plant. There are no references to page numbers, although the common names are thoroughly cross-referenced to the families under which the descriptions appear.

B. W. HIGINBOTHAM.

THE SCIENCE DIGEST READER

Windsor Press, $3.00, 310 pp.

FOLLOWING the recent trend, the pocket magazine *Science Digest* has presented an interesting and stimulating collection of outstanding articles from its pages for the past ten years. Some 72 articles and a number of smaller items are included in this collection. For the most part, the articles are those of outstanding feature writers in the field of popular science. About one-third of the articles represent condensations of chapters from outstanding books published in the past decade. The subjects selected cover a wide range, from jet planes to pigeon raising, from smoking to electron microscopes. The reviewer was interested to discover that almost half of the articles deal with modern medicine and mental hygiene. The remainder deal with what one might call the physical and natural sciences.

The magazines in which some of the articles originally appeared include the *New York Times Magazine, This Week Magazine, Hygeia, Tomorrow, New England Journal of Medicine, Wall Street Journal, Air Forces, Industrial Bulletin,* and our own NATURAL HISTORY Magazine. Included also are articles that originated as radio broadcasts in the field of science.

Although the compilers of the *Reader* state that the selection was from the first ten years of publication, it is interesting to know that at least half of the articles selected were published in the two-year period, 1944-1945. The shortness of the articles prohibits any exhaustive treatment of the subject matter. And yet, this is an interesting book to pick up and read—perhaps one or two articles at a time. As is customary in books of this sort, the articles are not grouped according to a plan. They appear in about the same sequence as they would in any single issue of the magazine from which they are taken.

The book give us a worth-while collection of some of the best science writing produced recently by feature writers and other non-scientists, and thus it passes on to the layman a clear picture of some of the important events taking place in our laboratories. The professional journalist who does not specialize in one field of investigation cannot substitute for the scientist who records activities in his own special field, but he can help bridge the gap between the researcher and the layman.

JOHN R. SAUNDERS.

PANFISH

- - - - - by Byron W. Dalrymple

Whittlesey House, $4.50,
398 pp., 50 illust.

MANY readers of outdoor subjects, and particularly those who are familiar with the magazine articles and stories written by Byron W. Dalrymple, will be pleased to learn that this author's first book, *Panfish*, has recently been published by Whittlesey House.

A number of books have been written on the popular subject of fishing, but most of the authors have disregarded the sporting possibilities of the common panfish such as Perch, Sunfish, Bluegills, Crappies, Rock Bass, and Walleye Pike. Mr. Dalrymple's book is unique in that it deals only with the common, often despised fishes, and shows that there is a great deal of sport and pleasure in catching them. The author describes the right technique for fishing, including the proper tackle, so that anyone can learn to get real fun out of angling for fish that most sportsmen think are only fit for small boys to catch.

The dryfly purists will be surprised to learn that many of these fish will rise to the fly. This revelation alone will bring the skeptics out to give the lowly panfish some consideration.

The complete anglers may argue over the merits of the author's fishing philosophy, but I am sure they will agree that *Panfish* opens the door to a wealth of fishing prospects that they did not realize existed.

For those who wish to identify the common fishes, a few scientific details are presented in such a manner as to simplify the problem. The illustrations are also an aid to identification, particularly the fine color plates, contributed by the State Natural History Survey Division of Illinois, and the line drawings by Dede Shephard. The excellent action photographs by Clement Crouch are also commendable.

This book is a fine addition to any sportsman's library, and I also highly recommend it to the man who needs to discover a new interest and hobby that will take him out into the open.

GEORGE F. MASON.

WHEN MEN AND MOUNTAINS MEET

- - - - - - - - by H. W. Tilman

Cambridge, England, The University Press; New York, The Macmillan Company, $3.50,
232 pp., 54 illust., 5 maps

WHILE mountaineering was, as the title of this book implies, the major object of Mr. Tilman's explorations, the narrative of his adventures gives a very realistic insight into the lives of remote mountain people not to be found elsewhere.

In Part One are vivid descriptions of two peace-time adventures in the lesser Himalayas. The first, so far as the objective is concerned, was a failure. However, his real purpose—thrilling adventure—was adequately fulfilled and his misadventures are told with a dry personal humor. The second campaign was a definite success.

In Part Two, we find the mountaineer transformed into a soldier, and, though stranded for a time in Iran and Iraq, he managed to find perilous mountains to climb. Eventually he shows up in the secret service with the partisans, first in Albania and later in northern Italy. The dramatic descriptions of his activities in this branch of the armed forces is a revelation. Parachuting down through fog to strategic points in enemy territory, no matter how carefully planned, always carried a grave element of risk in this precarious field of warfare.

Mr. Tilman's conclusion carries a generous tribute to his comrades, the partisans. "With no Garibaldi to inspire them with his dauntless and unquenchable spirit, the men of northern Italy took the course that he would have taken on the terms he himself had offered to their forebears: 'I offer neither pay, nor quarters, nor provisions: I offer hunger, thirst, forced marches, battles, and death.' Such were the terms on which they served. That they held together indissolubly during the hard winter months, and were able and willing to give of their best when the time came, is some measure of their determination, self-sacrifice, patriotism, and of their rekindled ardour for the cause of freedom."

GEORGE G. GOODWIN.

IGLOO FOR THE NIGHT

- - - - - by Mrs. Tom Manning

University of Toronto Press, $3.00,
234 pp., 27 illust.

TO readers and collectors of Arctica, *Igloo for the Night* is a must. It is a day by day account of a newly-married couple's two and a half years (1938-40) alone around Foxe Basin.

This tiny expedition is remarkable in contrast with the highly organized ones of today, and though the Mannings accomplished the mapping of the east coast of Baffin Island and the collecting of specimens, as well as various other scientific undertakings, the bulk of their time and traveling is expended in the struggle for existence.

Indeed, the most absorbing interest of the book is the great effort they made to survive. What would be considered noteworthy journeys in themselves are taken as a matter of course to get the necessities of life: caribou, for their winter clothing; seal, for dog-feed; oil, for their lamps. Long and hard trips are made to collect widely scattered caches, and the final journey by boat and dog team to Churchill is in itself a major adventure.

They escape disaster, one feels, by the skin of their teeth time after time—the rudder is torn away, a precious oar is lost, the mast is broken, dogs are drowned, maps are forgotten, but their spirit and adaptability manage somehow to get them through.

Mrs. Manning's personal reactions to this new life, her yearnings for her nice brown oxfords and tweed suit, her thoughts dwelling so often on delicious food, her wondering about the sensation of truly warm feet, and the little bits of domestic life add much charm to the book. The passages dealing with the dogs are always delightful.

The book's great value as a unique document is due to its simplicity and its honest and intelligent chronicling of events following the author's diary. Because of this form, all the episodes are given the same value. At times the protagonists become shadows wandering before the bleak backdrop of Baffin Island, and one begins to wonder what they are doing there and whether it is worth the hardships. But then Tom Manning's affinity with the North, his prowess as a traveler, and his obvious enjoyment of this life in the tradition of the early explorers make it all clear again. And for such a man one concludes that Mrs. Manning is the perfect companion and helpmeet.

ALYCE FINNIE.

Out of some cold figures, came a story to warm America's heart

NOT LONG AGO, the Secretary of the United States Treasury studied a figure-covered sheet of paper.

The figures revealed a steady, powerful upswing in the sale of U. S. Savings Bonds, and an equally steady decrease in Bond Redemptions.

But to the Secretary, they revealed a good deal more than that, and Mr. Snyder spoke his mind:

"If you give them the facts," he said, "you can always depend on the common sense and long-range judgment of the American people.

"The last few months have given us heart-warming proof of that.

"After the Victory Loan, sales of U. S. Savings Bonds went down—redemptions went up. And that was only natural and human.

"It was natural and human—but it was also dangerous. For suppose this trend had continued. Suppose that, in this period of reconversion, some 80 million Americans had decided not only to stop saving, but to spend the $40 billion which they had *already* put aside in Series E, F & G Savings Bonds. The picture which *that* conjures up is not a pretty one!

"But the trend did NOT continue.

"Early last fall, the magazines of this country—nearly a thousand of them, acting together—started an advertising campaign on Bonds. This, added to the continuing support of other media and advertisers, gave the American people the facts . . . told them why it was important to buy and hold U. S. Savings Bonds.

"The figures on this sheet tell how the American people responded—and mighty good reading it makes.

"Once more, it has been clearly proved that when you give Americans the facts, you can then ask them for action—and *you'll get it!*"

What do the figures show?

On Mr. Snyder's sheet were some very interesting figures.

They showed that sales of Savings Bonds went from $494 million in last September to $519 million in October and kept climbing steadily until, in January of this year, they reached a new postwar high: **In January, 1947, Americans put nearly a billion dollars in Savings Bonds. And that trend is continuing.**

In the same way, redemptions have been going just as steadily downward. Here, too, the trend continues.

Moreover, there has been, since the first of the year, an increase not only in the volume of Bonds bought through Payroll Savings, but in the number of buyers.

How about YOU? The figures show that millions of Americans have realized this fact: there is no safer, surer way on earth to get the things you want than by buying U. S. Savings Bonds regularly.

They are the safest investment in the world. They pay you $4 for every $3 at the end of 10 years. And you can buy them automatically, almost painlessly today, through either of two plans:

If you are eligible for the Payroll Plan, for your own sake and your family's sake, get on it . . . and watch your savings mount up.

If you are not eligible for the Payroll Plan, but have a checking account, see your banker and get him to tell you about the new Bond-a-Month Plan.

Either of them will set you on the road to financial security, and the happiness that comes with it.

Save the easy, automatic way—with U. S. Savings Bonds

Contributed by this magazine in co-operation with the Magazine publishers of America as a public service.

HARLES FRANCIS PRESS
NEW YORK

September **NATURAL HISTORY** 1947

Unnatural Naturalist · Animal Eyes · Frank A. Beach

New Missing Link · Singing Sands · Falcon · Ugly Moth

LETTERS

A discussion in the April NATURAL HISTORY, questioning the possibility of a man's being swallowed by a whale and surviving, elicited a letter signed by Dr. Egerton Y. Davis, Jr., which readers may remember having seen in our June issue. The writer of this letter told how, while he was serving as surgeon on a sealing vessel out of Newfoundland in 1893 or '94, a seaman was swallowed by a whale and removed from the whale's stomach a day or two later, having apparently been killed almost instantly. Shortly after this letter was published, the Magazine received the following one:

SIRS:

I am greatly interested in the report by Dr. Egerton Y. Davis, Jr. of the singular occurrence noted on the voyage of the schooner, "Toulinguet." An uncle, who shipped as seaman for many years aboard that vessel, frequently told of the lamentable end of his fellow sealer and related many times the attending circumstances. As a member of the party that dissected the animal, his recollections differed from those of Dr. Davis in two particulars: my relative said that only he and the surgeon were willing to make a long examination and that the voyage extended through the season of '93. . . .

YORRICK M'CONNACHIE.

Chicago, Ill.
(late of Caughnawauga,
P. Q., Canada)

However, the modest check that had been sent to Dr. Davis in acknowledgment of his informative letter remained uncashed, and a letter to him brought no answer. Had the good doctor heard once more the call of his youth and slipped off on another sealing expedition? Or . . . ?

Evidence upon which it can be asserted that Dr. Egerton Y. Davis, Jr. probably had never been sealing at all is revealed in the following letter from one of our readers, whose astuteness is most commendable:

SIRS:

Were he alive today, Sir William Osler, the eminent physician, would have thoroughly enjoyed and chuckled over the entertaining letter of Egerton Y. Davis, Jr., in the June issue of NATURAL HISTORY. He would have approved of the meticulous care with which the writer described his operation on the soft under-belly of the whale, and he would have congratulated him on a memory which was able to reproduce with photographic accuracy an event that had taken place over 50 years before.

Why do I stress Sir William's possible reaction? Because it so happens that the famous doctor had an "alter ego," a "M'Connachie," * to whom he gave the name Egerton Y. Davis, and in whose pranks and jokes he took great pride.

Though Egerton Y. Davis, Jr.'s letter was sent from Boston, Mass., I wonder if he, too, is a native of Caughnawauga, Canada, which Sir William described as a beautiful suburb of Montreal, "just across the river," with an excellent hospital, school, and charming residences, and which, unfortunately, cannot be located on any map.

To anyone interested in what the "Y." stands for, I can only give Dr. Osler's say-so that it is Yorrick, and I remind my reader that Yorrick was described by his friend Hamlet as "a fellow of infinite jest."

(MRS. PERCIVAL M.) MAY C. SAX.
Overbrook, Pa.

* A fictitious character created and used by Sir James M. Barrie as a masquerade for his own practical joking.

An interesting camera study of the Desert Short-horned Lizard in defense posture, photographed by Dwight W. Williamson. It is frequently called the "Horned Toad." Its Navaho name means "The snake that is rough like a rock"

The story has a final chapter. Shortly before this issue went to press, the Magazine received a letter from the director of one of the country's foremost hospitals, located far from Boston, the city Egerton Y. Davis, Jr. had given as his address. The director explained that a check had been found in the hospital, made out to Egerton Y. Davis, Jr. and endorsed by him. Since Dr. Davis could not be located, the check was being returned to NATURAL HISTORY Magazine.

So one mystery still remains. Did "Dr. Davis" lose his check? Or had he, in more sober mood, resolved to make a small benefaction to a worthy medical institution? Or was he simply trying to see how far he could carry the "infinite jest"? The answer has probably vanished as completely as the unfortunate seaman who (as the story has it) was removed from the body of a whale and buried in the icy North Atlantic.—ED.

SIRS:

Recently I read about the theory that the Norse not only discovered America long before Columbus but explored the

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NATURAL HISTORY

The Magazine of the American Museum of Natural History

FREDERICK TRUBEE DAVISON, President — ALBERT E. PARR, Director

VOLUME LVI—No. 7 — **SEPTEMBER, 1947**

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You will find NATURAL HISTORY Magazine indexed in *Readers' Guide to Periodical Literature* in your library

THE COVER THIS MONTH

The cover illustration is from a Kodachrome by Albert E. Vogt of *Lilium auratum*, commonly known as the gold-banded lily of Japan. It was first brought to flower in the United States by Francis Parkman, one of our great historians who was also an outstanding horticulturist.

The huge open flowers are white, spotted with varied tones of crimson, with a conspicuous yellow band running down the center of each petal. Under favorable conditions the plants sometimes reach the height of six feet and in August bear twenty or more fragrant flowers, from eight to twelve inches in diameter.

Lilium auratum is classed among the "moderately easy" lilies to grow. It is susceptible to the dread mosaic disease, which mottles and twists the leaves and distorts the flowers as well. For this reason you should isolate it from other lilies, keeping it as much as thirty feet from virus-infected plants.

Bulbs should be planted in the fall. Consult your nurseryman as to the proper depth to sink them, since this varies with the quality of the soil. Clayey soils call for shallower planting than light loams or sand.

This is an excellent lily for the perennial border, or with shrubs on the edges of woodlands. It prefers an acid or neutral soil and thrives equally well in sun or semi-shade.

CLARENCE L. HAY

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NATURAL HISTORY is published monthly (except July and August) at New York 24, N. Y. by the American Museum of Natural History, Seventy-ninth Street and Central Park West. Subscription price \$4.00 a year, single copies fifty cents. Subscriptions to Canada, Newfoundland, and all foreign countries \$4.50. Entered as second class matter March 9, 1936, at the Post Office at New York, under the Act of August 24, 1912. Manuscripts and illustrations submitted to the Editorial Office will be handled with care, but the publisher cannot assume responsibility for their safety.

The American Museum is open to the public every day in the year without charge

YOUR NEW BOOKS

NAVAHOS • NATIONAL PARKS • SCIENCE
CONSERVATION • GEOLOGY • BUMPUS

ON UNDERSTANDING SCIENCE

- - - - - - - by James B. Conant

Yale University Press, $2.00, 145 pp., 10 figs.

NO idolizer of Science, Dr. Conant argues in this book that the people need a widespread understanding of science. In his opinion, at present, science is alien to the majority of our people. The only way science can be assimilated into our secular cultural pattern, according to Conant, is by this widespread understanding of science. Here is no foolish attempt to offer a solution for the mass education of mankind. The author is an educator as well as a scientist, and he specifically proposes a college course, the objective of which is the understanding of science. The course is to serve particularly the non-science students, such as those specializing in government, politics, and the social studies. The approach would be historical, and it is proposed that the instructor select a few case histories from the scientific endeavors of the seventeenth and eighteenth centuries. By developing these case histories, the students could be shown how important man is in any consideration of scientific study. Instances of weakness in scientific thinking would point out the pitfalls that lie in wait for any seeker after truth.

Specifically, this book contains the lectures that Dr. Conant gave at Yale at the request of the Dwight Harrington Terry Foundation. Four chapters make up the book. Two of these chapters give model case histories that might well be used in the proposed course, although Conant suggests that there are many others which might be substituted. One of the case histories he gives is that of the work in the seventeenth century on the air pump and Boyle's Law. The eighteenth century example is the story of man's investigations in the field of electricity and combustion.

The first chapter presents the author's explanation of the need for the course and a defense of the use of the historical approach. The final chapter is entitled "Certain Principles of the Tactics and Strategy of Science." In Conant's own words, here are the principles which "represent the sound doctrines which have guided experimentalists in the past and are guiding them at this very moment." It is these principles that should be of interest and importance to all who are concerned with the understanding of science—the scientists, the educators, and the laymen.

JOHN R. SAUNDERS.

EXPLORING OUR NATIONAL PARKS AND MONUMENTS

- - - - - - by Devereux Butcher

Oxford University Press, Paper Binding $1.75, 160 pp., 168 illust.

ALL who are planning to visit any of our National Parks and National Monuments will welcome this copiously illustrated guide, prepared by the Executive Secretary of the National Parks Association. To leaf it through is to become enthralled by the beautiful and arresting photographs of these wonderlands. As soon as one opens the attractive booklet, he is quite sure to examine all the well-chosen pictures at one sitting and also to read many of the brief descriptions that make up the text. There is one of the famous photographs by the late William Henry Jackson, which brought about the setting aside of our first National Park, the Yellowstone.

With 25 National Parks, including the proposed one in the Everglades of Florida, and 38 National Monuments, it is evident that no other country in the world has preserved so much of primeval beauty and natural wonder for the people of present and future generations. Indicating the interest and appreciation of the people, over eight and a half million people visited the great parks in 1946. The park that led in number of visitors in this same year was Great Smoky Mountains National Park. Largely due to its location in the thickly-settled East, more than one million people visited this park in 1946—a greater number than have come to any other national park in a single year in the history of the system.

But there are practically no statistics in this book. Following a condensed, readable description of the area is a compendium of useful information for the prospective visitor, including the post office addresses of the headquarters of each park or monument, highway directions, overnight accommodations, and camping facilities.

At the close of the book is an excellent bibliography of three pages, titled "For Further Reading," divided into Specific Areas, General, Fauna, Flora, and Geology.

CLYDE FISHER.

CHILDREN OF THE PEOPLE

- - - - - by Dorothea Leighton and Clyde Kluckhohn

Harvard University Press, $4.50 227 pp., 14 illust.

WHILE this important book is addressed especially to social scientists, educators, and administrators of Indian affairs, it should also appeal to all interested in child psychology. Never before has such preparation or such detailed information been brought to bear upon the study of the child in a primitive society.

Children of the People is a companion volume to *The Navaho*, published by the same authors last year, and to some extent a full appreciation of the second depends upon a knowledge of the first. *The Navaho* described the tribal culture. The present volume deals with the psychological end-product—the individual Navaho. In describing the ways of feeling, thinking, and reacting that are typically Navaho, this study provides a sound basis for the administration of tribal affairs.

Because personality trends are set early, the book accents childhood and youth. The first half traces the life cycle of the individual from birth to adulthood and shows how he is molded to the ways of his society and to the demands of his changing world. The second half describes the results of an elaborate series of standardized psychological tests given to Navaho children. The authors find that while the Navaho child is loved and indulged, the Navaho adult is often moody and anxious. Hence the data corroborate what many critics of psychoanalytic theory have long suspected: that these theorists have attached too much significance to childhood and youth in the matter of personality formation and have not paid enough attention to later events. While an indulgent childhood lays the foundations for a secure adult personality, it does not, in and of itself, promise fulfillment.

Although the brief and general conclusions are somewhat disappointing after such an imposing array of factual material, the authors have done an admirable job of "explaining" the Navaho people to us in terms that we can understand and appreciate. They emerge, not as picturesque primitives, but as human beings who have grown up in a different setting, facing different problems.

HARRY TSCHOPIK, JR.

HERMON CAREY BUMPUS, YANKEE NATURALIST

- - - - - by H. C. Bumpus, Jr.

University of Minnesota Press, $2.50
141 pp., 14 illust.

THE biography of a man who was for a decade Director of the American Museum is bound to be of more than passing interest to the members of the Museum, not to mention the present staff. This is all the more true because Dr. Bumpus' administration covered the period in which natural history museums were just "thawing out of their ice age." He himself was in a large part responsible for the enhancement of our institution from the status of a storehouse of specimens and a laboratory of abstruse research into a driving center of popular education, which not only drew throngs into the building but also reached out to make its influence felt in many aspects of the life of the metropolis.

H. C. Bumpus, Jr. has done a workman-like job in picturing the career of his father. In eleven chapters he describes his ancestry and boyhood, his student and teaching days, his organization of research at Woods Hole and elsewhere and its application to human welfare, and his experiences as university administrator, creator of museum exhibits, conservationist, and man of affairs. Dr. Bumpus' force, persuasiveness, ingenuity, and steadfastness are illustrated by many homely and whimsical incidents. How many Museum members know that our famous tattooed Maori heads came from New Zealand in the private luggage of the Director, and that the astounded and nonplussed customs inspectors passed them as "leather goods"?

Perhaps the most outstanding characteristic of Dr. Bumpus was his refusal to accept discouragement. His resignation from the American Museum threatened to take him permanently into fields far removed from his strongest desires. Nevertheless, he found an opportunity in due course to work back into his proper milieu. As the creator of the trailside museum and the catalyzer of a new program of visual education in National Parks and Monuments, he made for himself a unique place in which he continued to labor to the ripe old age of 81.

R. C. M.

FUNDAMENTALS OF EARTH SCIENCE
- - by Henry Dewey Thompson

D. Appleton-Century Co., $3.75
461 pp., 304 figs.

THIS, the latest in a number of Earth Science Survey textbooks, is in many ways the best. It covers more than just physical geology, for it includes an effective discussion of maps and map-projections, and a most valuable consideration of weather and climate that is well integrated with the consideration of the geologic effects of climate. It covers the field well, with enough detail to establish the principles involved, but not so much as to confuse the reader.

Although designed as a textbook, and certain to be widely used as an aid in introductory courses in Earth Science, the book is not overtechnical and deserves a wide distribution among those interested in knowing something of the planet on which they live.

The only criticism that this reviewer can make of the work stems from the very poor reproduction of the exceedingly well-chosen illustrations. The author has maintained as high a standard in the choice of his illustrative material as he has exhibited in the preparation of his text, but the paper used in the first printing is so poor that many of the pictures are little but formless, gray blots. This aspect, we are informed, is to be corrected in a second printing, promised for September. When this is available, the work will be a highly desirable addition to every geologic library.

Perhaps the best expression of this reviewer's opinion of this work is the fact that he has adopted it as the text for the geologic portion of a Science Survey course at the Johns Hopkins University—with the stipulation that the publisher supplies the new printing for this use.

H. E. VOKES.

SCIENCE YEAR BOOK OF 1947
- - Edited and with an Introduction by J. D. Ratcliff

Doubleday, $2.50, 247 pp.

THIS is the sixth annual collection of articles on science from the general magazines gathered together by Mr. Ratcliff. As usual, these are very readable articles, popularly written for the layman. The book is made up of 27 articles from the magazines of 1946 and one brief chapter from a book. Of the magazine articles, seven are from *Collier's;* five from the *Scientific American;* four from the *Saturday Evening Post;* three from *Fortune;* two each from the *Atlantic Monthly*, *Cosmopolitan*, and *American Magazine;* and one each from *This Week* and *The Ladies' Home Journal.* Of the articles, ten (more than one-third) have been classified under medical research; six under physics and chemistry; four under agriculture; four under aviation. There are also articles entitled "Extra-Sensory Perception," "Earth Shaker" (volcanoes), and "Gadgets Galore." And from Professor Hibben's book, *The Lost Americans,* we have the story of Folsom Man.

Among the articles on medicine is one by William L. Laurence of the *New York Times,* about the Russian serum developed by Professor Bogomolets; also the story of surgery for blue babies, the development of penicillin and streptomycin and other antibiotics. Among those under physics and chemistry, we have one by President Baxter of Williams College on the proximity fuze. Under agriculture, we have "Facts About DDT" (from *Fortune*), and "Silk: Made in America" (from *Cosmopolitan*). Under aviation there is an article from *Fortune* on "Jet Propulsion," and from *Scientific American* one on "Radio Navigation" and one on Helicopters.

In the twenty-two-page introduction the editor stresses discoveries and hoped for advances in the field of medicine, almost to the exclusion of other branches of science. The proportion of the book devoted to medicine has evidently been influenced by his major interest.

CLYDE FISHER.

THE LAND AND WILDLIFE
- - - - - by Edward H. Graham

Oxford University Press, $4.00
232 pp., 32 plates

MR. GRAHAM has written a text that should become a standard reference manual for the wise use of land whenever wildlife is to receive consideration. Indeed, it is difficult to imagine how land can be put to its best use without practicing the policies he advocates even if the owner is indifferent to wildlife as such.

The topic is a very important one, of vital consequences to us all; and because it deals with so many factors, there is no simple formula that will solve every problem. Nevertheless, there are many land practices that are unquestionably sound when tested for the best interests of the landowner and for the advancement of wise conservation policy. These practices are discussed, exemplified, and proved by the author.

The book opens with a chapter on our wildlife heritage and proceeds to lay the historical foundation for the important part wildlife plays in our cultural and economic existence. Something is said of the early appearance of laws in favor of wildlife (700 B. C.) and the progressive recognition of the need for conservation legislation. Mr. Graham continually expounds the thesis that the starting point for conservation is the land. His arguments are convincing.

"If the theme of this book is correct, we must expect to produce wildlife as a result of land use. This thesis presumes a pattern of land management in dynamic equilibrium with the physical capabilities of the land, . . ." This is a philosophy to deal with land already so altered by man that the primeval balance is lost. With regard to National Parks and the all too few remaining samples of primitive ecology, the author writes, "We also need wilderness areas preserved inviolate—wilderness in the sense of undisturbed natural communities of plants and animals." His attitude toward poison as a panacea is revealed by: "We may indeed have found a good rat poison, but its use as the solution to range-management problems is in a category with dependence upon a new type of destructive bomb as the solution to differences between nations."

The Land and Wildlife is ably written, documented, and the illustrations are well-chosen. It is convincing and provocative of deep thought.

H. E. Anthony.

Science and freedom
- - - - - - - - by Lyman Bryson

Columbia University Press, $2.75, 191 pp.

What kind of a society do we want, and how do we go about getting it? Dr. Bryson's book is another attempt to answer these questions, questions that have confronted mankind ever since men began to live together. The author, an educator and a recognized authority in the social sciences, has had wide experience as a teacher and as an active worker in the field of adult education. He presents his definition of a "good" society and the part that scientific thinking can or should play in the achieving of this goal.

In the main, modern freedom is synonymous with democracy. Thus thinks Bryson, and he goes on to develop what he calls the democratization of social relations. The specific question proposed and discussed in this work deals with the possibility of scientific human engineering or scientific social reconstruction in natural sequence.

Bryson does not claim to have discovered what he calls scientific humanism. He indicates that this work of his is an attempt to support and strengthen the argument that man can study the social behavior of man as objectively as he has studied other manifestations of energy. We must think about things "abstracted out of the observation of human behavior." However, the nature of the activities and behaviors of man that we must think about scientifically are not the isolated and insignificant, sometimes amusing and interesting items. In Bryson's final words, "The highest morality to a creature who can think, the inescapable duty is to think in the most difficult regions about the most subtle and terrifying problems. Man's toughest problem is man himself." However one may feel about the social philosophy and method of attacking the problem, one must agree with Bryson that the scientific thought expended to give the world an atom bomb is but child's play compared

Continued on page 334

RAFINESQUE

The Unnatural Naturalist

The life story of one of the strangest personalities that ever passed across the scientific stage in America

By Victor Wolfgang von Hagen

THE man sat stiffly in death's rigidity. It was a delicate figure, and the face, dominated by large, dark, staring eyes and long, curling eyelashes, must once have been quite handsome. Now the skin was ashen; and the hair, falling over the high-domed head, looked somewhat like a disheveled wig.

In the disorderly garret was a cabinet with a broken pane in which stuffed birds were dustily exhibited, along with skeletons of small mammals, fossils, shells, and dried fishes. On the bed were scattered specimens of dried plants and a stuffed bat that bared its teeth in a hideous mimicry of life. Hanging on the back of the dead man's chair was a soiled yellow nankeen coat, its enormous pockets stuffed with shells, plants, broken butterflies, and Coleoptera—the hopeless potpourri of an erratic collector. His left hand still held open the title page of *Autikon Botanikon*, on which he had jotted small, neat notations in Latin.

At daybreak the door creaked open, and the dead man's landlord peered in. Day by day the landlord had known that his unwanted roomer, "the crazy herb doctor," was dying, and he had repeatedly urged him to get on with it and, at the same time, to pay his rent. He went to the desk, disengaged the stiffening fingers from a swan's quill, and looked down at what the dead man had written: "Time renders justice to all alike."

The landlord shook his head as if in disagreement, then pulled the small body to another room, stuck it in, and locked the door. Because his tenant had not paid the rent, he would sell the body to a medical school. Even when the man's only friends learned of his passing, the landlord refused to allow them the body. So that night Dr. James Mease, with the assistance of a Mr. Bringhurst, climbed to the garret, broke open the door, and lowered the cadaver by ropes to the backyard.

The funeral was probably held secretly, because the landlord had summoned the city-watch to search for his 93 pounds of flesh. Dr. Mease kept strict account of the expenses: "Coffin of Walnut $7.00, Winding Sheet and Shroud $3.00, Hearse and Carriage $6.00." Thus one of the strangest personalities that ever crossed the American stage came to rest in a cemetery set apart for strangers dying away from home and friends.

The next morning, September 19, 1840, the *Philadelphia Inquirer* carried a brief notice: "*Died* 18th inst. Prof. C. S. Rafinesque-Schmaltz, for many years a resident of this city and the author of several scientific and literary works. . . ."

No more bizarre a figure has ever appeared in the annals of science. He was a latter-day Paracelsus who tried to embrace the universe, and he died secure in the knowledge that he had described more fishes, more plants, and more insects than anyone who had ever lived.

Who and what was he? He answered the inquiry himself: "It is a positive fact that in knowledge I have been a Botanist, Naturalist, Geologist, Geographer, Historian, Poet, Philosopher, Philologist, Economist, Philanthropist. . . . By profession a Traveller, Merchant, Manufacturer, Collector, Improver, Professor, Teacher, Surveyor, Draftsman, Architect, Engineer, Pulmist, Author, Editor, Bookseller, Librarian and Secretary." And, strangely, he lived *all* these.

The extraordinary man who embodied these protean manifestations—Constantine Samuel Rafinesque-Schmaltz—may, on first blush, bedazzle one. But his faults, which were the consequence of his virtues, must be balanced against his achievements if the student of biology is to avoid adding permanence to his blunders.

Rafinesque was born on October 22, 1783, the offspring of a German mother and a French father, in Galata, a suburb of Constantinople. The world, then as now, was agitated by unrest and talk of revolution. For a brief time the firm of *Lafleche and Rafinesque*, general importers, kept their offices open at Marseilles, but when the avalanche of revolt swept to the seaport, *papa* Rafinesque left his family at Leghorn and, as part owner of a frigate, took a voyage to China, sweeping around the world with his gathered merchandise, only to die of yellow fever in Philadelphia.

That event changed the life of young Rafinesque. His mother remarried, and his stepfather, a Frenchman named Lanthois, took over the family exporting business. There at Leghorn, between extended travels, the parents tried, with the help of strolling scholars, to inject some systematized knowledge into the head of the inquisitive young Constantine.

His learning was wide, unguided, spotty, and in many languages; he spoke Greek, Italian, French, and English. "I learnt many other things by myself," he admitted. "Before

Courtesy Transylvania College, Photo by La Fayette Studio

▲ **Miniature** of Rafinesque in blue coat and white stock—a delicate man with handsome eyes and long, dark hair

twelve years of age I had read the great Universal History and 1000 volumes of books of many pleasing and interesting subjects." His early natural history passion was botany. At eleven he had formed an herbal; at twelve he had written an essay on "Notes on the Apennines," gathered as his family traveled by mule from Leghorn to Genoa. It was an excellent beginning, but then he was made to clerk in his stepfather's export house in Leghorn. This separated him from natural history, yet he made up for it, in part, by reading travel books that he stuck between the ledger accounts. His young soul was afire.

To America

Travel came upon Rafinesque sooner than expected. At nineteen he sailed to America with his brother on the frigate "Philadelphia." No sooner had he stepped ashore than he picked up a new species of plant ("altho' the American botanists would not believe me," he said). In Philadelphia, the precocious young botanist found himself in his proper setting, for this was then the cultural capital of America. Here were the Peales (painters and naturalists), Alexander Lesueur (an artist-zoologist), Ord, Thomas Say, and the princely ornithologist Charles Lucien Bonoparte.

At first he found many willing hands to aid him in his botanical itinerary. With a collector's vasculum under his arm and a gazetteer for a guide, he began his botanical travels through Pennsylvania, New Jersey, and upper New York, acquainting himself on the way with "all the Botanists, Naturalists, and Amateurs of that period." He traveled through Delaware and Maryland, stopping off at Washington, D. C., where he was introduced to Thomas Jefferson, President of the United States. There he quickly gained a certain notoriety when, midway through the president's discourse, he interrupted and contradicted the great man, who was no insignificant naturalist himself. Yet Jefferson liked this brash youth and invited him to Monticello, an invitation Rafinesque accepted, but he was not able to go, for early in 1805 he was again on the high seas on his way back to Italy.

In Sicily

Rafinesque chose to live for the next ten years in Sicily, a land with ". . . a fruitful soil, delightful climate, excellent productions, perfidious men and deceitful women." He soon found employment at Palermo with Abraham Gibbs, an American merchant and part-time United States Consul. With this status, his export business increased, and he acquired a modest fortune. Rafinesque then centered his attention on the medical squill, *Urginea scilla,* a diuretic used for children's diseases in Russia, and he managed to sell 200,000 pounds of it before he was imitated by the Sicilians, who soon flooded the market. Then, his talents flowing in all directions, he distilled a brandy, "equal," he said, "to any made in Spain." How he knew this is not clear, since he never tasted a drop of it. "I hate all strong liquors," he asserted, and this prevented him from "relishing this new employment"; so he gave it up.

He did not allow his sizable export business to lessen his interest in natural history. He exchanged his collected plants with the learned of Europe—Baron Bivona-Bernardi, de Candolle, Giuseppe Poli, Francesco Chiarelli, and many other half-remembered names of science. To Baron Cuvier he sent fishes that he collected in the Mediterranean, giving to each a new scientific name and describing them in a vibrant, colorful latinity. Cuvier was at first grateful for these collections, but as they poured in, he became astounded and then shocked, for the pickled specimens he received had lost their iridescent beauty and did not conform to the descriptions. "Besides," he said frigidly, "M. Rafinesque greatly multiplies the genera and sometimes on slight grounds." This attack only infuriated Rafinesque, and he described a hundred more new species.

This strange figure was well-known to the Sicilians as a merchant who spent much of his time collecting plants, insects, fishes, and fossils. He even climbed Mt. Etna in search of new genera. Naturally, he was regarded as slightly mad. Scientific inquiry into nature was regarded in that day with suspicion.

There was much political agitation between Italy and France, and Rafinesque, because of his French name, fell under the suspicion of the secret police. "Prudent considerations," he wrote, "induced me to add the name of Schmaltz, my mother's name, to my own and to pass for an American."

In 1808, Rafinesque-Schmaltz found an utterly new species—a high-bosomed, dark-eyed Sicilian beauty of volatile temper. He discovered her one bright day under the Dresden-blue sky of Sicily. If there was a courtship, it must have been in Rafinesque's own strange style. Yet we must admit that if a woman could overlook the young man's many eccentricities, there was much to commend him. His features were good: he had a long, delicate nose and brilliant, dark eyes laced with long eyelashes. And financially he was reasonably well-off. Whether he actually married or not we know only from what he said: "I deemed myself lawfully married from 1809 to 1815 to Josephine Vaccaro."

Home Life

It was a violent relationship, almost ending during its first night, when the groom insisted upon taking to his nuptial bed a new species of fish that he wanted preserved for Baron Cuvier. Life with Rafinesque must have been trying. A son, whom he named Charles Linnaeus, died in infancy. But later he had a daughter, who seems to have been the only person he ever really loved.

The family saw little of him. When he was not in his counting

▲ **Rafinesque became one of the most talked of scientists of his day because of his erratic behavior and his voluminous but ofttimes incautious writings**

rooms, he was haunting the shores, poking his nose into the nets of red-shirted Sicilian fishermen, in search of "new species." When not collecting, he was arguing with the printers over the publication of his monthly journal, "Mirror of Science."* It was his first publishing venture and, like much in his life, ended in a dispute. It brought him, as he writes, "only persecutions and displeasures," for the first issue of the journal was kept by the printer. Rafinesque went to the courts to begin a suit of which he never saw the end.

Meanwhile, he had published his first book, *Principes Fondamentaux de Somiologie,* explaining the principles he thought should control the recognition of newly described species, and, also, the now famous *Analyse de la Nature,* wherein he

* *Specchio delle scienze o giornale enciclopedico di Sicilia.*

tried to give his outline of the whole world of nature. The purpose of this work was to make him known to Paris, where he intended to go; but at that moment, Napoleon, eluding his guards at Elba, marched upon Paris, and, in the confusion of the Hundred Days, The Analysis of Nature was lost in the cacophony of war.

At that juncture, Josephine Vaccaro was wandering from her husband's bed, for her passionate nature never fitted into the *analyse* of her strange husband. She eloped with a strolling comedian. That was the final blow. Rafinesque decided to quit the Isle of Sicily for the United States. On the ship "Union of Malta," he put his whole life's work—parcels of drugs and merchandise, 50 boxes of herbals and other collections, most of his library, his manuscripts, 2000 maps, 300 copperplates, and over half a million shells—and sailed for the United States.

There are some unfortunate souls who seem to attract misfortune as a loadstone attracts iron. This is quite understandable; a man of action constantly collides with the external world. But consider poor Rafinesque. On November 2, 1815, after a horrible voyage, the small ship ran into Race Rocks in Long Island Sound, and all of Rafinesque's precious belongings were lost. He managed to get ashore at the lighthouse at New London, perhaps without quite as much difficulty as he implied shortly after in a letter in which he indicated he had had to swim for his life. But true to his life purpose, he rejoiced that while swimming he had been able to observe many new species of fishes and marine plants, which he proposed to add to the scientific literature.

A Tutor at Clermont

For days Rafinesque was in utter despair. He slowly made his way, mostly on foot, to New York City, as though in a trance. "I had lost everything," he grieved, "my fortune, my share of the cargo, my collections and labors of 20 years past, my books, my manuscripts, my drawings, even my clothes." In

Rafinesque's mother, *"drawn from memory as she was in 1805, by her loving son"*

Lafayette Studio phot

"She was seductive, beautiful, lovely, and charming"

SKETCHES by Rafinesque while he was a teacher at Transylvania University

"True emblems of sweetness and beauty, these flowers always speak the simple truth"

Juliet: *"I knew her in the prime of her beauty and youth, when she was the chaste emblem of candor and truth. But alas! what a change! . . ."*

New York he found succor. Dr. David Hosack, founder of the Botanical Garden, who knew him through his writings, secured a position for him as tutor to the young daughters of Edward Livingston, the American statesman and jurist. At Clermont on the Hudson, Rafinesque knew some months of rest. He taught Italian, French, drawing, and botany to the Livingston girls, and they, in turn, treated this strange man with unusual kindness. But this life could not hold him. He was constantly wandering away, botanizing on the Hudson's banks, writing essays, and attending scientific meetings. In the course of all these activities, he became one of the founder-sponsors of the Lyceum of Natural History.

In 1819, Rafinesque had a turn of good fortune; he was offered a position to teach botany, natural history, and modern languages at the newly created Transylvania University at Lexington, Kentucky. He was guaranteed neither salary, fees, nor pupils; but he could board free at the Commons and accept remuneration from students who were willing to pay him. So Rafinesque left with high hopes "for his great western tour of 2000 miles." He walked through the Alleghenies, going through all the "western" villages. He stopped at Pittsburgh long enough to draw and publish a new map of the Ohio River. Then, floating south in an ark, he went to Cincinnati and proceeded to Louisville.

In May, 1819, when Rafinesque arrived at Transylvania University to begin his classes, there was a meeting between the categorically absurd and the ineffably incongruous. It was not his fault that internal rivalries still convulsed the school, or that Dr. Horace Holley of Boston, its president, had small interest in botany and all "its related rubbish." There were troubles at once between the eccentric little naturalist and the college authorities. He insisted upon holding all his classes in the open fields in Rousseauan fashion—and they were nightmares of indiscipline. In the middle of a lecture, he would stop and chase off after a butterfly, most

Photo by La Fayette Studio

▲ Transylvania University at Lexington, Kentucky, where Rafinesque taught for several years. Erratic and absent-minded, he could not parry the practical jokes of his students, but he was never dull

certain to be a "new species." Paid notices in the *Kentucky Reporter* advertised that he would give "private classes to the ladies in town," and in the evenings he taught French, Italian, and Spanish.

Mostly, however, he devoted his spare moments to raising funds to establish a Botanical Garden. He tried every means, then settling on the idea of creating a joint stock company, he set out to sell 50 shares of natural history certificates. Henry Clay took five; Nicolas Longworth, the "Bacchus of Cincinnati," purchased six. Then his dream collapsed.

Failure Almost a Habit

"I am thwarted in everything," he wrote to his friend Zaccheus Collins, the Philadelphia botanist-merchant. "I have failed in establishing a Museum and Botanical Garden. I have some serious thought of leaving Lexington. . . . This is no place for me as yet. I can't publish my works nor Discoveries and hardly make a living while the idle rhethos wallow in sumptuous luxury."

As usual, he had his troubles with printers. An ambitious project to publish a journal, *The Western Minerva,* followed the now familiar Rafinesque formula. There was a misunderstanding between the printer and the promoter. Only one number was printed; then it ended, most of the copies being destroyed in rage by the unpaid printer. Rafinesque saved only three copies of *The Western Minerva*, and it is now so rare a piece of Americana that it is worth a bibliographer's ransom.

Everything Rafinesque touched seemed to end this way. His entire life was spent under an incubus of mistrust. He had a fixed idea that everyone was determined to cheat him, and his whole outlook on mankind was jaundiced by these illusions. To women he was gallant and withdrawn, but his recently discovered drawings of Kentuckian women, ornamented with quatrains of pedestrian doggerel, suggest that he was far from being the complete misanthrope that he has been pictured. "Ah, you women," he wrote, "female angels of this Earth, budding and blooming awhile to please and delight, maturing to renovate and adorn mankind. Do not misuse the powers of your charms. . . ."

His obsession to discover "new species" continued. They flowed from his pen in a never-ending stream. Hurried, ofttimes inexact, and sometimes repetitious, his scientific work was a precise reflection of its author—restless, brilliant, impatient, enthusiastic, and terribly erratic. His contemporaries were openly contemptuous of him; the more charitable called him an "inspired idiot." Yet Rafinesque was then, in 1822, almost the only American botanist who maintained that Jussieu's system of natural classification was superior to Linnaeus' sexual system. But this alone was enough to put him beyond the pale of other American botanists. He collected the fish of the Ohio and published *Ichthyologia Ohioensis* (once quoted at a dollar, now a bibliographical rarity) — a book which, despite its obvious errors, stands as a milestone in the study of American fishes. It has been extolled by no less a figure than David Starr Jordan, who once called Rafinesque "the first student of Western Fishes."

Rafinesque's reputation for gullibility was increased by a practical joke that John James Audubon played on him. When they met, Audubon showed Rafinesque some grotesque drawings of fishes, mostly imaginary, and the credulous Rafinesque copied them down, gave them names in sonorous Latin, and published them as new genera!

The Oddest Fish of All

Audubon first met Rafinesque in 1822. He discovered a small man "with a long loose coat of yellow nankeen stained with the sap of plants . . . with a bundle of clover tied to his back." The strange creature asked him if he could point out Audubon's house.

"Why, I am the man," replied Audubon, "and will gladly lead you to my dwelling." Rafinesque then handed him a letter of introduction from a friend in the East:

> "My dear Audubon,
>
> I send you an odd fish, which you may prove to be undescribed and hope you will do so in your next letter."

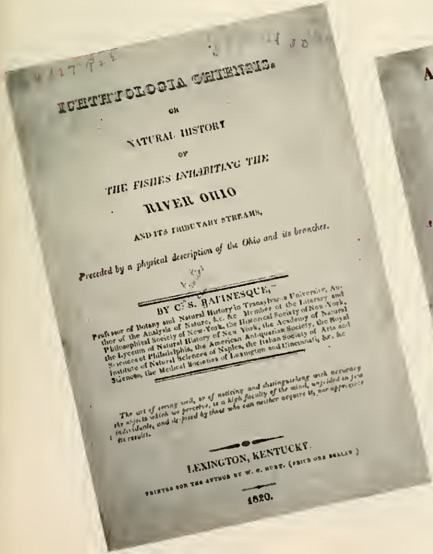
Audubon raised his eyes to the blank face of Rafinesque and asked to see this odd fish.

Rafinesque, who was not entirely humorless, answered, "I am that odd fish, I presume, Mr. Audubon."

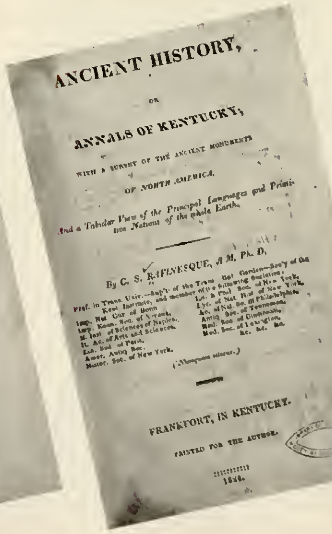
So Audubon, leading the way through the fields, brought home the most curious specimen he had ever collected. Rafinesque was in excellent humor. He chatted of many things while he pulled off his wet shoes. But when his host offered him clean, dry clothes, Rafinesque refused and, to quote Audubon, "performed lavations with evident reluctance." Yet if he was unprepossessing in appearance, his speech overflowed with learning and was made melodious by the interjection of Latin and French. "I listened to him," wrote Audubon, "with as much delight as Telemachus could have listened to Mentor."

That midnight, Audubon was awakened by a tremendous commotion in the attic. He ran up, flung open the door, and saw Rafinesque entirely naked, chasing bats with Audubon's newly purchased violin. He was trying to knock down "a new species," he shouted, cavorting about the room. Rafinesque's plants were strewn all about. "Never mind," Rafinesque shouted as he chased the bats, "I'll arrange them

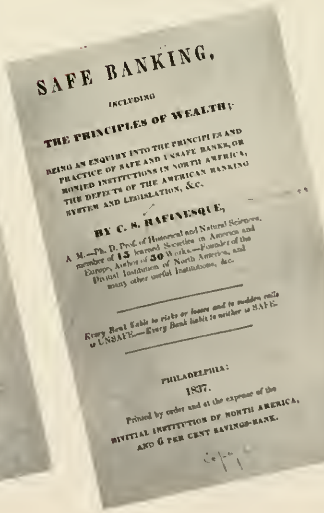
▼ THIS BOOK, once quoted at a dollar a copy, is now a collector's rarity


ICHTHYOLOGIA OHIENSIS.
OR
NATURAL HISTORY
OF
THE FISHES INHABITING THE
RIVER OHIO
AND ITS TRIBUTARY STREAMS,
Preceded by a physical description of the Ohio and its branches.
BY C. S. RAFINESQUE,
Professor of Botany and Natural History in Transylvania University, Author of the Analysis of Nature, &c. &c. Member of the Literary and Philosophical Society of New-York, the Historical Society of New-York, the Lyceum of Natural History of New York, the Academy of Natural Sciences of Philadelphia, the American Antiquarian Society, the Royal Institute of Natural Sciences of Naples, the Italian Society of Arts and Sciences, the Medical Societies of Lexington and Cincinnati, &c. &c.
The art of seeing well, or of noticing and distinguishing with accuracy the objects which we perceive, is a high faculty of the mind, unfolded in few individuals, and despised by those who can neither acquire it, nor appreciate its results.
LEXINGTON, KENTUCKY.
PRINTED FOR THE AUTHOR BY W. G. HUNT. (PRICE ONE DOLLAR.)
1820.

▼ AMONG his many other interests, Rafinesque tried to determine the origin of the American Indian


ANCIENT HISTORY,
OR
ANNALS OF KENTUCKY;
WITH A SURVEY OF THE ANCIENT MONUMENTS
OF NORTH AMERICA,
And a Tabular View of the Principal Languages and Primitive Nations of the whole Earth.
By C. S. RAFINESQUE, A. M. Ph. D.
FRANKFORT, IN KENTUCKY.
PRINTED FOR THE AUTHOR.
1824.

▼ HE INVENTED a new economic system to alleviate poverty, but he never got far with it


SAFE BANKING,
INCLUDING
THE PRINCIPLES OF WEALTH;
BEING AN ENQUIRY INTO THE PRINCIPLES AND PRACTICE OF SAFE AND UNSAFE BANKS, OR MONIED INSTITUTIONS IN NORTH AMERICA, THE DEFECTS OF THE AMERICAN BANKING SYSTEM AND LEGISLATION, &c.
BY C. S. RAFINESQUE,
A. M.—Ph. D. Prof. of Historical and Natural Sciences, member of 15 learned Societies in America and Europe, Author of 30 Works—Founder of the Divitial Institution of North America, and many other useful Institutions, &c.
Every Bank liable to risks or losses and to sudden calls is UNSAFE.—Every Bank liable to neither is SAFE.
PHILADELPHIA:
1837.
Printed by order and at the expense of the
DIVITIAL INSTITUTION OF NORTH AMERICA,
AND 6 PER CENT SAVINGS-BANK.

again. I have the bats and that's enough."

For three weeks the Audubons endured Rafinesque, endured the gathering mountain of plants, fishes, bird skins, and pickled fish that littered the house. Yet Mrs. Audubon was "perfectly reconciled to his oddities." He was certainly erratic, and his self-conceit was fantastic; but he was often gentle and indeed gallant with his old-world manners. He knew how to make a pretty speech, and when occasion demanded, he was one of the most eloquent men that the much-traveled Audubons had ever heard.

And Then He Vanished

There was a gentle melancholy about him. One night he laid his hand on Mrs. Audubon's arm and said, "*C'est crainte de pleurer, bien souvent que je ris.* (It is through fear of crying that I so often laugh.)" After that touching speech, and without so much as a "good-bye," Rafinesque was gone.

Audubon spent the whole night looking for him, not knowing, as he put it, whether his guest had perished in a swamp or been devoured by a bear or a garfish. Weeks later they received a letter in his small, neat hand, thanking them for their kind attention.

In 1822, he temporarily abandoned natural history for archaeology. In Kentucky and Ohio he described ancient Indian mounds and, moving impulsively as usual, tried to reduce the ancient history of North America to a chronological system. He worked up the comparative numerals of all the known languages of North America, which he published in 1824 under the title *Ancient History or Annals of Kentucky.* Many of its arguments were utterly fantastic; yet Rafinesque was the first person in America ever to use the word *Maya* and to suggest that Mayan hieroglyphics represented an important culture. For then, in 1822, only a single book had been published on the Mayas.

No sooner had his will-o'-the-wisp mind polished off the Mayas than he was off on another tangent. This time he was an economist. He devised a system of banking which he called his "Divitial Invention." It was to revolutionize the world's financial methods. Aglow with the idea, he wrote his friend Zaccheus Collins, calculating the astronomical sums he expected to earn from it. He envisioned millions, which he would use to publish his *Tellus*, or history of the earth and mankind." He was soaring in the empyrean, but he taxied to earth long enough to end his letter, "I am compelled to ask you for a loan."

Collins sent him the $15.00 requested with the advice, "Keep in view how oft your sanguine projects have misled you." The advice went unheeded. Rafinesque, with his Divitial Invention, was like an alchemist making gold out of the world's dross. He went to Washington to implore President Adams to adopt his banking system. Old John Quincy Adams was, understandably, a bit cool and aloof. Rafinesque, in a rage, went off to find Henry Clay and every other personality in the capital who would lend a patient ear. Eager to press the matter, he published an outline of his system, whereby bank stocks, deposits, or savings could be circulated by divisible certificates—"a great step," as he put it, "to increase the prosperity of the industrious classes." The invention has been called the forerunner of our present arrangement of coupon bonds by David Starr Jordan, who published an article on Rafinesque in 1886.*

His Dreadful Weapon

Joel Poinsett, the first American Minister to Mexico (after whom the genus *Poinsettia* is named), was amazed to find in his dispatches one day a letter from Rafinesque, appointing him the official Mexican agent for the Divitial Invention. The profits from the invention were to be used to build a canal through the Isthmus of Panama and to give Rafinesque funds with which to carry on research in Mexican and Mayan archaeology. He offered Mexico the exclusive use of his invention, together with "a dreadful discovery in the Art of Defensive War . . . a New Kind of Artillery, a single discharge of which will destroy one thousand men in Arms one mile off or sink a large Ship of War." He was awed by his own discovery: "This awful Invention will be communicated Secretly to all such governments who will grant me a Patent or Privilege for my *Divitial Invention. . . .*"

From 1826 on, Rafinesque remained in Philadelphia, except for occasional botanical journeys. He existed now in a sort of intellectual nirvana, oscillating between genius and madness. At the Franklin Institute he gave a course on the natural history of the earth and mankind. He planned a new periodical, *The American Journal and Friend of Knowledge*, and became its publisher, editor, sole contributor—and only subscriber. It was never published. But he continued to grind out a stream of writings on every phase of knowledge.

His passion remained in botany, but he turned to other inventions—a steam-plough, an aquatic railroad, and fireproof houses, none of which he was able to perfect or sell. But when the Academy of Sciences in Boston offered a prize of $100 for the best essay on the nations and tribes of America before Columbus, Rafinesque dropped all else to compete. The Committee decided that Rafinesque's paper was the "best" but refused him the prize because it was too long. This put Rafinesque in a rage and resulted in a long and acrimonious correspondence with the savants of Boston, which was hardly calculated to raise him in their esteem. Then, to counterbalance this ill-fortune, Rafinesque was awarded in 1832, the Gold Medal of the *Société de Géographie* of Paris for his memoir, "Sur l'origine des races negres Asiatiques." It was the first time that a citizen of the United States had ever been so honored, but it seems possible the award may have been made to escape Rafinesque's pressure for the honor.

But by this time Rafinesque was sunk in bitterness. "The petty quarrels and jealousies," he said, "of

* *Popular Science Monthly*, XXIX, 212-221.

our few learned men are disgusting. It is worse to see some trying to steal names and new objects from each other. . . I have much to complain of on that score. . . ." His abject poverty, meanwhile, was taking its toll. He was slowly being conquered by an advanced state of consumption, and cancer was eating away his stomach and liver. He did not, like the French explorer La Condamine, compose poems to alleviate his pains; instead, he set out to find a cure for tuberculosis.

"Having cured myself completely," he said, "of my chronic complaint, which was the fatal Phthisis, caused by my disappointments, fatigue and the unsteady climate. . . . I entered into arrangements for establishing a Chemical manufacture of vegetable remedies against the different kinds of Consumption. . . . I introduced a new branch of medical knowledge and art. I became a *Pulmist* who attended only to diseases of the lungs, as Dentists attend only to teeth. Being the first *Pulmist* and perhaps the only one here or elsewhere. . . ."

Living miserably in a garret on Philadelphia's Race Street, he was at friendly ease with only a few persons, including the druggist, Elias Durand, who sold his botanical elixirs. By day, Rafinesque was a peddler of his medicine; at night, by candlelight, he wrote his books—a veritable deluge of writings which finally numbered about 1000 items! But as the disease ate into his vitals, he became possessed by melancholia. "With a greater fortune I might have imitated Humboldt or Linnaeus," he said in an outburst of self-pity. Without financial aid, without recognition, denounced everywhere as a fool or a madman, Rafinesque followed to his horrible end the ideals that he had embraced all his life.

A Tangled Legacy

What Rafinesque left behind, both in controversy and actual scientific work, is so colossal that Dr. E. D. Merrill, one of America's greatest living botanists, is now arranging a comprehensive *Index Rafinesquianus*, which in typescript runs to about 1800 pages. In this work Dr. Merrill will try to resolve Rafinesque's contributions to world botany. Most of the new genera and species that Rafinesque established were redescribed by later botanists under other names. Yet, due to the priority rule in botany, some of his names are now accepted. "The majority of botanists," Dr. Merrill writes, "would be perfectly willing to outlaw all of Rafinesque's publications were it possible to do so," but it cannot be done, because many of his scientific names have been accepted. So Dr. Merrill, in this work, will attempt to arrive at a synthesis of Rafinesque's botanical writings.

An Untrammeled Spirit

There are many objections to Rafinesque's scientific methods. He devised his own laws of nomenclature. If a published generic name were too short, he lengthened it; if names were too long, or, as he wrote, too "uncouth in sound," he changed these, too. He did discover many new species based on his own collections, but he also created new ones by scanning a published description of the works of other authors.

Rafinesque continued to live in his dream world. No adversity could dissipate his illusion of greatness. Certain that "time renders justice to all alike," he was not dismayed by the failure of all his inventions, and, as death and a dubious transfiguration closed in upon him, he began his will. It was a detailed document of 20 pages. He directed his executors to sell his "Caveats & Secrets relating to Aquatic railways, Steam Ploughs, Rail Wheels, Artificial leather, Incombustible architecture." He outlined just how the monies from these inventions were to be applied to the publication of his works. His last testament was like the will of a millionaire bequeathing vast sums to enterprises that would give his name immortality. Poor Rafinesque. Even death cheated him. When his will was probated, his fortunes were found to be exactly $13.43.

A whole nation wept for Agassiz when he died. Nations and monarchs went into mourning when Alexander von Humboldt passed away at the age of ninety. Darwin was buried in Westminster Abbey; and Linnaeus was blessed as much posthumously as he had been honored during his life. But no one loved Rafinesque. He died as he had lived—alone. As David Starr Jordan suggested, a single word could fittingly have been carved on his tombstone, as it was on Albrecht Dürer's "*Emigravit*."

▼ RAFINESQUE was the first citizen of the United States to receive the Gold Medal of the *Societé de Géographie*

Obverse. Reverse.

GOLD MEDAL—EXACT FAC-SIMILE.

Celestial Violence

Falcons in the SKY

THE NOBLEST OF SPORTS: FALCONRY IN THE MIDDLE AGES

GREAT Moments IN ACTION

Winged Monarchs of the Air

Falconry and Conservation

BIRD ON THE HAND

The ANCIENT and NOBLE SPORT of FALCONRY

don't let the HEADLINES *fool you*

Those who yearn to practice the ancient sport of falconry are given a chance to look before they leap

By George G. Goodwin
Associate Curator, Department of Mammals, American Museum of Natural History

At no other time in history has the ancient art of falconry figured so widely in the public eye. During 1946, practically every adult citizen in North America, from coast to coast and in all walks of life, was made falcon-conscious in some way or other.

In the fashion world, *Harper's Bazaar* featured a full-page picture with the falcon as the motif. *Life* Magazine carried a similar illustration. One of the most famous and exclusive fashion shows opened its parade with a falconer carrying a peregrine. Fashionable Fifth Avenue was treated to an eight-window display featuring falcons and the medieval gold braid used in costumes. Even the motion picture world was not excluded: one of our leading stars, Olivia de Havilland, aided in the rescue of some helpless, young falcons from the towers of a tall New York building. This story was given publicity throughout the country. (Those interested may be pleased to learn that I raised these three young falcons and gave them their liberty.) The well-known men's magazine, *True*, featured a long article on falconry, and *Collier's* published colorful pictures of the sport. In the business world, the *Sun Life Review* devoted three full pages to these famous birds; and a falconry bill was entered in the New York State Legislature.

The emphasis given to the more picturesque features of falconry has fired the public imagination. And since the writer was frequently named as an authority on falconry in connection with these presentations, an endless stream of inquiries has poured in. "Where can falcons be bought? . . . Do they breed in captivity? . . . How much training do they require? . . ."

Without intending to dampen the ardor of would-be falconers who face the problem intelligently, I would like to offer a few home truths that may save a good deal of unnecessary effort.

There is no market where falcons can be bought. They do not breed in captivity. The open season for hunting with a falcon is at best short, yet the falcon must be fed and cared for every one of the 365 days in the year. During high winds and stormy weather, falcons cannot be used. Often after weeks of careful training, the falconer sees his pupil sail serenely away without so much as a backward glance. In most states falcons are rigorously protected by conservation laws, and permits are granted only after it has been definitely established that the falcon was obtained in an unrestricted state or country. Even armed with a permit, hunting with a falcon is not considered exactly legal in the United States.

The falconer, furthermore, must be a craftsman, able to manufacture the hawk's "furniture." There are hoods to be made that must fit comfortably and accurately; there are jesses, swivels, leashes, perches, and weathering blocks. This is primarily a hobby for a man of leisure with reasonable means and an endless store of patience. A country residence is essential. The hawk house or "muse" has a dirt floor covered with clean sand. It must be insulated and draft-proof yet well ventilated. A private lawn is essential, protected by a high fence and shade trees to shelter the hawk from the summer sun.

At least two hours each day are required to look after the hawk and six hours each day during the training period. The supply of food for a falcon is a problem in itself; fresh-killed pigeons, poultry, and beef- or sheep-hearts are the staple requisites. These are just a few of the obvious factors to be considered before venturing into this field of sport.

True, there are falconers in America, but less than a dozen successfully take wild game with a falcon. The majority of the self-styled falconers merely keep a hawk as a pet and follow the usual routine of training until the victim dies from improper treatment or in an unguarded moment gains its freedom in flight.

There are volumes published on the art and practice of falconry, but all the treatises ever written can never convey the sympathetic understanding necessary to wean the wild falcon from her love of freedom and make her trustful of the hand that tends her.

Lofman-Pix photos, courtesy Collier's

▲THE FALCONER must be a craftsman to make the necessary hoods, jesses, leashes, perches, etc. These accouterments, with slight modifications, come down to us from ancient times. Probably the earliest evidence of falconry is an Assyrian bas relief showing a hunter carrying a falcon on his wrist, from the time of Sargon II, 722-705 B.C.

◀SIX HOURS a day during the training period! And after weeks of it, the bird may serenely sail away without a backward glance

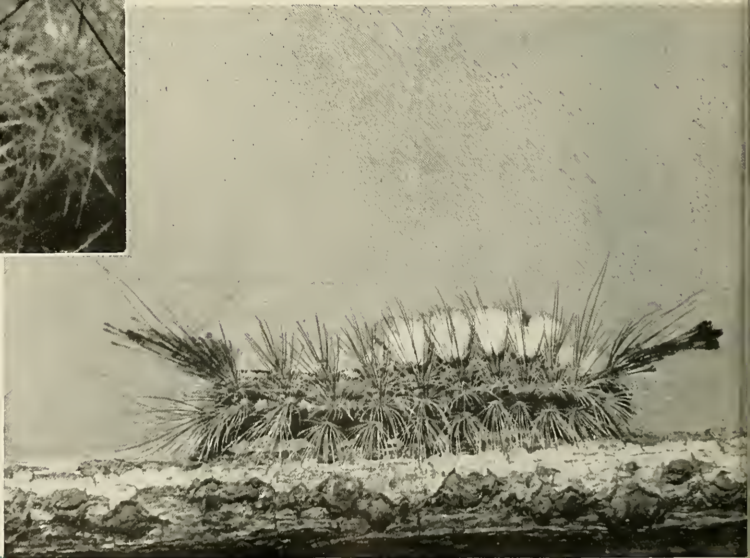
Ugly Duckling

By George Elwood Jenks *and* Kay McKay

Among the many strange life stories to be found within the realm of nature's enchanted weedlands is that of the common Tussock Moth, *Hemerocamps vetusta* Boisduval. The female is no glamour girl. She is fat, clumsy, and wingless, her only redeeming feature being . . .

1 ▲. . . a coat of silky, platinum-blond hair. The Tussock caterpillars sometimes devour much foliage of forest and garden trees, but the private life of the Mother Moth offers a rare example of selfless devotion

2 ◄Her newly-hatched baby (here highly magnified) is even less attractive—just a black, warty little "worm" about the size of a pinhead, an Ugly Duckling among caterpillars. But . . .



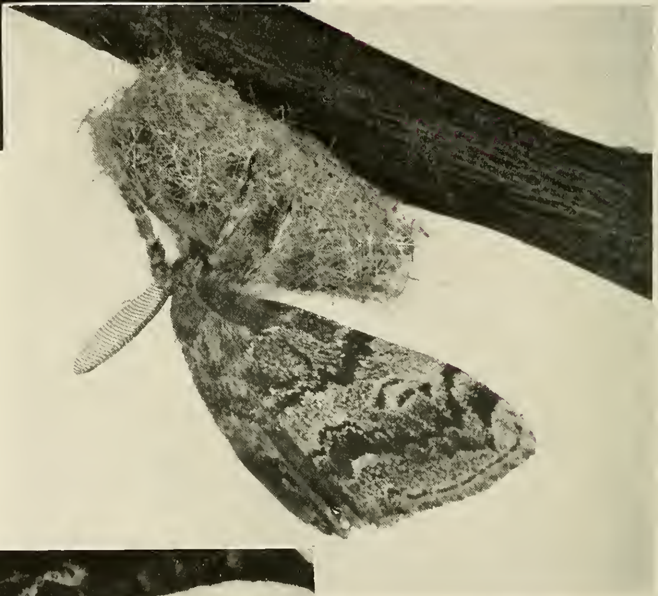
3 ►. . . with each molt she takes on new and elaborate ornaments — brilliant "buttons," black tufts, and the four thick "tussocks" of white hair for which she was originally named

4 ➤ WHEN she reaches maturity, we see that the long bristles provide the framework for her cocoon, being cemented in place with liquid similar to a spider's. The four tussocks are still in place, but every hair will be used

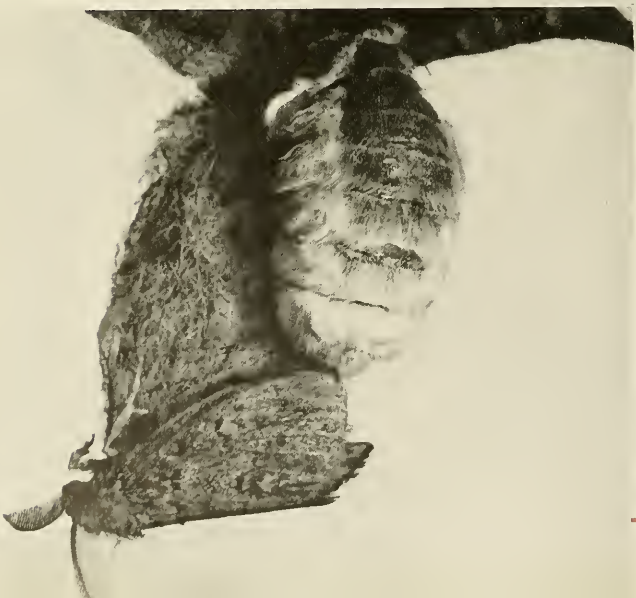
5 ◄ WHEN the cocoon is finished, she is completely hidden, so we shall cut and fold back the wall

6 ➤ AT FIRST the pupa is soft, but it soon becomes firm and compact. Within a few weeks the pupal stage will be completed, and an adult female moth will emerge. But what a moth!

7 ◄ SHE is fat and wingless. She can neither fly nor eat. So her life-span is only a matter of a few days, and the empty cocoon is the only world she will ever know!



8 ► BUT somewhere—near by or far away—another cocoon bursts, and a handsome winged male comes out. He rests quietly while his wings grow firm and his strength builds up



SOMEHOW the two must meet—which brings us to the mystery of insect communication. Various theories have been advanced. Some believe that it is accomplished by some sort of insect "radio." But remember, he must not only *get* the call, he must *locate* the lady sending it

9 ◄ IT IS BELIEVED that the female produces an odor which the male perceives with his remarkably sensitive antennae, and which guides him to the female. He finds the lady. But the honeymoon is all too brief, for Tussock males are "men who kiss and ride away, . . ."

10 ➤ . . . leaving the Little Mother to provide for the family-to-be. Her eggs must be sheltered during the long winter. Clinging to the cocoon with her front feet, the mother swings back and forth in an arc, . . .

11 ➤ . . . laying her eggs in regular rows across the surface of the cocoon in a sticky liquid. This glues them to the cocoon and also catches and pulls out the mother's long, white hairs to form a thick, waterproof "Angora" blanket

12 ➤ Before her job is done, she becomes noticeably weaker, then lays a few more eggs, and falls—an "expendable" in nature's war for numerical dominance. But she has fought a good fight and has not lived in vain, . . .

13 ➤ . . . for another spring will warm the white-blanketed eggs to new life—to another cycle of faithful mothers and errant fathers. Life must go on!

FOR MANY YEARS the pacarana was known from a single specimen captured in 1873

The NOT SO TERRIBLE *Mouse*

By WALTER HENRICKS HODGE
Associate Professor, Department of Botany, University of Massachusetts

The pacarana reminds one of a rat that ate some of Alice in Wonderland's mushroom. It is two feet long

Photographs by the author

DINOMYS, meaning "terrible mouse," is the generic name of one of South America's most curious and least known rodents—the so-called "giant rat," or "pacarana," as the Peruvians familiarly know it. One can understand how this oversized rodent could have suggested the name "terrible mouse" to the scientist who first viewed its anatomical characteristics from a collector's specimen. It is about two feet long and has coarse, blackish fur, streaked or spotted with white on the back and sides.

Alive in the flesh, *Dinomys branickii* is *not* so terrible. Except for its stout tail, you might think you were looking at a giant guinea pig.

The pacarana is very rare throughout its territory, which includes the rain forests of the tributaries of the upper Amazon, in the easterly ranges of the Andes from Peru to Colombia. Although the writer has traveled extensively in its homeland, he has made the acquaintance of only one pacarana, an animal that lived as a pet at Lima's small natural history museum, the Museo Javier Prado. This docile animal had been caught several years before in the Chanchamayo region of Peru, and he shows all the characteristics of his race. He is active throughout the day, waddling about his pen in a flat-footed, bearlike fashion, grunting peacefully at the approach of visitors and reacting favorably to the inevitable petting. In captivity, this apparent vegetarian relishes sweet potatoes, which he eats seated on his haunches, holding the potato squirrel-fashion in his forepaws. When released from the pen, he seems to "remember" his native habitat, for he makes a bee-line for the protection of shrubbery, but with no attempt to escape.

The pacarana is also called the "false paca" in distinction to the true paca, another large rodent, which, however, lacks the well-developed tail. The pacarana is a cousin of the dynamic and ubiquitous rats and mice but is very unlike them in its phlegmatic nature. In this respect, as well as in general body form, it resembles to a greater degree our eastern woodchuck. But whereas our familiar pasture friend seems well able to persist in competition with man, the Peruvian rodent has not been so fortunate. In fact, the pacarana appears to be on the road to extinction, even with a minimum of man's aggressive competition. This is nothing new in the family to which *Dinomys* belongs, because several other genera, native to certain of the larger West Indian Islands, apparently became extinct soon after the Spanish Conquest. That the pacarana is on the same road can be assumed from the thimbleful of information available about its distribution and habits. In a recent compilation, it is listed as one of the "vanishing mammals of South America."

For many years the pacarana was known from a single specimen that was captured in 1873 as it wandered about in a hacienda building at the hamlet of Vitoc, Peru, at the headwaters of the Chanchamayo, just east across the Andes from Lima. Until 1904, the species remained out of scientific headlines, but in that year two living pacaranas were seen from the Rio Purus in Brazil. In 1932, a large series of specimens was obtained from the forested Andean area east of Lima; and in 1925, the New York Zoological Garden finally obtained a living specimen for exhibition.

What kind of country is the pacarana's homeland? It is one of the most beautiful in the world—a land of narrow, verdant river valleys, steep mountain slopes, and moderate elevations, with a mild climate and abundant rainfall. This region is more or less isolated and has few settlers. It is the ancient belt of uninhabited country lying between the highland Indians of the old Inca civilizations and the lowland forest tribes. Thus it is a sort of no-man's-land, where one might expect animals like the pacarana to increase rather than decrease.

From its enemies—ocelots, coatis, and man—*Dinomys* seeks protection by finding shelter in the crevices of rocky outcroppings or in holes dug between the roots of large forest trees. In a land where meat is scarce, the human inhabitants relish the pacarana and can easily capture it with the aid of dogs. And although some of this rodent's forest enemies are on the decrease, this is not true of man, for the part of Peru where *Dinomys* "abounds" is now expanding with colonization. New roads have been pushed through the precipitous mountain and forested country. That the pacarana is a giant among rodents has not favored its survival, and the not-so-terrible *Dinomys* appears to be doomed.

▲THE PACARANA'S HOMELAND is a beautiful region of verdant valleys in the easterly ranges of the Andes

◄ITS COARSE HAIR is streaked or spotted with white. There is only a "thimbleful" of information about this animal, yet it is facing extinction

THE SLIT PUPIL of the cat's eye can close so completely that only a pinhole is left at top and bottom, through which the animal watches while basking in bright sunlight

UNTO

are

From a sensitive patch of
that can distinguish two p
the eye is one of Natur

By LORUS J. *and* MARGERY J. MILNE

All photographs by the authors

FROM time to time, one or two friends join us on a stroll through a near-by woodland. The path winds between smooth, gray boles of giant beech and rough, dark trunks of tulip poplar and follows one bank of a little stream. There we find the final flowers of autumn —the butter-yellow straps that are twisted petals of witch hazel. In the breeze that stirs the fallen leaves, these odd flowers flutter gently but blend into the changing hues of near-by foliage. Beneath the shrubbery, hidden in the litter of color-rich vegetation, are the peaked, vaselike flowers of next spring's skunk cabbage. Now they are as dormant as the cocoon on the ironwood branch, or as the buds that promise a splendid showing of white dogwood when winter has come and gone.

Usually our companions show surprised interest in these wayside trifles, but many comment on the emptiness of the woods, the lack of active wildlife. Where do the flies go in the wintertime? Nor is their criticism different if the walk is taken at another season. These woods lack for them the variety of animals they expect to notice. Where, now, are the many snails, birds, newts, and insects they have seen projected on our movie screen?

Probably none of these friends understand completely that our own continual chattering and moving around keep hosts of creatures from exposing themselves. Some people even seem a little hurt at this explanation—as though we were asking them to be silent. Others no doubt believe that we are making lame excuses for the absence of animals. Our claim that though unseen, untold eyes are watching is too evidently an exaggeration. If the eyes were there, the human intruders would be able to see dozens of pairs, peeping from behind every tree and over each fallen log. After all, are not human eyes better in every way than those of other animals?

But most of the animals hiding close by never give away their places of concealment. They remain "frozen" by fright, instinctively aware that as long as they are still, we shall not see them. For countless generations their parents have escaped enemies in this way.

JUMPING SPIDERS have eyes in a row around the front of the head. The two large ones seen here seem particularly important for binocular vision, as when jumping to a twig a foot or two away

THE KINGFISHER has double vision in each eye and so can see well both in air and while following a fish under water. The bird looks in two different directions through the same lens

They depend upon an elementary fact: seeing and recognizing are two entirely different processes. The first involves only the eyes. The second requires a trained mind as well.

A great many creatures are actually in plain sight as we walk through the woods. Their images are in our eyes and would be recorded on a photographic film with even greater precision. But our eyes do not see; they only help us to see. And until we ourselves have been trained to recognize a crouching rabbit on an irregular carpet of leaves, the mind makes no distinction. The animal is simply not there—unless it moves! If we are not close enough to step on its cowering body, the rabbit is likely to stay just where it is with only its sensitive nose twitching to test the wind. One large brown eye stares in our direction. It is but a single example of the hidden hordes of eyes that watch us, that warn their owners to stay silent, motionless, concealed.

These eyes are of many kinds, with few like our own except in general shape. Each animal's vision is neither better nor worse than is required for successful living by its customary methods. Some creatures are sensitive to light yet have no eyes at all. The earthworm's skin, except on the underside, is equipped with light-sensitive cells that inform it of the approach of dawn and early rising birds. But the robin must wait to leave its sleeping perch until the rising sun has brightened the sky; most birds cannot fly safely among branches until daylight allows good vision. And to locate a careless worm accurately enough to seize it requires an eye with particularly clear sight. So it is with other creatures. Most of those that dare to be active and to be seen by day benefit by the sun and sleep at night. Their eyes are designed to take advantage of adequate light. To do so to best advantage, these animals have dispensed with sensitivity and are completely blind when the sun sets.

The crackle of dry branches underfoot and human voices raised in conversation awaken mice curled up below fallen trees and among thickets. Each peers from its hiding place into the dazzling brilliance of daylight. But the eyes of the mouse allow its owner no clear picture of the well-lit scene. Anything that stands still or sways gently with the breeze is lost to view.

D EYES

n you

n to an intricate mechanism
ts 1/125 inch apart—surely
most amazing inventions

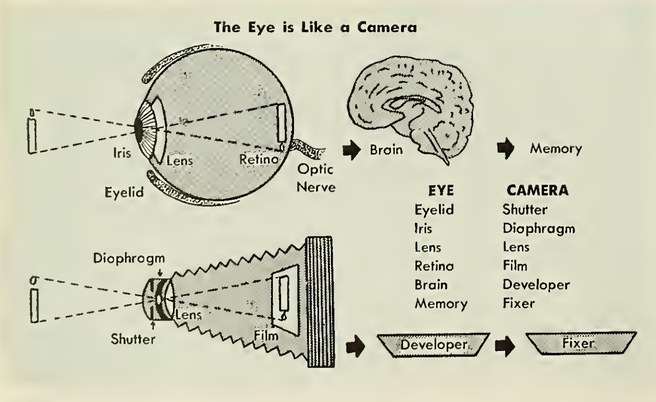
THE UNBLINKING EYE of an Indigo Snake can shift a little in its socket and focus on objects at different distances. It can stand the most intense sun but at twilight becomes blind

THE ROBIN'S EYE is fine for locating earthworms but is blind as soon as the sun goes down. Accurate vision is always associated with an eye that needs plenty of light

Mouse eyes are built to operate at night, to profit from the dim illumination of the midnight sky, when there are fewer foes. Accurate day vision has been sacrificed in favor of the extra sensitivity required by the nocturnal shadows. Even a few visual clues mean more to a night-active mouse than does clarity of vision. Sound and scent are less dependable than even the poorest vision, and touch usually gives its warning much too late.

Day eyes or night eyes, accuracy of vision or sensitivity—that is the question that confronted the ancestors of each kind of animal. Rarely can either mechanism be expert at both. It is the same dilemma that the photographer faces when he would like a single camera to take pictures rich in detail for photomurals of scenery and also to record the quick movements of children in deep shade. Like the camera, the eye is an optical instrument, with all its limitations. The more versatile it must be, the larger and more cumbersome is the mechanism. Only a large animal can carry around an eye big enough to work well both night and day, if the usual construction is to be left unchanged.

The human eyes with which we search the woods for signs of life are a compromise between specialization for day and night vision. Each is large enough to contain a double mechanism—one like that of the robin, the other like that of the mouse. The first we use by day and into twilight. It allows us to distinguish a fine hair at arm's length and to recognize as double at ordinary reading distance two points of light 1/125 of an inch apart. The daytime part of the eye operates through a range of brightness extending from full moonlight to full sunlight, a hundred thousand times as brilliant.



As night falls, the second system slowly takes over the visual tasks. It enables us to see a surprising amount even in very dim light. Yet like the mouse's vision, the night mechanism deals with general forms rather than specific details. It can tell us of the presence of a tree but not of a small branch. This vision is completely colorless. Worst of all, the center of the visual field, where we ordinarily look for best vision by day, is totally blind in our night eyes.

In spite of these important disadvantages, we can employ our eyes successfully in places so poorly lit that the brightness is one ten-thousandth that of full moonlight. In clear air, we can see a lighted candle a mile away. A landscape under a clouded, moonless sky is still recognizable once the eyes have adjusted to so dim a scene. The cat and the owl can do only a little better than this, yet they catch a stomach full of agile mice each night. But at the other end of the range, in the strong sunlight that a lizard, snake, or frog tolerates unblinkingly, we squint, shield our eyes with a hand, or reach for dark glasses.

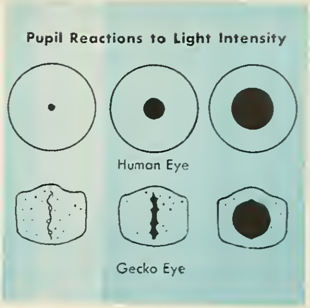
The mouse and the robin cannot make the same compromise as man, although it might be very desirable for these creatures to be active "around the clock." Their eyes are too small, and they have no more space in their skulls for bigger ones. A large animal is at a great advantage in this respect, and most of the animals that are active during all twenty-four hours of the day have large eyes. The cat has relatively huge visual organs —only a fifth smaller in diameter than our own and fully half as large as those of the horse. The horse has the largest eyes of any land animal, and excellent vision.

As in our own eyes, the camera-like eye of the mouse focuses light on a sensitive retina by means of a curved cornea and a doubly convex lens. The actual amount of light reaching the retina is controlled by the opaque muscular iris —the colored part of the eye that surrounds the central opening, or pupil. The retina on which the image falls is composed of millions of cells. These cells are approximately the same size in the mouse as in man, whale, or other vertebrate animals. The minute image in the mouse's tiny eye falls on far fewer of these cells than does the larger image in our own. Each cell can inform the brain of the relative brightnesses of the light falling on it, nothing more.

Thus the mouse must construct a mental picture of its surroundings from comparatively little information, and the picture consequently lacks detail. Worse still, each of the optic nerve fibers to the mouse's brain serves hundreds of retinal cells. Light reaching any one of these scattered but connected cells gives the mouse's mind the same information. Instead of a clear picture of large masses either light or dark, the whole image is blurred. It is like the vague and indistinct vision we ourselves have under a moonless night sky, and for the same reason. But the mouse's eye operates in this way both night and day. Little wonder, then, that the small rodents have retired from their many enemies into the "cavern of nocturnality," where their poor vision compares more favorably with that of other animals.

Whether or not "the Owl and the Pussycat went to sea . . . ," they are linked in our minds as creatures of the night. Many have claimed that the eyes of the owl, like those of the cat, have slit pupils. This is not the case. The creatures with slit pupils are mainly those that combine night eyes with activity in sunlight. Owls seek a shady clump of trees or a hollow stub in which to spend the day, and they close their eyes over circular pupils like our own. The cat, on the other hand, with its slit pupils, is able to enjoy basking in the sun. As Kipling implied, all places and all times of day are alike to him. The pupil takes care of the difference.

To control a round pupil, the iris contains a muscle with fibers arranged in concentric circles. When the muscle relaxes in dim light, the pupil opens—our own to a diameter of about a third of an inch. When the muscle contracts under strong illumination, the pupil is restricted to a small hole, perhaps an eighth as far across. But no matter how much the muscle pulls, it can never shrink the circular pupil to zero or anything near that; the muscle is in its own way.



A slit pupil is very different. The two sides of the slit can be pulled together until the opaque iris from one side actually overlaps that from the other, and the pupil is obliterated altogether. Just before this happens, the opening is the size of a pinhole. For the cat's sensitive night eyes, this is fine for day vision. Ordinarily, the cat's slit pupil closes to leave a pinhole at each end of the former opening. The geckoes (small lizards of the tropics that are active both night and day) leave a whole row of pinholes when they close the slit pupils on

THE ALLIGATOR, like the cat, has a slit pupil that can be closed down when its nocturnal owner enjoys a sun bath. A circular pupil cannot be closed as tightly their sensitive nocturnal eyes. This is an ingenious modification of the basic design that allows even a small eye to be used in dark or light. Scientists are often surprised that more creatures have not developed the slit pupil.

Cats and some owls have another feature in common—the "eyeshine" that makes their visual organs glow in semi-darkness. In a complete black-out the eyeshine vanishes. These eyes are like the reflector buttons installed for safety along highways, casting back to each motorist the rays of his headlights and warning him of curves far ahead. But the eyeshine of nocturnal animals is not intended to give away their position. It is a device for making their eyes more sensitive to the faint illumination of midnight and for sharpening the contrast between objects feebly lit by starshine. These eyes have a mirror-like layer behind the retina in place of the ordinary black layer of absorbing pigments. Light that fails to be absorbed as it passes through the sensitive retina is reflected back on it from behind, giving the light a second chance to affect the visual sense cells.

Crayfish and some insects such as the praying mantis have pigment in the eyes that migrates at dusk and dawn to achieve an effect comparable to that of the "mirror backing." At night, the pigment moves away from the light-sensitive cells, and the eyes appear darker in color. In the day, it migrates back to cover the light-sensitive cells and reduce the amount of light reaching them. The eyes then appear lighter in color.

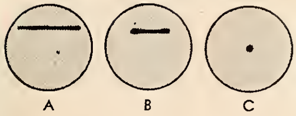
The owl is one of the very few truly nocturnal birds. Its head is large enough to accommodate big eyes. Its vision is overlapping, or binocular, and it possesses enough acuity to follow dodging mice through a field at night. Other nocturnal birds have feeding habits like those of most night-faring creatures. They use their eyes but little and depend upon "trawling" to obtain food in adequate quantities. The nighthawks and whippoorwills fly over the beechwoods in the twilight air with their broad mouths opened wide to catch any insects winging in their path. Anteaters and armadillos gather their tiny prey with sticky tongues, never seeing the food they swallow. Mice show definite preference for berries in clusters, grain in heads, or ears of maize. These things can be eaten without the use of eyes, and the multiple fruits may produce more attractive odors than solitary ones.

Most birds and squirrels, on the other hand, join the daytime creatures in attaining great precision of eyesight. Many, like ourselves, have developed one small region in the eye that is especially sensitive. This pit in the retina is called the "fovea," and each of the cells that line it has a private nerve fiber connected with the brain. In this area, visual acuity reaches its maximum, and the animal turns its head or eyes until any object of interest is focused in the fovea.

So well adapted to diurnal life has the bird's eye become, and so excellent is its visual acuity, that man must grudgingly admit that in some ways at least it is superior to his own. We praise someone for having an "eagle eye" and admire the vision (if not the habits) of the turkey buzzard, which can recognize a dying rabbit from a soaring point high above. In medieval times when falconry was in vogue, the hunter took along a small bird to keep track of the falcon. The little bird (often a shrike) was caged and mounted on the saddle. Whenever the falcon was flown, the caged bird became excited and watched the hawk intently. Long after the falcon had disappeared from human view, the actions of the small bird enabled the falconer

THE OWL'S roomy head encloses large eyes, and the bird has excellent vision compared with most other nocturnal creatures. The pupils change size rapidly and are independent of each other

Different Shaped Blind Spots



The Blind Spot (head of optic nerve) in eyes of Prairie Dog (A), Gray Squirrel (B), and Flying Squirrel (C)

to follow his trained tercel and be on hand at the kill.

The squirrels in the beechwoods have solved another problem of vision. At the point in each eye where the optic nerve leaves the retina to enter the brain, there are no sensitive cells, and the eye is blind. We seldom notice this because the blind spots of our two eyes do not coincide. What one eye fails to see, the other gets. But in animals without good binocular vision, the blank area in each eye offers a serious handicap. Keeping the blind spot small is not easy either, since day vision requires more nerve fibers than night vision, and the additional fibers swell the optic nerve and hence the blind spot. Squirrels must have good eyes to leap through the air from branch to branch. Blind spots could cause serious falls. Their solution to this problem is to spread the optic nerve into a thin ribbon where it leaves the eye, so that the blind spot is not a circular area but a thin horizontal line. It takes only a negligible bite out of the image of each vertical object; and by raising the head slightly, a squirrel can provide continuity in trees and other important features of its surroundings. As might be expected, the many kinds of squirrels throughout the world show this special feature of the blind spot in direct proportion to their activity in daylight. The brighter the sun and the more arboreal their habits, the broader and thinner is the blind line. Squirrels that keep to deep shade or are nocturnal like the flying squirrel have eyes of a more ordinary type.

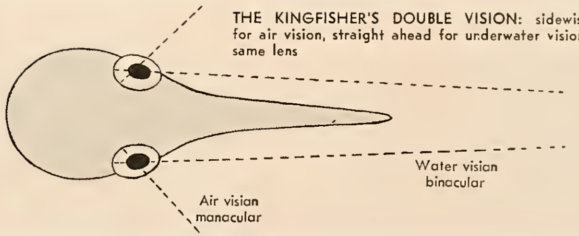
Frequently we see a kingfisher dart through the beechwoods along a little stream to a pond not far away. A rattling cry rings through the forest in the wake of its blue body and crested head. Sometimes we hear the bird but fail to glimpse its fast flight. Yet we know it to be another creature that has developed special eyes—eyes that can notice the exact position of a fish below the water surface and can follow the fish after the bird makes a sudden dive into the pond.

Vision in air and vision in water are entirely different. In air the cornea, which covers the iris and pupil, is even more important than the lens of the eye in forming an image on the retina. But when water comes in contact with the cornea, it loses all its optical properties, and the lens must act alone. Hence an eye that has normal vision in air is very farsighted in water, and an eye that has normal vision in water is pathetically nearsighted in air. For this reason animals that try to operate in both air and water encounter serious visual problems. The kingfisher, the seal, and the "four-eyed fish" of the tropics, *Anableps*, have developed special solutions to this dilemma, each in its own way.

The kingfisher succeeded in acquiring an egg-shaped lens and two foveas in each eye. The large end of the lens is in front. While the bird is looking "out the sides of its eyes," as it does in the air, one of the foveas in each eye gives a sharp image. But when the kingfisher enters the water and its cornea "disappears," the image of the fish is formed through the other end of the lens on the second fovea of each eye. The fish is seen, binocularly and in good focus, straight ahead of the beak, and the bird is able to complete the catch. The kingfisher thus has two eye systems in one—an underwater visual arrangement, which is hopelessly nearsighted in air but fine for binocular pursuit in the pond, and an aerial survey system with high visual acuity, which becomes completely useless when the bird dives after prey. Penguins that chase similar food under water have no such optical arrangement. Instead they have normal vision while under the surface and are notoriously nearsighted on land.

When we take friends on our walk through the beechwoods, we often ask how many frogs they see along the little stream. None. But we know from past experience that we only have to walk from the path to the edge of the water to cause several to appear, as though by magic. One at a time they become frightened and make tremendous leaps into the water, back into the realm in which they started life as tadpoles. But they no longer have tadpole eyes, which are constructed for vision under water. The frogs now secure their food in the air, and their eyes must be able to see flies with enough accuracy to catch them on their sticky tongues. So when the tadpole changes into a frog, losing its tail and altering its digestive tract to accommodate animal food instead of vegetable food, its eyes also change, losing their power to see under water and becoming adapted to vision on land. Frogs' eyes take on another function, too. When the frog swallows, it closes its eyelids and pulls the eyes inward through the sockets until they bulge down from the

THE KINGFISHER'S DOUBLE VISION: sidewise for air vision, straight ahead for underwater vision; same lens



roof of the mouth, thereby helping to push the hapless insects into the capacious stomach.

Frogs have three eyelids. They use the upper one least of all. The lower lid is opaque and rises to complete the closing of the eye. The third lid is *transparent*. It operates from the corner of the eye near the nostril and serves to keep it moist and to clean the cornea by sweeping away dirt particles. This is a big advantage, because it allows the animal to continue using its eyes. We waste a fortieth of a second every time we blink, accomplishing no more than does the frog. The frog gazes steadily at its surroundings while it clears its eye with the third eyelid. Human eyes expend much muscular energy in rolling rapidly upward as the upper lid comes down, increasing the relative rate of sweep and putting the important cornea out of harm's way in case of a blow during the brief blindness of the blink. Birds also have a third eyelid, which readers of NATURAL HISTORY were able to see in action in a recent series of superspeed photographs of an owl alighting. It is probably also a sort of aviator's goggle to keep the cornea from drying out as the air sweeps past the eyes. Since this lid is transparent, the bird can see through it perfectly well, and dust particles encountered at high speed cannot imbed themselves in the cornea.

These creatures, like all other backboned animals, have only one basic eye design—a liquid-filled balloon that keeps its form because of internal pressures and external stiffening. The only other animals that have used this method of construction are the octopus, squid, and the cuttlefish and its relatives. The giant squid and the large sharks and whales have pushed this eye form to the limit of its logical size. In the great blue whale the eye has reached the dimensions of a grapefruit. Other animals without backbones see the world through very different visual organs. The pearly nautilus has lenseless eyes like pinhole cameras. The rest have inflexible lenses formed from layers of the skin that focus light upon sensitive cells but produce no clear image. Each is a simple eye. Spiders in our beechwoods have six or eight of them, arranged in some definite pattern on the back. The eyes of the jumping spiders are grouped toward the front, and there can be little doubt that some form of stereoscopic vision is achieved. These creatures pounce upon their prey and can leap to a branch a foot or two distant, alighting with accuracy every time. Harvestmen spiders, less dependent on eyes in their nocturnal foraging, have a little turret bearing the visual organs in the middle of the back, like the windowed cabin on a caboose.

Dragonflies hawking over the little stream for midges, and crayfish among stones in the shallows, have excellent vision through use of great numbers of simple eyes, packed closely together like tiles in a mosaic mural. As in most insects and crustaceans, the surface of the compound eye is convex, so that each of the individual components faces in a slightly different direction from any other. Each is responsible for a small part of space and is sensitive to the amount of light coming to the animal from that particular portion of its surroundings. Anything lighter or darker than the background, such as a human being moving along the path, changes the illumination reaching each part of the compound eye faced in that direction. The change affects the mosaic, one facet after another, and gives the animal a fairly good representation of the visual scene. If the changes follow one another quickly, the object seen must either be a large one moving fast at a medium distance or a smaller one moving more

THE HORSE has the largest eye among land animals, and with it goes excellent vision, both by day and by night

PIGMENTS in the eye of the Praying Mantis migrate to make the eye dark brown at night and more sensitive. Note the false pupil (dark spot) which moves with the camera

slowly very near to the animal. In either instance, its eyes may bid the animal to be quiet, to fly away, or to grasp for food. The particular reaction depends on the nature of the creature.

If a honeybee is held in one position, facing a black screen, and a white flower or card is moved across its field of view, the insect follows the motion with its feelers. When the card is long, the bee follows the leading edge, then relaxes again until the trailing edge stimulates it to respond. A checkerboard passed in front of the bee creates a frenzy of feeler waving. The experimental situation is not greatly different from the relationship between the bee in flight and a stationary flower. The change in brightness created by the flower contrasted with its background affects facet after facet of the insect's eyes and guides it in finding nectar and pollen. A large flower has less attraction than a group of little ones separated by dark areas —like the checkerboard. And if the flowers wave in the breeze, the to-and-fro movement of the contrasting areas across the insect's eye mosaic has an even stronger impelling power. Apple trees on a mildly windy day are far busier with bees than when the air is still and the blossoms are not swaying.

The ultimate in contrast is a silhouette. Many creatures specialize in hiding from enemies by matching their silhouettes to their surroundings. Butterflies clinging to a branch may appear to be merely tattered leaves that have not fallen. Leaf hoppers, which Comstock describes as "insect Brownies," often resemble spines and thorns. So intimately connected to the twigs and branches do they appear that they escape notice until they move. Stick insects standing quietly among the vegetation blend with the sprigs and leaf stalks and are similarly hard to see. They watch us to decide when it is safe to resume feeding. But unless our eyes are sharpened by experience, we do not suspect that the insects are anywhere around. Underwing moths clinging to the bark of trees blend their gray upper wings with the support, and only a practiced eye can find them. But if approached while sleeping through the day, they take flight, exposing conspicuously fiery underwings that were hidden completely in the resting position. Even eyeless cocoons, hanging like withered leaves in the winter, form silhouettes against the sky that go unseen by passing birds and human beings.

The path beneath the beech and tulip poplar trees is often broken up into little winding ridges from near-by loamy soil, where moles have tunneled in search of insect grubs and earthworms, young mice, or other meaty prey. Their eyes are almost useless. No good images are formed, and the organs have so shrunk in size that they can function only if light penetrates into the mole's subterranean chambers. For a burrowing animal this suffices. Intrusion by enemies must be detected quickly, but to a mole an eye is otherwise just one more sensitive pocket that can be filled with sand.

Cave creatures can dispense with eyes entirely. Generation after gen-

Continued on page 333

A New *Missing-Link Skull* From South Africa

By Robert Broom

▲ Dr. Broom's provisional restoration of the head of the Sterkfontein female discovered last April

Introduction Note:

Bit by bit, scientists, excavating in many parts of the world, have been piecing together the early history of man. Asia and the East Indies have produced most of the earliest material and are generally considered the most likely place of origin. Europe, despite its abundance of prehistoric relics, has yielded nothing from the earliest periods; and North and South America appear to have figured only "recently" in man's history.

In the last few years South Africa has attracted the attention of scientists with the discovery of some very unusual fossil "ape-men" or "man-apes." New finds relating to this early being are presented here for the first time in an American periodical.

The skull indicates a brain capacity close to the average for gorillas and chimpanzees but is more advanced than the apes in some features, notably in the teeth. In others it is much less advanced than man, particularly in the lack of extension of the brain and skull behind the base. Additional studies will be needed before scientists can estimate its age or ascertain whether this represents a great-great-grandparent of man or only a great-great-uncle.—Ed.

In 1924, there was discovered at Taungs in the Western Transvaal, South Africa, a remarkable skull, which was described by Professor R. A. Dart under the rather long name, *Australopithecus africanus.* The skull was that of a young apelike being with the milk teeth in nearly perfect condition and with the first permanent molar teeth just coming into use. In general appearance the skull was not unlike that of a chimpanzee, but Professor Dart considered that its affinities were rather with man and that it probably represented a form somewhat intermediate between one of the higher apes and man.

Most English scientists considered that Professor Dart had made a mistake, and that the little being was really, if not a chimpanzee, a near ally of the higher apes. I was one of the few who supported him. Gradually, however, a few eminent anatomists—especially Elliot Smith and Sollas—came to regard Dart's view as probably correct. But the world remained unconvinced.

In 1936, I resolved to try to get an adult skull; and after a few weeks' hunting I was successful in finding at Sterkfontein near Krugersdorp in the Transvaal, an adult skull of an animal allied to the Taungs child. This skull I named *Plesianthropus transvaalensis.* It is clearly allied to the Taungs child but is of a much later date geologically. Unfortunately, the skull, though nearly complete, had been considerably broken and the upper jaws badly displaced. However, the premolar and molar teeth are practically perfect, and these are almost exactly similar in structure to those of men but distinctly larger. They are certainly not chimpanzee or gorilla teeth. During 1936, '37, and '38 numerous other teeth and some bones of the skeleton were found, all of which confirmed the view that the animal was nearly human.

In 1937, I was invited to Philadelphia to a Congress on Early Man, and I lectured there, as well as in most of the large cities from Boston to Los Angeles, on our South African ape-man and on the origin of man.

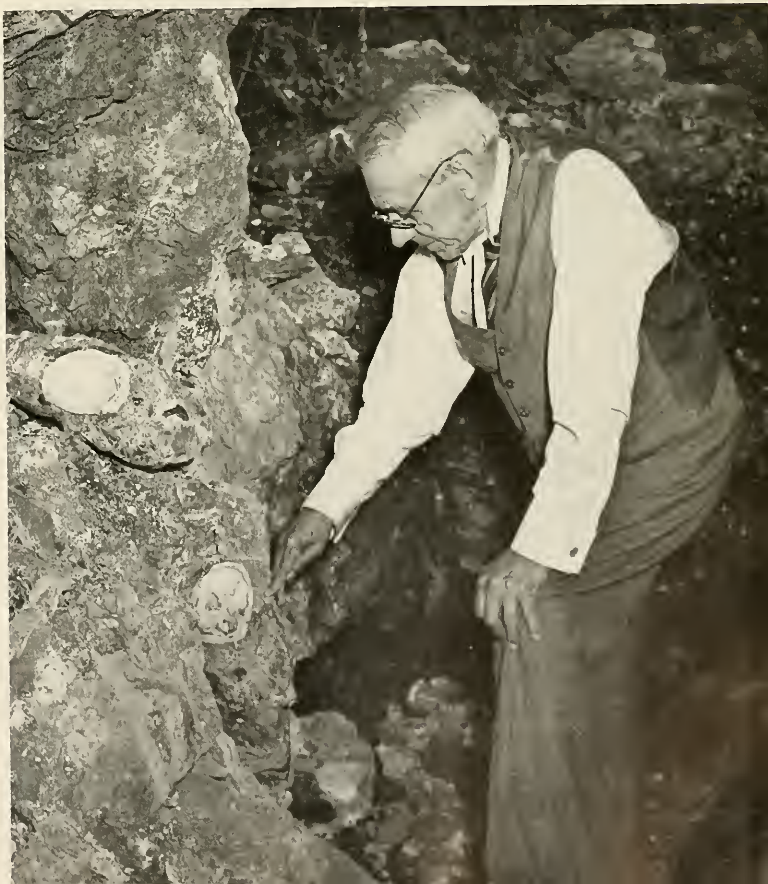
In 1938, I found the even better preserved but less complete

Herbert Lang photo

◀ A VIEW of the Sterkfontein quarry taken the day after the discovery of the first Sterkfontein skull in August of 1936. Dr. Broom's left hand shows where the first skull was found. The recent skull was found about a foot below his feet

▼ DR. BROOM is pointing to the base of the new skull still in position in the rock. The part of the rock containing the top of the skull has been detached and placed on the ledge above

J. Higgins photo



Kromdraai skull. This represented another slightly different type of ape-man skull.

In 1946, a book was published on *The South African Fossil Ape-Man,** describing all the known fossil remains. This book has shown to the world the importance of our deposits and convinced, I believe, most of the world's anatomists that we have had in South Africa a family of ape-men who were nearly human, from some member of which man may have arisen either in Africa or Southern Asia.

At the beginning of April this year, I again started work at Sterkfontein and almost immediately discovered remains of some more specimens of the ape-man. Then, on the eighteenth of April, I blasted a mass of bone breccia and in the middle of the rock found a nearly perfect adult skull of the Sterkfontein ape-man. The skull was broken across the brain cavity, and the inner surface of the bones was lined with a layer of lime crystals.

As the bones were very friable and the matrix rather hard and mixed with broken chips of chert,

* Transvaal Museum, No. 2, Pretoria, South Africa.

J. Higgins photo

▲ DR. BROOM and his assistant, J. T. Robinson, examine the two portions of the skull which have just been removed. Mr. Robinson is still wondering at the miracle of blasting a piece of solid rock and finding a missing link skull in the middle of it

it will take a good many weeks to have the whole skull cleared. At present, we have cleaned the face and much of both sides of the skull, and we can say a good deal about it. So it seems better to give some description now than to wait a few months until we can give a full account.

The brain must have been small. I estimate it to have been about 450 cubic centimeters, but soon we shall be able to give it accurately to a cubic centimeter. In structure it seems much more human than apelike. The forward half is amazingly human, but the back region is less so. The convolutions of the brain have left less distinct markings on the bone than are seen in the first Sterkfontein skull; the brain is also longer and narrower.

A brain of 450 cubic centimeters is, of course, much below the human range, which in most men is from 1200 cc. to 1500. But some lower races have brains varying from 1000 to 1200 cc. In the primitive Java Pithecanthropus, which is now generally believed to be an early human type, the brain size varies from 750 to 1050 cc. Now we know that this newly found skull is that of a woman, and if a woman had a brain of 450 cc., a male may have had one of 650 or 700 cc.—not so far below the brain size of Pithecanthropus.

And how do we know the skull belonged to a female? Well, though all the teeth are lost, the sockets of a number have been quite well preserved, and as we know the size of the canine or eyetooth in both males and females, we can say quite confidently that the skull is that of a female. The sutures on the top of the skull are closed and nearly obliterated. So we can say that the skull was that of an elderly or at least a middle-aged female.

Within a month or so it will be possible to give every detail of the anatomy of the skull. Meanwhile, the public may be interested

➤ THE FACE, nearly cleaned, but with the rock still attached to the right side and base of the skull. The pieces of the face are only temporarily put together and there are a number of small pieces still attached to the rock, but when these are added the appearance will not be appreciably altered

J. Higgins photo

J. J. Wesselo photo. Copyright.

THOUGH the Sterkfontein brain cavity is only a little larger than the chimpanzee (right), Dr. Broom considers it much closer to the human (left). In the front portion (above here), the temporal lobe is sharply separated from the frontal lobe by a ridge in both the Sterkfontein skull and the human, but only slightly so in the chimpanzee. Much of the back of the brain cavity is still filled with lime deposit. The bone is seen to be thick at the back part

to know that, while the skull is not quite human, it is nearly human and not very like that of an anthropoid ape.

The eyes are rather large and the eyebrows prominent and markedly overhanging the face. The nose is flat, and the front of the face distinctly prognathous, though not nearly so much so as in the chimpanzee. We have the sockets of the incisor and canine teeth and can definitely say that the front teeth have not been larger than in man, and quite unlike those in the chimpanzee and gorilla.

Ewing Galloway

MYSTERY OF *Singing Sands*

One of the strangest tales of the desert happens to be true—sands that roar so loud one has to shout to be heard! A yet unsolved riddle of Nature

By E. R. YARHAM

THE two explorers, Mr. Bertram Thomas and Mr. H. St. John Philby, the only white men ever to have crossed the Great Desert of the so-called "Empty Quarter" of Arabia, both describe how they were startled by the phenomenon known as "singing sands," the exact causes of which have long been debated by scientists.

Mr. Thomas and his party were in the heart of the vast desert, floundering along through heavy sand dunes, when the intense silence was suddenly broken by a loud droning of a musical note. One of his Badu companions pointed to a steep sand cliff about 100 feet high and shouted, "Listen to that ridge of sand bellowing!"

All the explorer could see was a filmy wisp of sand being carried up the gentle windward slope to spill like smoke over its top. On another occasion, Mr. Thomas was similarly startled by a curious note emitted from the sand as his camel trod on it, but the tribesman at his side, a Murri who was quite familiar with the phenomenon, could only give as an explanation some dark activity in the uppermost of the seven underworlds. The Arabs, as a matter of fact, attributed the sounds to the spirits of the sand dunes talking.

In Mr. Thomas' case, the note continued for about two minutes, ceasing as abruptly as it had begun. When Mr. St. John Philby experienced a similiar thing a few months later, it was set up artificially, although accidentally. He, too, was in the heart of the Empty Quarter, and he heard the noise in the afternoon, at about the same time as Mr. Thomas had heard it. The explorer was resting in his tent when his attention was arrested by a deep, musical, booming sound. Looking out, he discovered that it had been set up by one of the party walking up the steep sand slope of the dune encircling the camp.

The traveler's own description of what he heard and saw is worth quoting: "Quite suddenly the great amphitheatre began to boom and drone with a sound not unlike that of a siren or perhaps an aeroplane engine—quite a musical, pleasing, rhythmic sound of astonishing depth. . . . The conditions were ideal for the study of the sand concert, and the first item was sufficiently prolonged—it lasted perhaps about four minutes—for me to recover from my surprise and take in every detail. The men working at the well started a rival and less musical concert of ribaldry directed at the Jinns [desert spirits] who were supposed to be responsible for the occurrence. . . . I realized that the key to the situation was Sa'dan, seated on the top of the slope. It was evident that the music was being engendered by the sand sliding down the steep slope from under him."

Mr. Philby followed Sa'dan's example and found that he, too, was able to produce the same sound by setting masses of sand in motion down the side. The noise commenced with a grating sound and was gradually increased into a musical booming, which just as gradually decreased until it died away. He experimented by pushing a bottle into the singing sand,

and as he withdrew it there followed a wail like that of a trombone. At another time he plunged into the moving mass of sand halfway down the slope, and it appeared to throb beneath him like a great organ.

These singing sands of southern Arabia have only become known to science this century, but it has been truly said that there is nothing new under the sun. The phenomenon was known to the Chinese at least a thousand years ago. One of their writers left an account of an area in the province of Kansu where it had been noted in the ninth century. The document speaks of the "Hill of Sounding Sand," which was 500 feet high in places. According to the author it possessed strange, supernatural qualities: "Its peaks taper up to a point, and between them there is a mysterious hole which the sand has not been able to cover up." The writer said that in the height of summer this hill of sand gave out sounds of itself, but if trodden by men or horses, the notes could be heard for long distances. The manuscript also spoke of a queer custom which was followed at the time to induce the singing. The account runs, "It is customary on the tuanwu day (the Dragon Festival on the fifth of the fifth moon) for men and women from the city to clamber up to some of the highest points and rush down again in a body, which causes the sand to give forth a rumbling noise like thunder. Yet when you come to look at it the next morning the hill is found to be just as steep as before. The ancients called this the Hill of Sounding Sand; they deified the sand and worshipped it there."

The Misses French and Cable, well-known missionaries in inland China, have also recorded their observations of the phenomenon in Chinese Turkestan. The City of Sands (Tunhwang) takes its name from the ranges of sand dunes that lie to the south, stretching out into the great desert of Lob. These sand hills possess the property of "singing" when the sand is moved. Before the desert gale blows, a sound like the rattle of drums is heard, but at any time the hills can be induced to voice their curious song by those who will pay the price of climbing their steep slopes. Visitors do this and then slide down the sharp incline from the knife-like edge of the highest point for the sheer fun of hearing the great vibration, which seems to spring from the very center of the mighty hill of loose sand.

Tschiffely, the "Iron Swiss," hero of the famous horseback ride from Buenos Aires to Washington, records a strange experience he had on the Peruvian coast, and one wonders whether this, too, was allied with the phenomenon of singing sands. He fell asleep one night on a sand hill but was awakened several times by a strange noise like the beating of drums or like a motor launch traveling on a river. As he could see nothing, he went to sleep again and only awoke when the sun was hot. Then he noticed that he had been sleeping near a "gentilar," as the ancient Indian burial grounds are called.

The next day the natives asked him if he had heard the *manchang*. As this sounded rather like Chinese to Tschiffely, he asked them what it meant. They explained that the sand hill where he had slept was haunted and that every night the dead Indians of the "gentilar" danced to the beating of drums. In fact, they told him so many blood-curdling stories about the hill that he began to consider himself lucky to be alive.

When later he spoke with an educated gentleman, the latter told him that both Baron von Humboldt and Raimondi, who had once investigated the strange phenomenon of that hill, had expressed the opinion that the peculiar sounds so frequently heard during the night were due to underground waters that moved as the temperature changed. Another theory put forward is that sea breezes blowing from a certain direction hit the sandy ripples on the slopes of the hill to produce this strange sound.

It is to the deserts that one must turn to hear the finest exhibitions produced by singing sands, because the immeasurable quantities of sand which characterize them offer ample opportunities for the production of the sounds. But it should be noted that a similar phenomenon has been reported from beach sands. The little island of Eigg, in the Scottish Hebrides, for instance, is a spot unique along Scotland's western shores, for in the Bay of Laig are found sands that sing. The honor of the first discovery of similar sands in England appears to go to Mr. C. Carus-Wilson, who found them about 60 years ago at Studland Bay, on the coast of Dorset. They have also been recorded on the coast of North Wales; and in the United States two observers have reported them at 74 places on the Atlantic coast alone.

But the singing of beach sands is quite different from that of desert dunes. The beach sands are best described as "whistling" or "squeaking," according to R. A. Bagnold, who ably summarizes existing knowledge in the final chapter of his book, *The Physics of Blown Sand and Desert Dunes*. The squeak or whistle is produced, he explains, by any rapid disturbance of the dry top layer, particularly just above the high water level when the sand has recently dried out after a shower. It is produced when the palm of the hand is swept across it quickly or when the sand is given a light stab with the end of a pencil. When the sand is removed from the beach, it does not long retain its sound-producing quality. Grains of singing beach sand examined were rounded, but not markedly so, and were fairly uniform in size.

In contrast with the whistling of the beach sands, "the great sound which in some places startles the silence of the desert" is quite a different noise, according to R. A. Bagnold. "I have heard it," he says, "in southwestern Egypt 300 miles from the nearest habitation. On two occasions it happened on a still night, suddenly—a vibrant booming so loud that I had to shout to be heard by my companion. Soon other sources, set going by the disturbance, joined their music to the first, with so close a note that a slow beat was clearly recognized. This weird chorus went on for more

Continued on page 333

Brains and the Beast II

Open the Door, Richard!

What does it mean when an animal operates a mechanical device—reasoning, imitation, or trial-and-error? Animal psychologists following the "watch while they learn" method have found new answers to old questions

By Frank A. Beach

Professor of Psychology, Yale University

It is a cold, frosty morning in the year that much later will be known as 8047 B. C. The Horse Tamer stumbles out the doorway of his crude Neolithic hut, rubbing sleep from his eyes. He decides to take a look at the wild colt caught yesterday during the hunt. If it hasn't lamed or killed itself in the night, perhaps he can begin gentling it instead of using it for food.

What's this? The rude corral is empty! No breach appears in the walls of piled stone, but the gate of woven branches is ajar and hoofprints in the half-frozen mud show that the prisoner escaped without assistance. This is a mysterious matter. It must be taken up with the tribe's Man of Magic as soon as possible!

Another morning, this time in the Year of Our Lord 1047. Papa Flaubert is bringing a breakfast of scraps to Bruno, the dancing bear, whose antics are a source of delight to peasants and nobles alike and, therefore, a source of welcome income for Papa. But this morning Bruno is gone! The cage door swings idly on its hinges. It isn't broken. The catch has been unfastened but not by human hands, for only Papa would dare approach Bruno's cage in the dark, and he's certain the lock was secure when he put the bear away last night.

Staring incredulously at the open door, Papa begins to understand. Suddenly he crosses himself nervously and hurries to tell Mama and all the little Flauberts. He was right all the time! Bruno *was* too smart to be an ordinary bear. Just to think of it! For two years he, Papa Flaubert, has been leading a *demon* about the countryside with a ring through its nose. Mama isn't so sure. For some time she has suspected that there was a witch at large in the village. Strange things have been happening everywhere. In any event the priest must hear of this, and quickly.

Silly people, you say? Well, I don't know. Watch your daily paper during these enlightened days of 1947. Animals still open doors. What does modern man with his compulsory education and awareness of science make of such behavior?

Every now and then Old Dobbin lifts the bar that opens the pasture gate, or Faithful Fido undoes the hook on the henhouse door, and when this happens some folk scarcely can contain their amazement. Newspaper columnists and magazine writers who know good "copy" when they see it tell and retell the story, and you can trust me, it loses nothing in the telling. The tribal magician is gone and demons are out of style, but thousands of readers from coast to coast will nod their heads sagely and gaze with new respect at the milkman's horse or the neighbor's pup.

For some obscure reason, the act of opening a door has come to be regarded as a sign of great intelligence. This holds, of course, only when the act is performed by a lower animal. When our associates open doors, we rarely feel called upon to compliment them on their sagacity. When little children first learn to open doors, only the fond parents interpret it as evidence of genius. But just let a cat or a dog open a door, and public estimates of animal intelligence are due for a meteoric rise!

A Coachman's Cat and a Scullery Door

A famous English naturalist stood gazing into the courtyard one day, idly watching his coachman's cat as she picked her way across the cobblestones toward the scullery door. The behavior that followed impressed the naturalist so deeply that he later composed and published a full account of the incident just to prove how intelligent a cat can be. His description was as follows:

> Walking up to the door with the most matter-of-course kind of air, she sprang at the half-hoop handle just below the thumb-latch. Holding to this half-hoop with one forepaw, she then raised the other to the thumb-piece, and while depressing the latter finally with her hind legs scratched and pushed the door-posts so as to open the door.

Now this type of behavior actually is somewhat less rare than

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▲A REWARD for work well done. The cat has pushed down the lever to the latch of the door, thus opening the way to the food

might be supposed. (As a matter of fact, just after I ran across the account quoted here, I received a letter from Miss H. Ida Curry of Washington, D. C., describing almost the same behavior on the part of her pet cat.) The question is not whether animals occasionally do learn to open doors but whether such behavior is to be regarded as evidence of a quasi-human intelligence at work.

The writer whose description is quoted above had no doubt that his coachman's cat relied heavily upon reasoning power. He pointed out that people rarely open doors by hanging from the handle and kicking against the jamb, and, therefore, any animal that adopts this method cannot simply be imitating what it has seen men do. On the contrary, it was his sincere conviction that the cat must employ "rational imitation," which can best be described by another short quotation.

> . . . we can only conclude that cats in such cases have a very definite idea as to the mechanical properties of a door; they know that to make it open, even when unlatched, it requires to be *pushed*—

Nina Leen-Pix photo

◂ KITTY could scarcely be expected to turn on the faucet by herself, but cats have learned to operate equally difficult devices without being taught by human beings

a very different thing from trying to imitate any particular action which they see to be performed for the same purpose by man. . . . First the animal must have observed that the door is opened by the hand grasping the handle and moving the latch. Next she must have reasoned . . . "If a hand can do it, why not a paw?" Then strongly moved by this idea she makes the first trial.

To say that "we can only conclude" anything of the sort is sheer nonsense! We cannot, of course, ask the cat what she is thinking about as she opens the door, but there are other ways of discovering whether she really solves the problem in the logical fashion implied by this purely hypothetical sort of explanation. The first task obviously is simply to watch the animal *while she is learning* as well as after the habit has been perfected. This elementary approach to the question of animal intelligence was begun in England during the closing years of the last century, but it was given its greatest impetus by workers in this country.

Observing Learning in Progress

The first American exponent of the "Watch While They Learn" movement was a 22-year-old psychologist named Edward Lee Thorndike. Armed with a brand new M.A. degree from Harvard University, this impetuous young man brashly challenged the conclusions of his more mature contemporaries on both sides of the Atlantic. He accused them of composing animal eulogies instead of writing about animal psychology, of concentrating on animal intelligence and overlooking animal stupidity, of pretending to be impartial judges and acting like counselors for the defense.

Insisting that experimentation could solve many problems over which the "arm chair psychologists" were speculating and theorizing, Thorndike got himself a hammer, a saw, and a handful of nails and built crude cages of wooden slats and chicken-wire. In each cage he installed a door fastened by a sliding bolt, a turn button, a thumb-latch, or some other equally simple device. Springs pulled the doors open when the fastenings were released.

When it came to selecting his experimental "subjects," the psychologist made some observations on chicks and dogs, but the most interesting pupils were eight cats. Before feeding time, while they were quite hungry, the cats were put into the "problem-boxes," and a bit of fish was laid on the floor just outside. In test after test Thorndike patiently made detailed notes of everything his animals did. He kept account of the length of time the cats spent in unlocking the door. It soon became clear that after a great deal of practice all of the animals were capable of opening doors. They could do so by turning a horizontal bar, sliding

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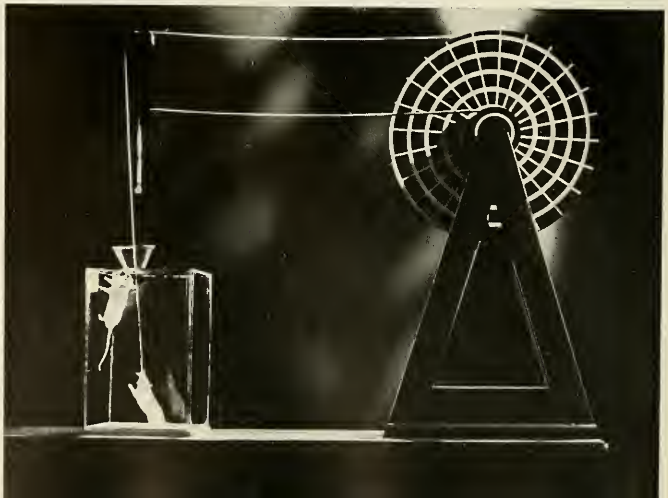

➤ EVEN RATS can learn to operate simple mechanical contrivances. After much random exploration in the glass cage, the white rats happened to pull down on the suspended string and thus "earned" their reward of food. In subsequent tests they learned to perform the task with a minimum of time and effort back a bolt, depressing a lever, pulling down on a loop of string, or going through any one of a number of similar acts.

These results were interesting, but the "sixty-four dollar" question was, "Do animals solve the locked-door problem by reasoning?" Thorndike thought not.

Accidental Success

The story of how cats learned to open the door by pushing down the horizontal bar that held it shut will serve as a perfect example of the experimental results, for the method of solution was similar in all cases, regardless of the type of fastening involved.

The first time cats were put in the problem-box they scratched, chewed, and pushed indiscriminately at each and every part of the apparatus. As a purely accidental result of this vigorous, random activity, the animal sooner or later happened to push the bar down, and the door flew open. Then the cat emerged and received its bit of fish as a reward. That the initial solution should be a matter of pure chance did not surprise the scientist, for this was, after all, a rather artificial problem as far as the cat was concerned and presented features which few cats would encounter in the course of their every-day lives.

However, Thorndike believed that if cats were capable of reasoning, they should behave differently after the solution of the problem had once been discovered. On the second test they might be expected to operate the lock in a fraction of time they had taken before. His results revealed that nothing of the sort happened. When a cat was returned to the problem-box immediately after opening it for the first time, the behavior was unchanged. Again the animal went through all of the "escape movements" in its repertoire, and again the working of the lock was clearly a by-product of this random activity. The number of seconds elapsing before the door was opened showed no striking decrease in the second test, nor in the third, nor in the fourth. In fact, never in the long series of trials did a single cat give the slightest sign of suddenly gaining an insight into the nature of the solution.

Automatic Elimination of Mistakes

To be sure, the time scores did become progressively shorter until eventually the animals could open the door in a few seconds, but this improvement came about slowly as a result of the gradual elimination of superfluous activity. The psychologist believed that unsuccessful acts (such as biting at the walls or scratching the floor) grew weaker and finally disappeared because they failed to bring any "satisfaction." Put briefly, his interpretation of learning shown by animals in problem-boxes was one of accidental success followed by the gradual and totally automatic elimination of ineffective movements. By a process of subtraction, after all of the unsuccessful acts had died out, only the successful one remained. But Thorndike denied that the improvement involved "thinking" on the animal's part, and he doubted that any cat was ever aware of the connection between its own behavior and the opening of the door.

The pioneer experimentalist was sure that his interpretation could be applied to many types of behavior that previously had been regarded as dependent upon reasoning power. For instance, three of his cats learned to open the problem-box door by operating a thumb-latch, and he pointed out that when pet animals open doors by manipulating such devices, they probably have learned to do so by methods seen in his experiments rather than by observing humans and applying "rational imitation."

Experimentalists are not immune to personal prejudices and preconceived notions, and Thorndike's startling negative conclusions raised many questions in the minds of fellow scientists who were loath to believe that animal learning consists exclusively of the unconscious, automatic formation of associations. These Doubting Thomases promptly decided to start conducting their own experiments.

"The Great Problem-Box Epidemic" swept the academic world. No furred or feathered creature was spared. Everyone was cramming one sort of animal or another into a cage and waiting impatiently while the bewildered beast puzzled his way out. (Apparently no one stopped to realize that every test to measure the intelligence of an animal serves also to indicate the intelligence of its human designer —but we'll save our criticisms till later.)

Birds in a Box

One psychologist concentrated on studying birds. He lured wild species into a large, outdoor flying cage and kept them there until they had become reasonably tame. Every day at feeding time meals were served on the ground inside a small problem-box with the door tied open. After the birds had become accustomed to entering the box to eat, the door was closed and locked. To open the door and get to the food the birds had to pull down a taut string, lift a latch, or perform some other simple action. Sparrows, pigeons, red-headed woodpeckers, cowbirds, juncos, bluebirds, crows and Baltimore orioles all learned to open the door. But in every instance the method of learning was exactly as Thorndike had described. Accidental success was followed by the gradual elimination of ineffective responses. No signs of "insight" or sudden comprehension of the problem appeared. In fact, instead of learning to pull a string or lift a latch, it looked as though the birds learned to light on the cage in a particular way or to peck at it in a particular spot, with the result that the door was released and swung open.

Other experimenters turned their attention to rodents, wild and tame. Rats, squirrels, and porcupines suddenly discovered that to get to their food, which previously had been readily available, they were expected to dig through sawdust, tear away paper seals, push down on levers, jerk at chains, step on foot pedals, turn buttons, or pull out wooden pegs. The animals passed the tests, but it took a lot of time, and even the quickest learners solved the problems "the hard way." In every case it was a matter of chance success and elimination of one useless response after another.

Old "Nimble-Fingers"

Among the most entertaining animal students selected for training were the raccoons. Opening doors secured by one or two simple locks was mere child's play for these nimble-fingered creatures, and they often re-entered the box voluntarily with no more reward than the opportunity to manipulate the levers and buttons a second time. When the problem was made more difficult by installing additional fastenings, this light-hearted attitude disappeared, but for a reward, food-hungry 'coons continued to solve one new lock after another until finally they were opening a door that required operating no less than seven different devices. In addition to depressing pedals and pulling down on loops of string, the animals had to lift a latch, slide back a bolt, undo a hook, and press down on a thumb-latch. And a raccoon that had mastered this series of operations could start from scratch and be out of the box in less than eight seconds!

Of course, the animals did not solve all of the locks at one time, nor were the locks operated in any set order after they had been learned. Each fastening was thoroughly mastered before the next was installed; and the learning of each new lock progressed by the familiar pattern of chance success and gradual elimination of errors.

Dogs have never made a particularly good showing in the problem-box. Certainly they cannot compare with the raccoon in these tests. Several dogs learned to open a food box by pushing down on a lever projecting from one side. After the solution had been perfected, the box was rotated through 90 degrees, one-quarter turn; this change was completely baffling to the dogs. They ran to the box and made motions with their paws *at the position where the lever had been.* The lever was in plain sight a few inches away, but this strange behavior persisted for several trials, and only gradually did the animals learn to operate it in its new position. A second quarter-turn produced another dilemma, and relearning was again necessary.

Pedagogy for Primates

As evidence against reasoning in lower animals continued to pile up, experimentalists turned confidently to the monkey, with the not unreasonable expectation that man's primate relatives surely would display insight in solving problem-boxes. In one experiment, two *Macacus rhesus* monkeys were taught to secure a banana by reaching into a little box on the floor of the experimental room. Then the door to the box was locked, and the animals had to master the operation of the locks in order to get the reward.

Before they learned this, however, the experimentalist was in for some unexpected instruction at the hands of his "subjects." He learned that a frustrated monkey can do a lot of damage to experimental apparatus. If he wanted to use his problem-box more than once, the animals would have to be prevented from tossing it out of the window when their first attempts to open the door were unsuccessful. After the box had been bolted to the floor, the experiment progressed fairly smoothly.

Many different kinds of locks were used, and they varied in difficulty as far as the monkeys were concerned. Simple turn-buttons, sliding bolts, and "bear-down" levers were so easy that they were sometimes solved within a few seconds. Other locks such as a vertical hook or a T-latch proved difficult at first but once learned could be operated very quickly. Some fastenings were hard to learn and were never handled very efficiently even in later trials. Shifting a previously-learned lock to a new position caused a little difficulty at first but not for long.

Monkeys were highly superior to birds and lower mammals in speed of learning, but their method of solving the problems was much the same, and the psychologists looked in vain for evidence of reasoning ability. However, they were interested to discover that after a monkey had learned to operate a number of different locks, he became what might be called "lock conscious," so that when a new fastening was added, he spotted it and started directly to work with no waste motion.

Furthermore, primates passed tests that dogs or cats or even raccoons almost certainly would have failed miserably. The box was arranged so that the door could only be opened by unfastening a series of locks in a definite order. The second one could not be undone until the first was free, the third had to be operated before the fourth, and so on. Under these circumstances, the monkeys were able to operate five locks in a predetermined sequence. It is true that raccoons successfully handled seven separate locks but not in any particular order, and this performance on the part of the monkeys called for much more ability.

"Monk" versus Man

As a matter of fact, the serial-lock problem is pretty difficult, and on the first trial human subjects took as long as monkeys to solve it. On the second trial grown-ups opened the door quite rapidly, but monkeys and human children still needed about the same length of time as in the first test. After approximately ten trials, however, people of all ages had completely solved the problem, whereas the monkeys were just beginning to improve.

For people, of course, the box had to be constructed in such a fashion that the problem could not be solved merely by looking at it. The separate devices had to be actually tried out. Men and women made haste slowly, systematically trying the various fastenings, rarely repeating an unsuccessful pattern, and quite evidently remembering what they had done previously. At first both the children and the monkeys flew at the problem and

➤ WHEN the day's lesson is over, the subject and the experimentalist remain on friendly terms

Nina Leen-Pix photo

repeated the same mistakes again and again. After relatively few trials the children abandoned this hit-or-miss method and worked more methodically, but the performance of the monkeys improved very slowly.

Did the Animals Have a Chance?

The description of the behavior of men and women when they first tackled the serial-lock problem-box tells us a good deal about what the animals were up against in problem-box tests. I don't think that they had much of a chance to use reasoning ability even if they had it. Let's stop reviewing the "evidence" and try to see what it means.

Adult humans were as slow as monkeys on the first trial. Why? Haven't we the capacity for reasoning or insight? Well yes, although probably to a lesser degree than we like to believe; but the point is that the problem-box offers little or no opportunity for the use of such capacities. Like the mechanical puzzles made of interlocking rings, it is deliberately devised so that the first success almost has to be a matter of chance; and the rapidity with which useless acts are eliminated in following trials is apt to depend more on simple memory than upon anything else.

Of course, single-lock problems would present no difficulty for humans, but from infancy we have constantly been *forced to learn* about such things. As children, we receive almost limitless practice in opening gates and doors and thus become thoroughly familiar with all sorts of fastenings. The everyday life of most animals involves very little opportunity or necessity for learning these things by experience. Therefore, the problem of the door locked with a thumb-latch or even a simple bar presents an entirely novel situation as far as a dog is concerned. Apes that are raised as members of human families develop a high degree of skill in manipulating locks and latches, and there's no doubt in my mind but that one of these animals would make an excellent score in problem-box tests.

It is obvious that in all of the problem-box experiments, the animals have had the cards stacked against them. The fact that cats and dogs and raccoons and monkeys fail to demonstrate insight in these experiments is no justification for concluding that they could not do so in other situations—situations not depending upon familiarity with mechanical devices but ones better fitted to the natural capacities of the species.

The "Problem-Boxes" of Every-Day Life

The psychologists were not giving the animals an even break in the problem-box tests, but this doesn't mean that the work that went into all of those experiments was wasted. On the contrary, the method is an excellent one for studying the way in which many skilled acts are acquired—not only by animals but by humans as well.

If you think Thorndike was talking nonsense when he said that his cats learned how to open the door without ever having any idea of how they did it, just consider the way in which you have learned many of the acts that you perform a dozen times a day. Did you learn to drive a car by "insight"? How much "reasoning" went into your mastery of bicycle riding? As far as that goes, do you *know* how you learned to ride your first bike? Or to swim? Or to play tennis?

As I write my fingers are getting a little stiff. Putting down my pen, I stare out of the window, and there on the sidewalk an energetic eight-year-old is taking one tumble after another as he tries out his new roller skates. Next month he'll be swooping around corners and jumping the curb, but I'm prepared to wager that he won't know how he learned to do it!

A great many very common types of behavior consist of complicated patterns of muscular coordination. They can never be learned in any way but the trial-and-error way, and they can be and frequently *are* learned without the learner ever becoming aware of how he is achieving his success. Human life has its "problem-boxes," and, to a large degree, we master them the same way a cat masters the thumb-latch on the scullery door.

★ America Is How You Want It ★

Every patriotic American loves his country's rocks and rills, its woods and templed hills. He also cherishes the freedom under which he enjoys them. But every freedom carries its responsibility. This quiz will test your knowledge of the democratic procedures through which you, as a citizen, should participate in the protection of the resources with which nature has endowed our land.

In this way, NATURAL HISTORY Magazine accents the theme of Conservation at the time when the American Heritage Foundation's "Freedom Train" starts its journey. Beginning September 17, the Freedom Train will travel 33,000 miles in the United States carrying the most significant documents of American history and emphasizing the rights and privileges guaranteed to every American citizen by our system of government.

Q. What branch of our government administers the Federal Wildlife Refuges?

A. *The Fish and Wildlife Service*

Q. What branch administers the National Parks?

A. *The National Park Service*

Q. What branch administers the National Forests?

A. *The U. S. Forest Service*

Q. What is the difference between a National Park and a National Forest?

A. *The purpose of a National Park is to conserve the native scenery, the wildlife, and the historic objects within its borders and to enable the public to enjoy and understand them. The national policy allows no logging in National Parks, no mining, no grazing except for former permittees, and no open season for killing wildlife.*

The purpose of a National Forest is centered largely in the utilization of its resources. The timber is sold to private concerns, which do the actual cutting. Cattle and sheep graze in some of the National Forests under permit, and mining and other commercial activities are permitted.

Q. Are National Parks protected by Constitutional provision?

A. *No. Congress made them and can unmake them. Legislation regarding these public lands is intended to express the public will, and if the public takes an interest in them, it can.*

Q. Concerning which National Park, whose area is currently threatened with reduction, were the following comments made:

By the Secretary of the Interior in 1938:

"Can we preserve too much of this kind of beauty in America?"

By the Director of the National Park Service in 1945:

"It has been gratifying recently to realize how many there are who stand ready to spring to the defense of the parks, when such a threat arises as that directed at reduction of . . . National Park."

By the Director of the National Park Service in March, 1947:

". . . The boundary changes [proposed by the Park Service], if adopted, will eliminate from the park 56,000 acres containing 2½ billion board feet of merchantable stumpage which will then be available for use by local industry. The Secretary of the Interior has approved the proposal."

From a letter to the New York Herald Tribune *(June 8, 1947):*

". . . is a doubtful State as far as the next election is concerned, and the . . . National Park, the property of the whole nation, established by Congress to be permanently preserved for the enjoyment, uplift, and inspiration of the public of today and of the future, is to be sacrificed as an expendable political resource."

Q. What Park is this?

A. *Olympic National Park, in the state of Washington.*

Q. If formerly cultivated land now destroyed by misuse could be restored, how much could every family in the United States receive?

A. *About 3 acres each, or a total area equal to California.*

Q. What division of the federal government is concerned chiefly with preservation of the nation's agricultural soil?

A. *The U. S. Soil Conservation Service, under the Department of Agriculture.*

Q. Abuse of the land in our Plains area so seriously deprived it of its soil-holding plants that one storm on May 12, 1934, carried away large quantities of fertile topsoil. If the U. S. Soil Conservation Service were to replace this one day's loss at one dollar a ton, how soon could it do so on its current operating budget?

A. *In six years. An ounce of prevention is worth a pound of cure.*

Q. Much of the soil carried away by the Mississippi River each year could be saved by proper soil control measures. How many tons of soil are carried away annually by this river?

A. *About 730 million tons—an amount that would require every man, woman, and child in the United States to carry 11,000 pounds back to its place of origin each year.*

Q. One of the principal sources of water pollution is from soil washed out of fields and pastures as a result of poor conservation practices. How many people in the United States have to use filtered water partly as result of this?

A. *30 million people and more than half of our industries. The silt removed would be a valuable asset on the fields where it belongs. In public water supplies it is a costly penalty for land misuse.*

Q. How many organizations in the United States are concerned with the protection of wildlife?

A. *306 federal, state, and private conservation organizations are listed in Circular 9 of the U. S. Fish and Wildlife Service (10¢ at U. S. Government Printing Office, Washington, D. C.) If you do not know the name of the local group that represents the conservation policies you believe in, find it out.*

MYSTERY OF SINGING SANDS

Continued from page 325

than five minutes continuously. . . . Native tales have woven it into fantasy; sometimes it is the song of sirens who lure travelers to a waterless doom; sometimes it is said to come upwards from bells still tolling underground in a sand engulfed monastary. . . ."

The sounds produced by desert dunes certainly vary, for travelers have compared them to a ship's siren, a throbbing organ, the beat of drums, a trombone, and the twanging of a monster harp. In some instances, it seems that the softer tones are missing; others say that standing on the sand when it is singing is like resting on a huge stringed instrument while a bow is being drawn slowly across it. The note emitted by the desert sand is much lower than that of the beach sand and at a distance of 600 yards has been likened to the rumble of thunder.

Writing from Egypt a year or two ago, Lieutenant Colonel de Lancey Forth spoke of the following experience in the great sand dune country to the south of Siwa, Egypt: "I found, after a strong westerly wind had blown throughout the day and had banked the fine drift sand high up on the knife edged tops of the dunes, that sometimes in the evening, when the wind had died away, leaving a deep stillness in the air, this fine drift sand slid down in streaks over the coarse big-grained red sand which forms the steep slopes of the solid part of the dunes, and the friction of the one rolling over the other gave out a noise like distant rumbling thunder with a deep musical note as that of a 'cello in it."

It is interesting that when Mr. St. John Philby was listening to the singing in the afternoon, one of his men referring to the desert spirits, said, "You wait, just wait till the evening and you will hear them letting off their big guns."

Mr. Bertram Thomas, too, noticed the noise late in the afternoon, when the heat of the day was fading. Apparently, another factor also favors the close of day. During the day the wind blows the fine drift sand to the tops of the dunes, and toward sunset, when the wind usually dies down, it begins to roll down the slopes. Dryness seems an essential factor, for the ancient Chinese manuscript states that the Hill of Sounding Sand gave out notes only at the height of summer; and Mr. Philby likewise testifies that early in the morning, when the air was cool and the sand somewhat moist, he failed to elicit any response from it. And a few weeks later when there had been a little rain, there was no music in the sands.

Examination of the sand has not revealed any peculiarity linking the whistling sands of the beach with the booming sands of the desert. Samples from the dunes do not reveal any distinguishing features. The grains are no more uniform in size than those of many silent sands; and though clean sand sometimes seems to sing best, R. A. Bagnold heard it in a desert region where the sand was dirtier than usual and was wetted appreciably only once or twice in a decade.

A. D. Lewis found that when singing sand was taken from the Kalahari Desert to Pretoria, it lost its "voice" unless kept in airtight containers. But the quality could be restored by heating it to about 390° F.

Scientists generally agree that the sounds are caused by the rubbing of grains against each other, but as yet there is no real explanation of the mechanism by which they are produced. When further critical studies are made, the answers may be forthcoming. Meanwhile, when you are in the desert, keep an ear open for one of the strangest concerts ever to come from nature's versatile music box.

UNTOLD EYES ARE ON YOU

Continued from page 319

eration passes without a glimpse of light. Yet blind salamanders found in these underground passages begin their lives with useful eyes. Until they metamorphose into adults, the eyes are sensitive to light; thereafter they dwindle to mere pads of gristle. The surprising feature of this form of blindness is that if the tadpoles are kept in an illuminated place, they do not lose their sight. Thus, eyelessness in cave salamanders has proved to be a loss resulting from darkness at the time of metamorphosis. It is only a degree different from the disappearance of color and the degeneration of visual organs in goldfish that are kept for as much as three years in complete darkness. Light or its absence has profound effect on eyes. At the other extreme are human eyes that lose their ability to see in the dark if they are used unprotected for a few months on the glaring white sands of tropical sea beaches.

When walking through the out-of-doors, you cannot expect to see more than a few of the eyes that watch your every movement. Many do not have to change position to follow your route. Different facets of an insect's compound eye accomplish this automatically because of their bulbous form. Birds and rodents will swing their heads slowly to keep you in sight, for their eyes are so large that they can be rotated only slightly in their sockets, and the neck must make the compensating movements. The owl on a branch close to the shady side of a tree may not even bother to open both eyes. You may fail to detect the presence of a squirrel no more distant than the far side of the nearest tree. The clatter of sharp claws on the bark may give away the creature's position long before you see a single eye and ear project around the trunk to keep suspicious account of your actions. The kingfisher probably will pay no attention as it speeds along above the stream. But a blue jay will voice raucous cries, informing all the creatures of the woods to watch you well. A stranger is in their midst.

BOOKS *Continued from page 295*

to the quality and amount of scientific thought that man needs to expend now to keep himself alive, physically, socially, and morally.

JOHN R. SAUNDERS.

YOUR WESTERN NATIONAL PARKS

------- by Dorr G. Yeager

Dodd, Mead and Company, $3.50, 275 pp., 18 plates

THE first National Park in the United States was established in 1872, and today there are 27 of them, as well as a number of Monuments, historical sites, and miscellaneous memorials. All told there are 169 areas under the jurisdiction of the National Park Service, established belatedly in 1916 as a bureau of the Department of the Interior. The present book deals with 39 representative National Parks and Monuments west of the Mississippi River, and an appendix supplies brief notes dealing with those omitted.

An introductory chapter tells how the concept of National Parks originated and something of the history of their administration. Mention is made of the commercial interests, including lumbermen, stock raisers, and miners, who constantly harass the government by endeavoring to have restrictions lifted so that areas set aside "for retention in their natural condition" may be exploited. Nothing is said, however, about the others, the hotel men, the travel agencies, and similar groups that are anxious to exploit the parks in another manner, turning them into expensive resorts that cater only to the wealthy. But by and large the National Park Service has done a commendable job, despite such pressure groups, national apathy, and the influence of misguided politicians in Washington.

Your Western National Parks is essentially a guide book. Unfortunately, the space available is not sufficient to permit the author to say much about any single park. The Grand Canyon is covered in eight and one-half pages, and half as many, or less, are devoted to most of the monuments. What to see, how to get there, and a few comments on the history and exploration leave little room for much of value concerning the flora, fauna, or geology. The book should be of value to those planning a trip, but they should avoid the error of the author and not try to cover too much territory at one time.

C. M. BOGERT.

AN INSECT BOOK FOR THE POCKET

------- by Edmund Sandars

Oxford University Press, $3.75, 349 pp. 35 colored plates, numerous figs.

THIS is a book on British insects dealing chiefly with those having a length of "half an inch or more" but including many smaller ones. It gives a simple discussion of habits, reproduction, growth, and classification, followed by accounts of the various orders and families. In this way, the author has brought into one volume most of the interesting facts about the habits and unusual developments in the life stages of insects and their relatives, and many of the kinds discussed are similar to related insects occurring in America. The volume may serve as a guide to all amateurs interested in classification.

Many of the 35 colored plates are of fine quality, and most of the numerous other illustrations are good. The bibliography, complete for the British Isles, is of great value in indicating sources from which extremely interesting material has been drawn. The book contains much information not found in American popu-

NEW DISCOVERIES

"Pocket-Size" Dinosaurs Unearthed

A QUARRY of complete skeletons of dinosaurs that inhabited this continent 200 million years ago in the Triassic Period was unearthed during the summer by Dr. Edwin H. Colbert, Curator of Fossil Reptiles at the American Museum, who is heading a Museum expedition in New Mexico. This find marks what is probably the most important discovery yet made of the first dinosaurs in this country.

Unlike their gigantic relatives, these dinosaurs were barely three feet high, and their heads were no larger than a wolfhound's. They had very long hind legs on which they ran and short forelegs which they used to grasp prey. Despite their small size, they were carnivorous and fed upon the smaller reptiles of the period. Eventually they gave rise to the great flesh-eating dinosaurs of much later ages, such as *Tyrannosaurus rex.*

According to first reports, the reptiles are representatives of the Saurischian dinosaurs and are called Coelophysis. Their existence was previously known only on the basis of bone fragments.

The skeletons are being removed in blocks of rock weighing several tons, which will be shipped back to the Museum for careful extraction of the remains.

According to Dr. Colbert, one of the world's leading authorities on the ruling reptiles and their relatives, these new skeletons show an animal much smaller and more primitive than the earliest dinosaurs in the American Museum's collections and indicate the real beginning of these reptiles.

Forty Prehistoric Animals

As this issue goes to press, the American Museum's expedition in northwestern New Mexico, under the leadership of Dr. George G. Simpson, reports that more than 40 kinds of 60-million-year-old animals have been found in what may be called the richest single deposit of early prehistoric mammal bones ever discovered. The location is only a few miles from the excavations that produced the dinosaur skeletons mentioned above, and the two parties are part of the same expedition.

Dr. Simpson has reported to the Museum that the expedition has already revealed extinct species of snails, fishes, lizards, snakes, turtles, alligators, and a great array of the earliest mammals. Small lemurs uncovered in the excavation are referred to by Dr. Simpson as "relatives and forerunners of monkeys and perhaps of man, himself." Other early mammals found include squirrel-like rodents, ancient flesh-eaters called creodonts, the diminutive four-toed horse called *Eohippus,* tiny hedgehog-like insect-eaters, and *Hyopsodus,* one of the most primitive herbivores.

In commenting on the importance of the American Museum of Natural History's field study of Eocene fossils, Dr. Simpson stated:

"This particular time in the history of life is of special interest and significance because it is the 'Dawn of the Recent,' as the term Eocene indicates. It was in this epoch, not long after the great dinosaurs had become extinct, that the earth was being over-run by myriads of smaller but smarter animals, the warm-blooded mammals. Study of the beginning of the Age of Mammals—the life age in which we are still living—reveals the ancestors of most of the creatures important to us now, and even of ourselves, and shows how the great group of mammals developed and evolved."

The most outstanding discovery of the expedition to date, according to Dr. Simpson, is the first complete skeletons of *Meniscotherium,* a "mystery animal." Previously known only through scattered small bone fragments, *Meniscotherium* can now be identified as a small mammal, with a head only four or five inches long, and standing about a foot or less high at the shoulders. It had a hoof on each of its five toes and was a plant eater. Eventually the group to which *Meniscotherium* belongs gave rise to the hoofed mammals of today.

The startling, recent discoveries came in the second season of a long field program, which will probably require five to ten years for the completion of phases now under way.

Readers may expect articles on these new discoveries when the joint expedition returns from the field.

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lar books, and while the terminology may differ from ours, the book is recommended to all who are at all interested in the study of insects.

C. H. CURRAN.

ADVENTURE IN JADE
- - - - - - by James Lewis Kraft

Henry Holt & Company, $3.50
81 pp., 1 illust.

THE tremendous fascination of jade affects many people in different walks of life. The primitive peoples of many lands have found the felted, interlocking texture of needle-like crystals an ideal medium for the fashioning of intricately worked ornaments. Their patience in the time-consuming task of wearing away the stone, in terms of how the time might otherwise be spent, is no more remarkable than is the patience of a busy, successful businessman, head of a large cheese industry, spending somewhat less time working tediously and lovingly with his hands, although with power driven tools. An enthusiast's love for this stone shows on every page of this little book.

Mr. Kraft is fortunate that his success has permitted him to pursue the jade will-o'-the-wisp all over North America, to purchase a mountain dotted with green boulders of a near-jade mineral, and to project further researches in combined archaeological-mineralogical searches. Recent developments in nephrite discoveries—and Mr. Kraft can surely take credit for a great share in many of them—indicate that nephrite jade is not nearly so rare as had been thought. The new discoveries have not helped, of course, in the solution of the Maya jade problem, for almost none of their jade is of the nephrite type. No mineralogist today takes any interest in archaeological controversies over its source, for it cannot be doubted that the source was near by in Central America.

In time, concentrated, planned investigations like those that Mr. Kraft has encouraged in the past will uncover the ancient workings. Probably the reverence with which fine jade is so often viewed encourages a romancing not justified in the eyes of the mineralogist to whom nephrite is just another amphibole.

F. H. POUGH.

 Continued from page 289

Great Lakes region as far west as Minnesota.

Among the proofs listed was a runic stone found at Kensington, Minnesota. The inscription as translated by Hjalmar Holand tells of a Norse exploring party that was attacked by Indians in 1362.

I would appreciate your comments on this theory.

LAWRENCE RYEL.

Milford, Mich.

The Norse discovery of America is today accepted as a fact by all historians and critical commentators. The supporting evidence is of three kinds: detailed accounts of the principal expeditions, handed down in the Icelandic and Greenlandic sagas; independent but confirmative general remarks on the landfall by the nearly contemporary European historian, Adam of Bremen, writing in 1073; and the discovery in recent decades of stray items of Norse archaeological remains along the coasts of Labrador and Newfoundland.

According to the sagas as now interpreted, the discoverers first saw the shores of the western continent about the year 986, first landed for exploration about the year 1000, came again several times later for timber, found a desirable region they called "Vinland," where they brought cattle and tried vainly to make a permanent settlement.

Regarding the Kensington Stone and other alleged proofs of the Norsemen's explorations in the interior of North America, it must suffice to say that expert opinions are not yet in agreement. The general subject has been under serious discussion for more than two hundred years and is therefore covered by extensive literature. A good, up-to-date general treatment entitled *Voyages to Vinland*, by Einar I. Haugen, was published by Alfred Knopf, New York, 1942.

N. C. NELSON.

SIRS:

I wonder if you could tell me if a bear's nose is very sensitive to a bee's sting. Many books I have read say that the bear has no fear of the bee, while others maintain that he is very careful to protect his nose. What is the truth?

HELEN REHBEIN.

Appleton, Wis.

The following information is offered by George G. Goodwin of the American Museum's Department of Mammals:

There is no reason to suppose that the nose of a bear is either more or less susceptible to the sting of a bee than that of the average mammal. For the most part, the bear is covered with a thick coat of hair and a tough hide which protects him from bees. However, there are some vulnerable parts on the nose and face, and these offer a ready target for the bees when the bear is invading the nest.

Because the adult Brown Bear and the Grizzly cannot ascend a tree, they would be unable to rob a beehive. But the Black Bear, which has a special fondness for sweetmeats, is an excellent climber and can go up a tree almost as fast as a squirrel. The amount of protection each bear gives his nose differs; for there is almost as much variation in the behavior of individual bears as there is in human beings. When robbing a beehive, some bears are timid and careful not to expose themselves to unnecessary pain and discomfort. The inexperienced, however, in their bungling, are often attacked by the entire swarm of angry bees, and although they bawl loudly with pain, they continue to scoop up the honey, comb and all, and, between noisy outbursts of protest, devour it with greed. Sting or no sting, the Black Bear always gets his honey if it is physically possible.

Despite a fondness for sweetmeats, it should not be assumed that any bear feeds exclusively on honey. This is just an occasional feast. Bears are omnivorous and feed on practically everything that is edible. A list of a bear's staple diet consists, not of what he will eat, but of what he can get. In the early spring it is roots, grass, bark, and insects, especially ants and ant eggs. In the berry season he feeds on strawberries, raspberries, blackberries, etc., and in the fall he grows fat on the showers of nuts and acorns.

TIBETAN PLAQUE ON EXHIBIT

One of the finest examples of Tibetan culture—a rare and beautiful icon of wrought copper covered with gold and set with precious stones—has been presented to the American Museum by the Princess Serge Belosselsky.

The icon, measuring twelve by eighteen inches, has as its central figure Tibet's patron saint, Chen-Re-Zi, the god of mercy and compassion. Although religious works of art were never signed or dated by Oriental craftsmen, the icon is believed to have been made in the eighteenth century by artists of the Derge Province.

The piece, purchased by the Princess from a collection assembled for Czar Nicholas II, can be viewed among the permanent exhibits in the Museum's Tibetan Hall.

RARE INSECT COLLECTION

John C. Pallister, entomologist at the American Museum, has returned from a solitary, nine-month expedition to the rugged highlands and jungles of Peru with a collection of more than 28,000 insects and spiders, which represent the first complete collection of Peruvian insects ever brought to this country.

The extensive collection includes many previously unknown species and some of the Western Hemisphere's rarest insects and spiders. Among the more unusual specimens are gigantic, ferocious beetles, half a foot in length; rare, cave-dwelling spiders; the grotesque lantern fly; and giant silk moths with a wing spread often exceeding six inches and with long tails on their hind wings.

Most important of the discoveries, according to Mr. Pallister, were many new species of Diptera which require study because of their potential disease-bearing character. He feels that these minute insects of the mosquito and fly type may provide vital and basic information on the role played by certain insects in the transmission of disease.

Mr. Pallister also believes that the region through which he traveled in search of new specimens is one of the key spots on the globe for the study of insect evolution and the relationship of insect life to the environmental background of the country.

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"Ho, for the sea!"
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PEARL DIVERS

October NATURAL HISTORY 1947

Living Mayas · Animal Psychology · Indian Costumes

Glaciers · Blood Fluke · Sun Towers · Contrary Shell

Mysterious Tree

SIRS:

Mrs. Hunter and I will always be grateful to you for the interesting article in the June, 1940, issue of NATURAL HISTORY about Benjamin Franklin's tree, as we fondly term a thriving specimen we planted on our place the following spring.

Our *Franklinia alatamaha* has not only served to interest many friends, but it has also encouraged us to investigate the tree's curious history. Geologically, we fail to find any reference to its having been found in fossil form, which poses another problem for the paleobotanists. On the other hand, thanks to Mrs. Hunter, we seem to have discovered something new about the tree, which strangely enough involves the great ornithologist, John James Audubon.

All the botanical literature we have been able to secure on the Franklinia agrees with your 1940 article, which states that this interesting genus of American tree was never found in the wild state after 1790. Also, it seems clear that there is no record of its having been seen anywhere except in a little grove along the Altamaha River, near old Fort Barrington, Georgia. However, the botanists may be wrong about this, because Mrs. Hunter has discovered that Audubon's print No. 185 of Bachman's "Warbler" depicts the birds perched on a branch of a flowering Franklinia tree; and the print, reproduced by Havell, is dated 1833! The foliage and flowers of the Franklinia in this Audubon print were actually painted by Miss Maria Martin of Charleston, South Carolina, according to Mr. Stanley Clisby Arthur in his fine book on Audubon entitled *The American Woodsman.*

In other words, about 40 years after what has been supposed to be the last observation of the Franklinia tree, Maria Martin seems to have seen a living specimen of the same tree in the vicinity of Charleston, where she painted it for Audubon in 1830 or 1831. While I have no doubt that the botanists are quite correct in claiming that "their" famous little grove was not seen again after 1790, this does not seem to tell the whole story. The Audubon document indicates that the tree was growing near Charleston as late as 1830 or perhaps later, for all we know! There may have been a second wild grove, or possibly offshoots of the few samples taken to Philadelphia from the original grove had made their way south again to Charleston and were transplanted.

It is very fortunate that the discriminating Audubon has left us a picture, probably the earliest, of this mysterious American tree, which was named by John

Bartram for his friend, Benjamin Franklin. It is also fortunate that the few slips that William Bartram carried in his saddle bag from old Fort Barrington to his father's gardens in Philadelphia lived and that their cherished descendants still thrive in a few American gardens.

FENLEY HUNTER.

Garden City, N. Y.

Porpoise—Friend of Man?

SIRS:

From time to time, I have heard reports in Florida that the porpoise is such a friend of man that he will push a drowning person to shore. However, I have never talked to anyone who has witnessed this. It has been suggested that I might inquire of you whether there is any basis in fact for these reports . . .

WALTER LANDIS SMITH.

Cleveland Heights, O.

Folklore has handed down through the ages many strange and mysterious tales about marine life. Even today the rank and file of seafaring men are still superstitious about things that happen at sea. Some of these superstitions, strangely enough, have some foundation, though the interpretations are all too often misleading.

The belief that a porpoise will befriend a drowning person and attempt to save

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NATURAL HISTORY

The Magazine of the American Museum of Natural History

FREDERICK TRUBEE DAVISON, President — ALBERT E. PARR, Director

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THE COVER THIS MONTH

North America has two native species of swans—the Whistling Swan and the now sadly depleted Trumpeter Swan. The Whooping Swan, a European bird, is found in Greenland. The Mute Swan, shown on the cover, was introduced from Europe and widely distributed as a park bird. But its existence was so successful elsewhere that in many places it is more often seen than our native swans.

It has had a long and interesting history as a domestic bird in England, where it is said to have been introduced in the twelfth century by Richard I. It was made a bird royal, and possession of it was strictly limited by the crown under special grants and restrictions. Heraldic swan-marks were once scratched on the birds' bills to show their ownership.

The Mute Swan is not entirely voiceless, but it does not have the loud and resonant tones of other species, possibly because its windpipe is straighter and lacks the trumpet-like convolutions found in the louder-voiced swans.

Swans build bulky nests of grass and other rubbish, in which they lay from four to six dull, whitish eggs. These hatch in five or six weeks to produce the dark-colored young, whose ungainliness has been popularized in Hans Andersen's tale of the ugly duckling.

JOHN T. ZIMMER.

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ART AND PRODUCTION: Robert E. Williamson.
Jean Bruck, *Assistant in Art and Production.*

Magazine subscriptions, Membership applications, and Advertising inquiries should be sent to Charles J. O'Connor.

NATURAL HISTORY is published monthly (except July and August) at New York 24, N. Y. by the American Museum of Natural History, Seventy-ninth Street and Central Park West. Subscription price $4.00 a year, single copies fifty cents. Subscriptions to Canada, Newfoundland, and all foreign countries $4.50. Entered as second class matter March 9, 1936, at the Post Office at New York, under the Act of August 24, 1912. Manuscripts and illustrations submitted to the Editorial Office will be handled with care, but the publisher cannot assume responsibility for their safety.

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ANIMAL ART • MALAYSIAN BIRDS • PLATYPUS
SIERRAN TRAILS • PATAGONIA • MYSTERIOUS SEA

ANIMAL ANATOMY AND PSYCHOLOGY FOR THE ARTIST AND LAYMAN

- - - - - - by Charles R. Knight

Whittlesey House, $5.00
149 pp., 57 pp. of illust.

THIS book is the effluence of a man who is competent both as artist and naturalist. It is written simply and colorfully, and it shines with the spirit of one who accepts his calling with deep seriousness. Text and illustration are practically interwoven, although here and there we find some lapses for which the editor should be held responsible. For example, Mr. Knight writes that reference to his accompanying drawing of a beaver skull will do more than any number of words to explain the workings of a rodent's gnawing tools. Alas! the publishers have evidently eliminated the beaver skull without apology.

The author deals successively with a wide variety of mammals, including infantile examples. He deals with facial expression in relation to mood and with the structure of birds, reptiles, fishes, and invertebrates. He emphasizes how difficult it is for the draftsman to see what he needs to recognize without first mastering a knowledge of fundamental anatomy. He stresses the importance of studying the planes produced by overlying muscles and integument and the extremely complicated and subtle patterns due to tracts of hair, feathers, scales, etc. A lifetime of observation, sound training, and practice has made the author a master in his chosen field, as all will realize who glance at his facile sketches. The depiction of skeletons in true action and the plate showing how various kinds of animals lie down will be worth the price of the book to many an artist.

Like Leonardo da Vinci, the author exalts the use of the plain old-fashioned pencil. "Drawing is drawing, no matter what the subject, and exactly the same rules of light, shade, contour, perspective, and construction apply equally well in every instance." And this must be learned anew by the sweat of each young student. The Introduction is an able review of animals in art, from the prehistoric Cro-Magnons to the present. The iron moral with which Mr. Knight permits no compromise is that "sound academic drawing of . . . casts, human figures, animals, or landscapes, is a prime necessity" for all who deserve even serious attention in their task of translating living animals into creative art.

R. C. M.

SPRING IN WASHINGTON

- - - - - - by Louis J. Halle, Jr.

(Illustrations by Francis L. Jaques)

William Sloane Associates, $3.75
227 pp., 56 illust.

THE Rites of Spring—its resurgence and reawakening, with the ever-recurring, forever new upsurge into flower and fruit, into song and nest and multiplication, which we of cities so seldom pause to contemplate—these things form the theme of Mr. Halle's beautifully written book, *Spring in Washington.*

It is about Washington, D. C., with its human background of politics and world affairs and its minutiae of government detail. Yet here, too, Spring bursts all bonds as winging birds etch themselves against prosaic office windows and flowers garland street and park.

Mr. Halle gives us eyes to see and ears to hear. He resurrects senses half forgotten, and Pan calls from every wayside bit of earth, every greening bush and tree!

The delightful vein of philosophy that runs through the entire volume intrigues the reader with its thought-provoking conclusions. As an example, take these arresting statements, chosen quite at random:

"I come to the conclusion that only nature in its pure form is absolutely beautiful, that any distortion of nature lessens its beauty by so much . . .

"It is well not to have too much of a good thing. Anything loses virtue when it becomes ordinary . . .

"To bring order out of chaos is the noblest function of man."

This is perhaps primarily a bird lover's book, yet even one only mildly interested would be stimulated to delve deeper into the subject after reading the author's fascinating descriptions and observations on the feathered spring visitors and native birds of Washington.

The illustrations by Francis Jaques sympathetically reflect the spirit of the writer. Somehow he has the uncanny ability in a few strokes to bring feeling and reality into his drawings.

Altogether Mr. Halle achieves his objective in this book of making you realize that Spring in Washington is something very, very special.

IRVIN N. HOFFMAN.

BIRDS OF MALAYSIA

- - - - - - - - by Jean Delacour

The Macmillan Co., $5.00
382 pp., 84 illust.

IT seems impossible to include in one single volume of only 382 pages (331 pages of descriptions) the enormously rich bird life of the Malay Archipelago. Yet Captain Delacour has accomplished this. He has described some 700 species, giving their correct names and distribution, and pointing out by means of simple keys the diagnostic differences between members of each family.

To the traveler as well as the resident of Malaysia this will serve as a handy, complete guide to the birds of a region about which no such information has hitherto been available. Even the stay-at-home naturalist will welcome this book, with its wealth of information about bird life in a faraway country. It tells him how richly represented are the partridges, pheasants, pigeons, cuckoos, woodpeckers, cuckoo-shrikes, bulbuls, babblers (62 species!), and the sunbirds in Malaysia. Excellent bird portraits in black and white, by Earl L. Poole and Alexander Seidel, add to the usefulness and attractiveness of the volume. This is a notable addition to the Pacific World Series.

E. MAYR.

ALONG SIERRA TRAILS

- - - by Joyce and Josef Muench

Hastings House, $2.50
101 pp., 144 illust.

THIS is the story, told chiefly in pictures, of one of our country's great scenic areas. Written descriptions of the glory of our National Parks depend largely on an author's ability to portray their beauty impressively. A good vocabulary, coupled with the knack of presenting the information in an alluring manner, may transform a commonplace countryside into a veritable paradise and thus give the reader an entirely wrong impression. *Along Sierra Trails* transports you, through the medium of the camera, to the scene itself. True, photographs can be misleading, too; but there is no question of the validity of these 144 superb illustrations reproduced in gravure.

The brief, colorful text includes the history of Kings Canyon National Park and gives the reader a good idea of the authors' personal reactions to their travels in this area. It is the pictures, however, that take the reader to the highways of the mountains and to the edge of spectacular canyons. Through the eyes of the camera one climbs the passes on dizzy ridges, newly freed from their winter's cloak, and surveys a region bursting with the enchantment of spring. Everywhere there is the sparkle of water running from the feet of perpetual snow. The reader can fairly smell the fresh aroma of the clean pine woods and feel the cool breezes on sunlit mountain meadows.

It is not all dreamy vistas. There are flowers in all their delicate detail, gnarled trees that tell a story all their own, and groups of mule deer treading softly in filtered sunlight through cool forest glades, or flashing by in a moment of frightened haste.

The Muenches have presented the magnificence of Kings Canyon National Park in a manner that cannot help but convince everyone of its charm.

GEORGE G. GOODWIN.

A YANQUI IN PATAGONIA

- - - - - - - - - by Bailey Willis

Stanford University Press, $3.00
152 pp., 32 illust.

INTO this handsomely designed and well-printed volume Bailey Willis has stirred many of the episodes and interests of the first 50 of his 90 years. His earlier career is summarized before taking up the main topic of his several years of work in and about extreme northern Patagonia and the southern Andes. The treatment is episodic, and it is not easy to follow the sequence, to distinguish hope from reality, or to get a real feeling of what life was like in that region in the 1910's. Considerable space is devoted to the paraphrasing of old Spanish chronicles, not notably pertinent to this tale and better told elsewhere. In the discussions of the geological and faunal history of Patagonia, it is distressing to find Dr. Willis, one of our most eminent geologists, falling into some elementary errors of fact and judgment. The reviewer cannot honestly ignore this book's defects but can happily add that it contains much that is of great and permanent value.

Dr. Willis' colleagues will appreciate and treasure this autobiographical record of part of one of the longest and greatest of geological careers. More general readers will also find much to interest them and will gain some acquaintance with a fascinating and little-known region.

G. G. Simpson.

The Platypus
- - - by Charles Barrett, F.R.Z.S.

Robertson and Mullens, Melbourne, Australia,
Two shilling and sixpence, 63 pp., 28 illust.

We Breed the Platypus
- - - - - - - - - by David Fleay

Robertson and Mullens, Melbourne, Australia,

Two shillings and sixpence, 45 pp., 31 illust.

HERE at last are two books on the world's most fantastic mammal. While both publications are small and not pretentiously bound in ornate covers, they present authentic information on this strange creature in an entertaining and readable manner. The books are written by different authors, who approach their subject from different angles, but both give remarkable insight into the private life of the platypus. Fortunately, the authors are not only competent writers but are familiar with the animal from first-hand observation. Much of our previous literature on the platypus was compiled from various doubtful sources, so that the data were far from complete and the facts often incorrect.

One of the interesting features in Charles Barrett's work is the pictures, which trace the growth of a platypus from the egg to a fourteen-week-old baby. He also gives many peculiar facts such as, "The platypus lays two eggs which firmly adhere to each other and thus are prevented from rolling out of the position in the nest." He says there are rarely three eggs in a clutch and occasionally only one. They are almost as large as a pigeon's egg and resemble those of a reptile. The most extraordinary characteristic of this strange animal, he says, is the absence of external evidence that the platypus is a mammal: "The milk glands exude nourishment of milk through the skin and it is lapped up by the young."

David Fleay tells of his practical experience in raising the platypus. The principal purpose of his book is to chronicle his observations on the breeding and hatching of this strange creature. Contrary to the popular belief that the platypus is verging on extinction, Mr. Fleay says it has responded to rigid protection and is coming back.

George G. Goodwin.

The Mysterious Sea
- - - - - by Ferdinand C. Lane

Doubleday and Company, $3.00
345 pp.

THAT the author, though a scientist, uses the word "mysterious" in his title shows at once that he is a poet as well as a student of facts.

He first deals with various theories regarding the origin of the sea and the evolution of its salty waters. He describes the great extent and configuration of the oceanic basins and the methods that oceanographers have used to determine their depth and bottom contours. The nature and composition of oceanic water, the currents, the tides, and the form, power, and nature of the various types of waves are explained and analyzed succinctly and vividly.

Dr. Lane then turns his attention to the life of the sea. The theories as to where and how it began are considered. This is followed by a series of pithy and swiftly-moving chapters covering the plant and animal inhabitants of the oceans, including the sponges, jellyfishes, sea-worms, sea stars and their kind, as well as crabs, lobsters, shrimps, and the sea mollusks. Then, with amazing ability and excellent powers of description, he deals with the vast multitudes of marine fishes, even plunging into the profound depths to visualize the dwellers in "regions of darkness and strange light," with their luminescent organs and grotesque forms. Not content with these, he rises suddenly to the surface and invades the rookeries of the amphibious creatures along the ocean borders, including the seals, walruses, and sea-lions. Nor does he omit whales and their relatives, or the feathered tribes that soar, hover, dive, and fish for food at the ocean's surface.

He then emphasizes the importance of the sea to mankind throughout the ages, and discusses man's various inventions for fishing and utilizing the other products of the ocean. He describes the waters as a highway for ships, the evolution of navigation, the mapping of the sea lanes and open spaces, as well as the far-reaching effect of the oceans on human history and on the health, wealth, and well-being of mankind.

ROY WALDO MINER.

MAMMALS OF NORTH AMERICA

- - - - - by Victor H. Cahalane

Macmillan Co., $7.50, 682 pp., 93 illust.

THIS is the best single volume devoted to the life histories of North American mammals that this reviewer has ever read. Not until a reader goes to such a multi-volumed work as Seton's *Lives*, to take the best example for comparison, will he encounter the detail and the thorough treatment found in this book.

Mr. Cahalane does not attempt to cover the broad field of North American mammals in a fashion that will place the 1500 species and subspecies in separate pigeonholes. Instead, he employs 94 headings, and with these he conveys such a good over-all picture of what takes place in their daily lives that the user of the book can easily apply the proper pattern of

Continued on page 383

▲ VALLEY GLACIERS start as snow fields in high mountains. While the forces that built this Aleutian volcano, Iliamna, still act feebly, snow and ice are tearing it away, carrying the volcanic rock downhill, piece by piece

GLACIERS

The whys and wherefores of the tremendous ice masses that blanket six million square miles of the earth's surface. What causes them, how do they behave, and are they declining or increasing?

By RICHARD FOSTER FLINT

Professor of Geology, Yale University

ONE day in the summer of 1937, I went over the side of an exploration ship in an iceberg-dotted fiord of East Greenland and, in a spirit of scientific inquiry, rowed toward a large "dirty" berg. Icebergs come from glaciers that have flowed down to tidewater; the ends of the glaciers break off or are buoyed up and then float away. A "dirty" berg is one with pieces of rock and earth embedded in it. Usually such a berg comes from the very base or sole of the glacier—the part that has been in contact with the ground beneath it during its long, slow-flowing journey to the sea coast.

I wanted to find out what kinds of rocks and minerals constitute the ground beneath all that glacial ice in the interior of Greenland—ice with an area of 637,000 square miles. There is no way to get to the subglacial surface. The best one can do is to let the glacier tear off, transport, and deliver what it will, and to look hopefully at what is offered. On that particular day in 1937, I found nothing noteworthy, but the possibilities are dramatic. Who knows what mineral wealth may be hidden beneath the 637,000 square miles of the Greenland Ice Sheet, or beneath the 5,000,000 square miles of ice that cover the Antarctic Continent? These ice sheets are the world's two largest glaciers.

Not many Americans have seen a glacier at close range, simply because there aren't many glaciers in the United States and because those we have are tucked away in fairly high, inaccessible places. Still, the residents of such western cities as Seattle and Portland live within sight of glaciers. To the large number of Swiss citizens who live in farmhouses within a short walk of one or another of the more than 1200 glaciers in the Alps, a glacier is an everyday thing, hardly worth noticing. But to most of us it is an object of considerable curiosity.

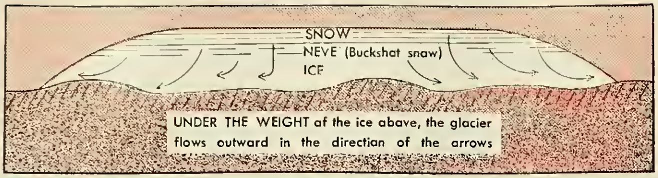
A glacier is nothing more than snow compacted into ice, spreading outward and flowing downward from the places (usually high) where the snow accumulated. What makes a glacier move is roughly the same thing that makes batter spread outward when it is poured onto a griddle. To be sure, batter is a liquid—a rather stiff liquid—whereas ice is a solid. But when it is hard pressed by the great weight of more ice on top of it, it becomes a very weak solid; it yields easily and flows almost as if it were a liquid. On a flat surface, it spreads out and forms an ice sheet having the pancake form of the spread-out batter. On an irregular surface, ice flows down the steepest path it can find. Because snow is usually thicker and more persistent on mountains than on plains, the resulting ice takes the form of the mountain valleys down which it flows, thus forming the tonguelike valley glaciers that we associate with most cold mountain regions. Valley glaciers are the glacial counterparts of the streams of water that course downward through mountain valleys in milder climates.

How thick does a pile of snow have to be in order to flow and become a glacier? Only about 100 to 200 feet. At that thickness, most of the snow will have become ice. Scientists on sledge expeditions across large ice sheets have found, by digging pits into the surface, that the snow is layered. Each layer represents one year's accumulation, and each is a little more dense than the layer above it. Layer by layer the snow packs down, settles, and recrystallizes. Because of these changes, the snow is transformed, as we follow it downward, into granular névé ("buckshot snow") and finally into solid ice. The weight of a few score feet of this ice is enough to overcome the rather feeble strength of the ice still farther beneath. As a result, the ice underneath moves slowly outward in much the same way as will toothpaste or vaseline gently squeezed out of an opened tube laid on a table.

In the uppermost 100 to 200 feet of the glacier's thickness, the weight is not great enough to produce

▼ A SMALL AIRPLANE in southern Alaska over some of the most spectacular scenery in North America. Below and to the left of the plane's nose is the snow field that forms the head of a small valley glacier. The ribbon-like stripes beneath the plane are rock and earth that avalanched from cliffs onto the edges of tributary glaciers and have been carried down to the main stream. The grayish glacier on the right is almost obscured by a covering of earth and rock

Spence Air photos



this effect, so the ice there remains rigid and brittle. It is somewhat like the rigid shell on the back of a turtle, which is carried along by the mobile animal "underneath" it.

Like all brittle and rigid substances, this upper shell of ice will crack when subjected to great stress. This happens when the flowing ice moves over a buried hill or down a sudden steepening of the slope of the glacier's rocky floor. The resulting cracks, or *crevasses*, are very numerous in some places. They extend 100 to 200 feet down into the glacier but no farther, for below this depth the pressure is great enough to close them up and keep them closed.

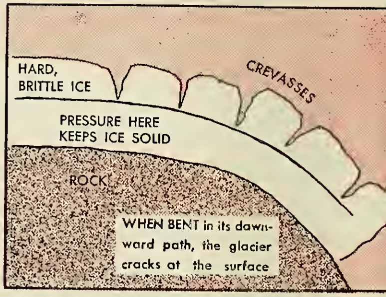
Crevasses are a tremendous hindrance to travel over the surface of a glacier. In the winter, they are likely to become bridged by drifting snow, which obliterates the great gaping cracks many feet in width. Often the bridges will support the weight of a man or a sledge, but sometimes they collapse, causing tragic disasters.

In 1820, three climbers on a valley glacier on Mont Blanc, in the French Alps, were overwhelmed by a snow avalanche, swept into a crevasse, and lost. From measurements of the glacier's rate of flow, it was predicted that the bodies of the unfortunate climbers would reach the lower end of the glacier about 40 years after the accident. The prediction proved accurate. Beginning in 1861, after the lapse of 41 years, their heads, other parts of their bodies, and their clothing and equipment were delivered up, having traveled at an average rate of 225 feet per year. The shearing stresses involved in the flow of the ice had gradually dismembered the bodies.

The rate of flow of this Mont Blanc glacier, 225 feet per year, is a typical figure for a valley glacier. Average figures mean little, because variable slopes, temperatures, and thicknesses cause great variations between one glacier and another and even between different parts of the same glacier.

A record rate of flow was established by the Black Rapids Glacier, in the interior of Alaska. Ten miles long in 1936, this tongue of ice suddenly began to move rapidly, increasing its length to 13 miles within less than five months. During this time its rate of flow exceeded 115 feet per day. The burst of speed, however, soon died down. Investigating geologists decided it was brought about by a previous succession of winters that had been marked by unusually heavy snowfall. Today the Black Rapids Glacier, after its spectacular effort, is melting and shrinking away.

A similar burst of speed by an Alaskan valley glacier became a serious threat to a $1½ million railroad bridge. This bridge, key link in the $20 million Copper River and Northwestern Railway, was built in 1909 and 1910 at the only practicable crossing of the river—a point well below the end, or terminus, of the Childs Glacier. The terminus was a formidable cliff of ice 300 feet high and three miles wide, but its presence caused no great concern, because for many years the cliff had been nearly stationary. Melting had struck a balance with the slow forward flow of the glacier. Then, before the bridge was completed, the ice cliff suddenly began to edge forward, as if aroused by the trespass upon its domain. By the summer of 1911, it had crept down to within 1500 feet of the bridge and towered above it. Its rate of advance had touched a high point of 8 feet per day. The bridge engineers were helpless to avert the impending catastrophe. Then, late in 1911, the cliff suddenly faltered, stopped, and began to recede; it has been receding ever since. The cause of the abrupt change is not known. The best explanation seems to be that earthquakes in 1899 and 1900 caused the avalanching of a vast quantity of snow and ice onto the upstream part of the glacier. This unusual increment was added to by a succession of very snowy winters between 1902 and 1909. The glacier was made thicker, and its rate of flow increased correspondingly. The wave of increased flow traveled down the length of the glacier somewhat as the high point of a flood travels down the length of a river.



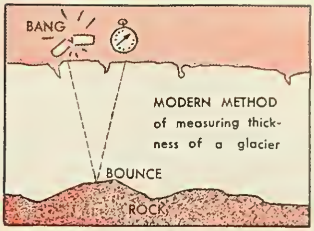
One reason why most valley glaciers do not flow rapidly is because they are not very thick. Many small valley glaciers are probably no more than two or three hundred feet in thickness, and most of the big ones are probably less than a thousand feet. For most glaciers these figures are only estimates, as very few have actually been measured. The method of measurement is the same as one used by oil geologists to determine thicknesses of rock layers buried beneath the surface. It consists of starting a little earthquake, with a charge of blasting powder, at the surface of the glacier. The earthquake waves pass down through the ice, are reflected by the rock floor beneath, and return to the surface, where they are recorded by special instruments that accurately time the round trip of the waves through the glacier. The approximate rate of travel through ice being known, the ice thickness can then be computed.

This method was used on the Greenland Ice Sheet by a small group of scientists. These men, with dogs and sledges, braved much hardship in hauling their equipment hundreds of miles inland and up to an altitude of 10,000 feet, and they lived for many months on the high, barren surface of the ice sheet. Their measurements in one place showed an ice thickness of 6200 feet. This figure does not mean that the Greenland Ice Sheet is everywhere more than a mile thick. Many such measurements are needed before we can hope to know the kind of land surface on which the glacier lies and can visualize what plains, plateaus, mountains, and valleys are concealed beneath the thick and frigid blanket. We suspect that much of the terrain is mountainous, with rocky peaks sticking far up into the ice.

A close view of the Greenland Ice Sheet has occasionally been possible without a fatiguing climb requiring months of preparation. In one of the earlier war years, a Navy pontoon plane, with its crew of five, was making a routine patrol flight along the west coast of Greenland. Suddenly, as is all too common in coastal Greenland, the weather thickened, and within a few minutes the visibility shrank to zero. The pilot climbed to a safe altitude—some thousands of feet—and continued on his way. For a time nothing happened; then the plane seemed to slow down, and, glancing at his air-speed indicator, the pilot was amazed to see the needle swing gradually over to zero! Nothing but mist was visible, but it was evident that the plane had stopped. Climbing gingerly out, the crew discovered that their ship was resting comfortably on the snow-covered Greenland Ice Sheet, above the level of the mountain tops! Blindly and unsuspectingly, they had come in at just the right angle, along the contour of the sloping ice sheet, and the deep snow had comfortably cushioned their landing.

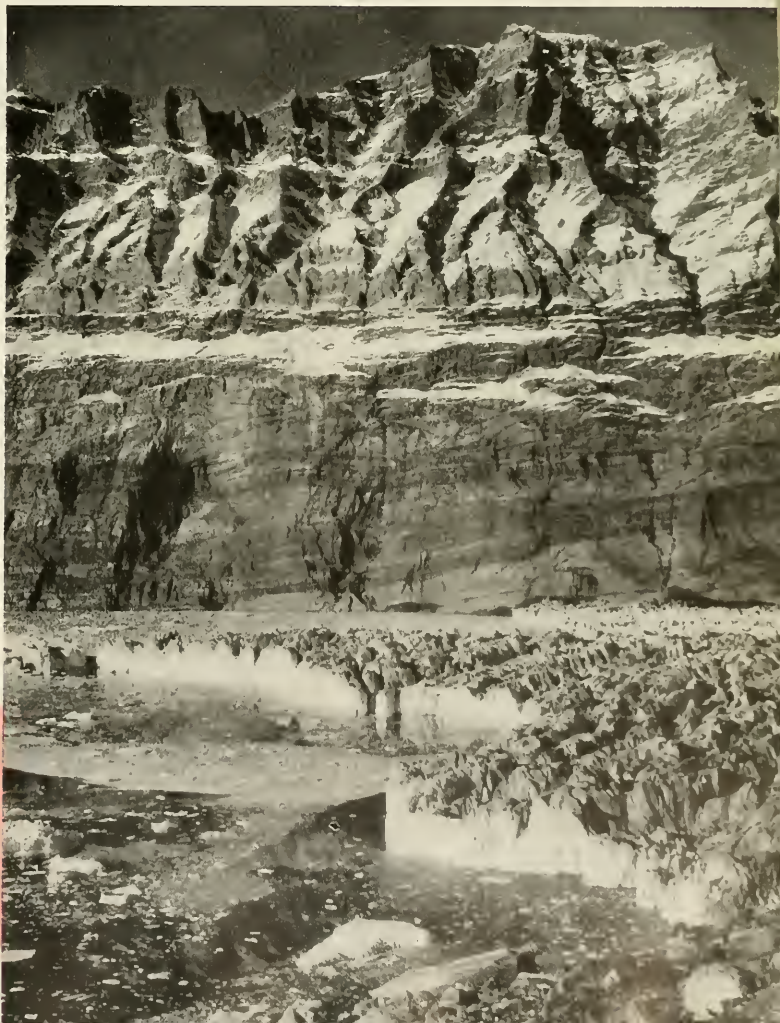
The plane was undamaged, but the crew were unable to turn it around into take-off position. Accordingly, they radioed for aid, and after two or three days of waiting in warm Arctic clothing, and with emergency rations and an electric grill, they were rescued by a ground party with dog sledges. Their only discomfort came during the sledge journey down over the ice to the shore!

The abandoned plane was left on the ice sheet. How soon, if ever, it will be covered with snow and thus gradually enclosed within the glacier is a matter that will be decided by the contest between snowfall, wind-drifting, and melting. Stray airplanes stranded on the Greenland Ice Sheet are not necessarily snowed in. This is illustrated by the story of one of the early attempts at a transatlantic flight.



MODERN METHOD of measuring thickness of a glacier

Ewing Galloway photo



▸ THE HEAVILY CREVASSED SNOUT of this glacier near Umanak, Greenland, juts into the sea beside a mighty cliff. The rocks of Greenland's ice-free coast can be studied at spots like this, but the geology of the interior must be learned largely from rocks carried to the coast for hundreds of miles in the lower layers of the glacier

Frederic Lewis photograph

▲ A RIVER OF ICE meets the sea. Born in high, cup-shaped recesses in the mountains, it winds slowly down, carving a typical glacial landscape and shoving great quantities of ice into the sea each year

In the summer of 1928, B. R. H. ("Fish") Hassell made a bold attempt to fly from Rockford, Ill., to Sweden via Labrador and Greenland. Thick weather prevented his finding a planned refueling point on the west coast of Greenland, and he flew around until he ran out of gas. Finally he landed well inland on the ice sheet. He and Cramer, his mechanic, made a cold and dismal forced march of ten days down the treacherous ice to the coast, arriving at tidewater just as a University of Michigan geological expedition was on the point of departing for the year—and thus, by one day, they were saved.

Most people supposed that the little airplane abandoned on the ice sheet would be covered up with snow and gradually enclosed within the glacier. But sixteen years later, in 1944, a party from an Army Air Forces base discovered Hassell's plane just where it had been left. Its position was so exposed that instead of burying it, the snow had drifted away. One of the party rescued a fountain pen, a keepsake Hassell had left behind in his haste to abandon the plane, and returned to its grateful owner a pen older by a sixteen years' sojourn high on the ice sheet.

Since the development of the atomic bomb, people sometimes ask whether atomic bombs could be used to eliminate the great ice sheets of Greenland and the Antarctic Continent. Unhappily, the effect of one of these bombs, when dropped on a human community, is only too well established. But its destructiveness is limited to a radius of a few miles. How many bombs would it take to destroy even the superficial ice in the Antarctic Ice Sheet, with an area of five million square miles, to say nothing of disposing of the deeper parts of the ice sheet, 2000 feet or more below the present surface? The atom bomb is surely not the answer. Indeed, we know of no means of melting the great volumes of polar ice, except by patiently waiting for a warm climate to do its slow work.

Those who suggest that we do away with our big ice sheets cannot have stopped to consider what would happen to our coastal lands, including many of our largest cities, if such a thing could somehow be made to happen. The two million or more cubic miles of ice thus converted into water would pour into the sea, raising the level of the oceans throughout the world by an amount estimated at 70 to 100 feet. How much inhabited land lies less than 70 feet above present sea level? For a start, large parts of Boston, New York, Philadelphia, and New Orleans lie within this vulnerable zone, not to mention many others among the world's great cities. The map at right shows what would be left of Florida. Consider this, and you will probably decide that the polar ice had better be left undisturbed.

It is hardly surprising to find most of the world's glaciers in or near the polar regions. There is, however, one great difference between the two polar regions. The south polar region is a continent covered by a great ice sheet that reaches 10,000 feet above sea level. The north polar region, on the other hand, is largely sea, most of which is filled with frozen sea water in the form of floating ice. Therefore, although it is proper to speak of a South Polar or Antarctic ice cap, it is incorrect to speak of a North Polar or Arctic ice cap. The only large ice cap, or ice sheet, in or near the north polar region is the Greenland Ice Sheet.

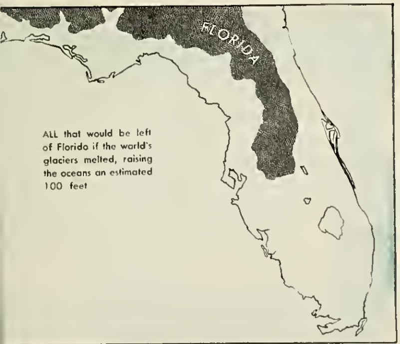
Although the lion's share of the world's ice is situated in high latitudes, there are, nevertheless, glaciers in Africa, South America, and even New Guinea—regions directly on, or almost on, the equator itself. True, the equatorial belt includes the low-lying basins of the Amazon and the Congo, but it also includes some high mountains. In Ecuador, the Andes, more than 18,000 feet above sea level, have glaciers. So do the three highest peaks in equatorial East Africa—Ruwenzori, Kenya, and Kilimanjaro—16,000 to 19,000 feet above sea level. And high on the 16,000-foot mountains of central New Guinea, surrounded by hot, steaming, tropical rain forest, are two small ice sheets! All these ice bodies exist because of the low temperatures at such high altitudes, and because of abundant snowfall brought by moist winds blowing from nearby oceans. The combination of low temperature and abundant moisture is the key to the existence of glaciers anywhere in the world.

Are these and other glaciers maintaining themselves in health and vigor, or are they gradually disappearing? The answer to this question is easy, because we have the records of many observations made in recent years and in the historical past. During the last hundred years or so, glaciers the world over have been on the decline, and they are still dwindling. Since the time of the exploration and settlement of western United States, some of the smaller ones in that region have disappeared completely. This is a serious matter for communities in the Pacific Northwest that get their power from electric installations on streams fed largely by glacial meltwater. If the present trend should continue, these people can look forward to a time—and not far in the future, either—when their power supply will virtually disappear.

The question of whether this worldwide shrinkage of glaciers will continue indefinitely is closely connected with the familiar question: Are the glaciers of today relics of the "Ice Age"? Until recently it was widely believed that our glaciers are vestiges of those cold prehistoric times. However, recent research has led us to believe that, although the big ice sheets are "Ice Age" survivors, thousands of the smaller glaciers of today are only a few thousand years old. These glaciers were "reborn" about the time of the earlier Egyptian civilizations, when chillier world climates followed upon a period when climates were, in general, warmer than they are today. This climatic change implies that the Earth's temperature has not been growing uninterruptedly colder since the "Ice Age." If the temperature trend has reversed in the historical past, we see no reason why it cannot do so again; and so it is not at all certain that we are moving steadily toward a glacier-free world.

Spence Air photo

▲ CREVASSES in the surface of Tiger Glacier, Alaska. Too wide to jump and too deep to descend and reascend, they make travel almost impossible. An Army Air Forces' B-17 crashed in such a spot on a Greenland glacier in 1943. The tail broke off and fell into a crevasse. Rescue of the survivors took four months



ALL that would be left of Florida if the world's glaciers melted, raising the oceans an estimated 100 feet

Natural Camouflage
AIDS GAME BIRDS

The camera demonstrates that in order to see everything on a woodland stroll, you have to look twice

By BEN EAST

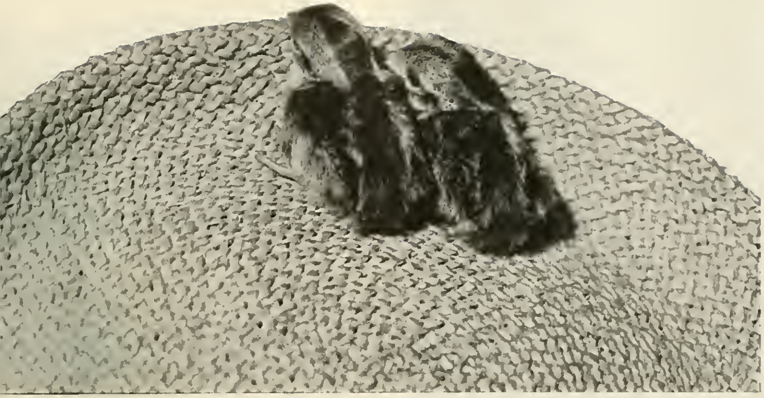
▲ HUNTING WITH THE CAMERA. The author levels a "Big Bertha," a 24-inch naturalist's camera, on a well-camouflaged hen pheasant nesting upon the bare woodland floor a few yards away

► THE PROTECTIVE COLORATION of the brooding hen pheasant is so effective that she is ordinarily safest when motionless. This bird refuses to leave her nest even when a visitor parts the grass above her

▼ EVEN with a human hand only a few inches from her head, the pheasant remains quiet

ARMY technicians who qualify as camouflage experts have no reason to believe they are doing anything new. The natural world is replete with dramatic examples of nature's own camouflage, many of them astonishing in their effectiveness. Take, for example, ground-nesting game birds like the pheasant, the woodcock, the ruffed grouse, and the various wild ducks.

It is well known that game birds lead a hazardous existence. In addition to seasonal risks from hunters, they are beset on all sides by natu-



◄ Newly hatched chicks of the bobwhite quail are so well camouflaged that they must be placed on some alien background, such as this straw hat, to give the camera a fair chance at them. In their natural homeland of grass and weeds, no camera could spy them out

▼ Ruffed grouse chicks: masterly examples of the art of camouflage. There are seven among this handful of leaves. Did you spot them all at first glance?

ral enemies, which seek them out as prey literally from the egg to the end of their lives. And because they often nest in unsheltered and unprotected locations on the ground, they are especially vulnerable during the season when they are laying and brooding their eggs.

As if to compensate for this risk, they have been granted the boon of highly successful natural camouflage. We must be cautious, of course, in evaluating protective coloration in nature. A creature that seems to be almost perfectly camouflaged may have quite a different problem with enemies whose senses are different from ours, particularly if the sense of smell is relied upon. But there are few more impressive examples of protective coloration in the outdoors than those provided by the females of these birds. In many cases the males lack this protection or enjoy it only to a limited degree. The cock pheasant's gaudy colors suit him poorly when it comes to hiding himself in a grassy summer field. The plumage of the mallard drake renders him anything but inconspicuous. But there is never a false note in the color pattern of the hen pheasant or the female mallard. Every tone of black and umber, gray and tan, blends into the normal background of the bird to match dead grass, dry leaves, frosted brakes, bare earth, and mottled patches of shadow and sun. And the chicks, who must live the early weeks of their lives entirely on the ground, are also well protected in similar fashion. Camouflage is no new thing in nature!

Weird-looking astronomical "eyes" that probe some of the most fascinating mysteries of outer space

By Clyde Fisher

Honorary Curator, Department of Astronomy and the Hayden Planetarium, American Museum of Natural History

If you have ever driven past the Mount Wilson Observatory, near Pasadena, California, you may have wondered what sort of astronomical studies went on in a curious looking tower that rises 150 feet from the ground. What delicate instruments would one find inside the dome at the top, which can be reached only by a long, slender ladder? And what sort of information is gathered from outer space and interpreted here?

The part you see above the ground arouses one's curiosity, but what lies underground is stranger still. There is a deep well directly under the tower.

Photos by Gladys Diesing

▲ The highest sun tower in the world: the 150-foot solar telescope atop Mount Wilson, in the Sierra Madre Mountains of California. At a few scattered places throughout the world, imposing instruments like this one are discovering new facts about atomic activity in the sun's atmosphere, 93,000,000 miles away

➤ A mirror, delicately moved by clockwork, reflects the sun down through the central shaft and thence to the bottom of an 80-foot well

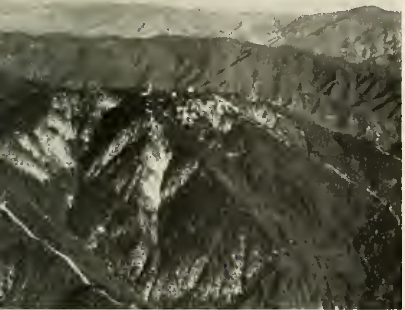
SUN TOWERS

This huge assembly is used for studying activity in the sun's atmosphere. Though most of us may be unaware of it, the sun emits gaseous outbursts of great size and violence. To get an impression of their size, imagine a gigantic flame-thrower that could hurl a flame from here to the moon. Many of the sun's "prominences," as they are called, shoot out as far as this and some much farther.

The greatest prominence yet recorded, which was photographed at Mount Wilson in 1946 by Edison Pettit, went to a height of over a million miles. (In contrast, the atomic explosion at Bikini was safely observed from a distance of only several miles.)

For reasons that are not quite clear, some of the sun's prominences leap into space and then suddenly reverse their direction and rush back into the spot from which they originated, as is beautifully shown by motion pictures made at the McMath-Hulbert Observatory. The physical principles involved in this puzzling behavior are probably the same as those associated with the explosions and implosions observed and photographed at Volcano Parícutin, in Mexico. These prominences are most conspicuous when sunspots are numerous, and they are known to be correlated with magnetic storms, the polar aurorae, interruptions in radio transmission, and perhaps with the weather of the earth.

Formerly the sun's prominences could be studied only during a total eclipse, but now it is possible to observe them on any clear day from one of these sun towers. There is another sun tower 60 feet high, near the tall one shown here on Mount Wilson; and two are located at the McMath-Hulbert Observatory, near Pontiac, Michigan—the only ones in the eastern United States. These are 50 and 70 feet high and remind one of tall and rather fancy farmer's silos. One 80 feet high is located in Arcetri, near Florence, Italy, on the hill where Galileo used his first telescope. And another is situated at the astrophysical observatory at Potsdam,



o by Clyde Fisher *Photo by Gladys Diesing*

▲ AIR VIEW of the Mount Wilson Observatory and Sun Towers

➤ NEAR the sun towers on Mount Wilson is the dome containing the 100-inch Hooker Reflecting Telescope, next to Palomar the largest in the world

Germany. This one, when first constructed, was known as the Einstein Tower, because it was used for one of the tests of the theory of relativity.

On top of every sun tower is a small dome in which there is a movable mirror that is turned by clockwork so that it follows the apparent motion of the sun. This

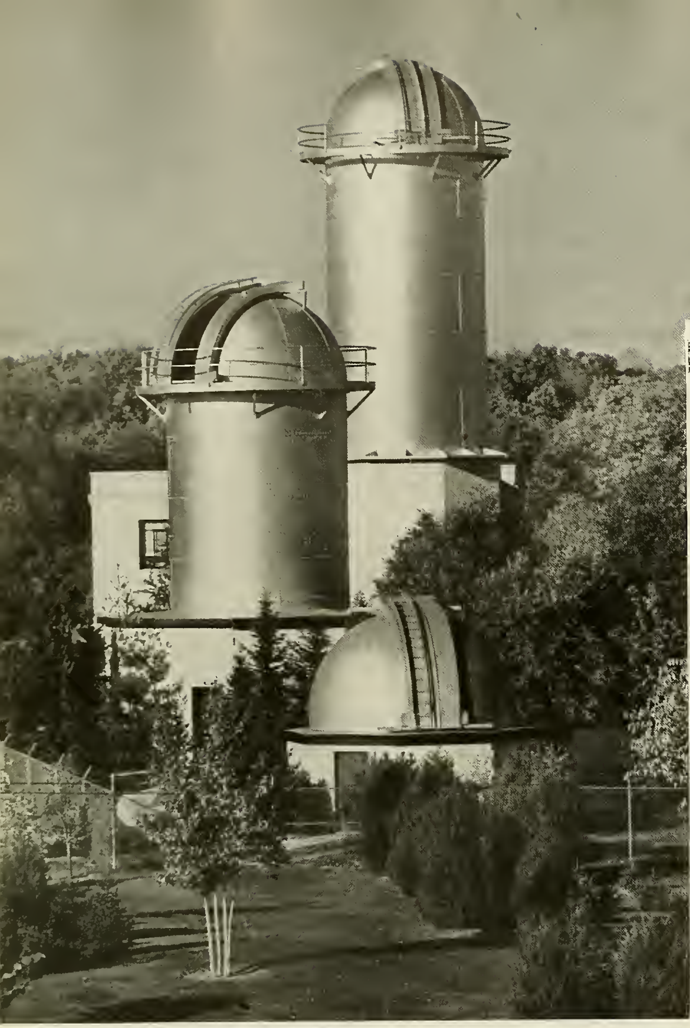
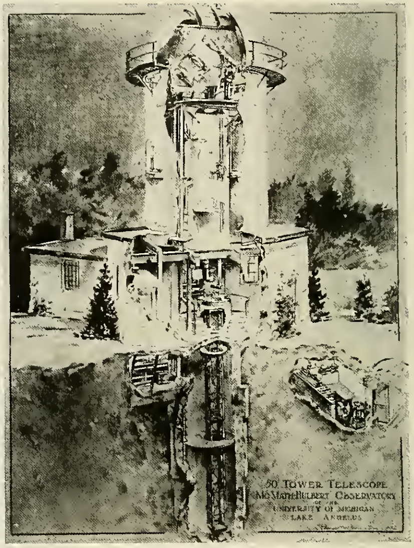


Photo by Colonel Sidney D. Waldon

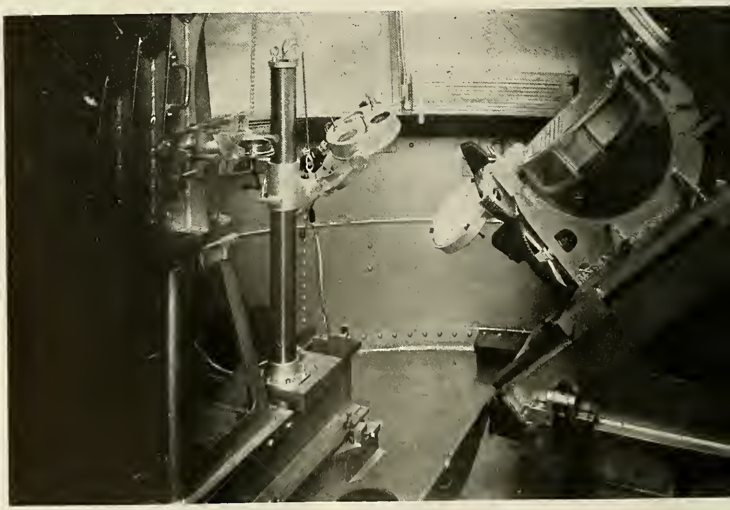
▲ THE McMATH-HULBERT OBSERVATORY at Lake Angelus, near Pontiac, Michigan. In the small dome, pioneer work in motion picture photography of the sun, moon, and planets was achieved. The Tower Telescope in the middleground, 50 feet high, contains the Stone Radial Velocity Spectroheliograph. The 70-foot McGregor Tower Telescope is in the background



McMath-Hulbert Observatory illust.

▲ A CUT-AWAY DRAWING showing the "well" beneath the 50-foot Tower Telescope, into which the image of the sun is reflected and returned to instruments in the observation room

McMath-Hulbert Observatory ph



➤ PHOTOGRAPH of the automatically controlled mirror which follows the sun. It reflects the image down the tower and into the well at the bottom by means of a second mirror at left mirror reflects the image of the sun to a stationary mirror near by, which in turn reflects it through a lens and down to a laboratory. In the 150-foot sun tower at Mount Wilson, the laboratory is at the base, and here an image of the sun 16½ inches in diameter is formed. Under the laboratory is a well 80 feet deep, at the bottom of which is a "grating" for spreading the sunlight into a very broad spectrum, like the "colors of the rainbow" produced by a prism. The spectrum is projected up into the laboratory, where it can be studied. It was here on Mount Wilson that the late Dr. Charles E. St. John demonstrated the shift of the spectrum lines of the sun toward the red as a result of the gravitational pull of the sun, in verification of one of the tests of the Einstein theory of relativity.

In the Einstein Tower, which the writer visited in 1925, the observation room was located underground. The spectrum was projected into a room at one side, which no one was allowed to enter. The room was sealed, and its temperature was automatically controlled to within one one-hundredth of a degree. The lines of the spectrum were studied from the outside through special windows by means of opera glasses.

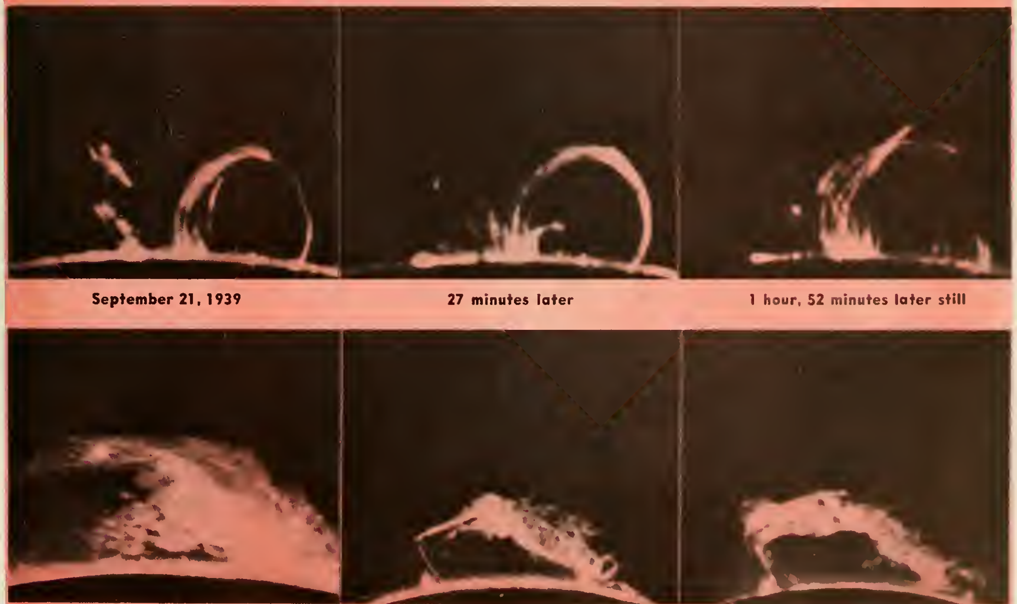
Most of our knowledge of the sun's composition comes from the study of these spectrum lines by means of the spectroscope, which is the most powerful tool of the astrophysicist. When Sir Isaac Newton discovered, in 1666, that white light is made up of component colors, the first important step was made toward the science of spectrum analysis. The spectrohelioscope permits observation of the collective activities of atoms in the sun and stars.

As applied to the sun, the instrument was originally an elaborate sort of camera known as a spectroheliograph (literally, a "recorder of the spectrum of the sun"). This was invented independently by George Ellery Hale and Henri Deslandres in 1890. Not until 1924 did Hale perfect an instrument for conveniently studying the prominences directly by eye. This was appropriately called a spectrohelioscope. Next, a way was found to record the prominences in motion pictures, and in the sun towers at the McMath-Hulbert Observatory this technique has been developed well-nigh to perfection. Since the process combined the principles of the spectroheliograph and those of the motion picture camera, the instrument was named the *spectroheliokinematograph!* Motion pictures obtained with this instrument by means of lapse-time photography reveal many amazing activities in the sun's atmosphere previously unsuspected by astronomers.

▾ WHAT THE SUN TOWER "SEES": activity in the atmosphere of the sun as photographed at the McMath-Hulbert Observatory. Gaseous outbursts that would reach considerably farther than from here to the moon have been observed

TWO TYPES OF PROMINENCES

McMath-Hulbert Observatory photos



September 21, 1939 — 27 minutes later — 1 hour, 52 minutes later still

August 24, 1939 — 17 hours, 4 minutes later — 3 hours, 38 minutes later

DO THEY *Follow the Leader?*

Philip Gendreau photo

▲ **MANY ANIMALS show a tendency to follow a leader. But they do not learn the common acts of everyday life by imitating another animal that has already mastered them**

Brains and the Beast III

It is popular belief that the young animal learns by imitating the behavior of its parents. But psychologists have proved that experience, combined with inherited tendencies, is the best teacher

By FRANK A. BEACH
Professor of Psychology, Yale University

A GREAT deal of nonsense has been written about imitation in animals. Of course imitation occurs, but the types of situations in which it appears and its effects upon subsequent behavior are often grossly misinterpreted. If you want to understand the role of imitation in animal life, you must learn what kinds of behavior are imitated and the conditions under which imitation takes place.

The simplest and probably the most common form of imitative behavior consists merely of following another animal. Naturalists have described "follow-the-leader" behavior such as that shown by the deer of England and the wild monkeys of many islands. Every farm boy has seen similar behavior in domesticated herd animals. When cows leave the pasture for the barn, one individual starts the procession, and the rest move slowly along, strung out in a line behind her.

The gregariousness of sheep is so proverbial that they seem almost incapable of independent action, and we characterize a person as "sheeplike" when he is dominated by group behavior. Too little is known about the psychological forces that impel men and women to lose their individualities in certain social situations and to behave like sheep. Perhaps social psychology will some day be able to explain the mass hysterias which lead to lynchings, and the other types of group behavior in which the almost irresistible power of contagious emotions robs the individual of personal initiative and independent thought. The answer is not yet available in terms of human psychology, but as far as the sheep is concerned, it has been discovered that much of his "sheeplikeness" is traceable to experiences acquired very early in life.

Dr. J. P. Scott, a zoologist interested in the social behavior of animals, has investigated the development of "following-tendencies" in lambs raised by ewes and in others raised on a bottle. From the first day of its life, the lamb's relations with its mother are such as to encourage and strengthen inherited tendencies toward a high degree of social behavior. When dogs or other animals molest the lamb, its cries bring the ewe, who does her best to drive away the troublemakers. Until it is old enough to graze, the youngster's sole source of food is its mother. Under natural conditions, then, the very young sheep is constantly "rewarded" for staying close to the ewe; and laboratory tests with many species of animals have shown that one of the most effective ways to transform any incidental response into a deep-rooted habit is to reward the animal each time the response occurs.

As its basic needs for food and protection gradually change, the growing lamb becomes less dependent upon its mother; but by the time it is weaned, it has formed strong habits of gregariousness which persist throughout life.

Bottle-fed lambs, however, are usually social outcasts as far as the rest of the flock is concerned. They do not respond normally to the calls of their fellows, and in the pasture they graze in solitude, paying little attention to the rest of the group. The basic tendency to form associations with other creatures is not lost, however, but merely modified, for the bottle-fed lambs learn to follow human beings much as a normal sheep follows its own kind.

Goosey, Goosey Gander, Whither Do You Wander?

Certain types of birds also give evidence of an unlearned tendency to follow and stay close to other individuals, but the "objects of their affections" may be strangely modified by the experiences of infancy. European Gray Geese are highly social, and the goslings rarely stray far from the goose. Usually she is the first living thing they see upon emerging from their shells, and from the moment of their hatching the parent represents a source of protection and food. From the first days of life the little birds come running when the mother calls, and frequently the reward is a juicy grasshopper or worm that she has discovered. A few weeks or months of such experiences suffice to "stamp in" habits that may endure until death.

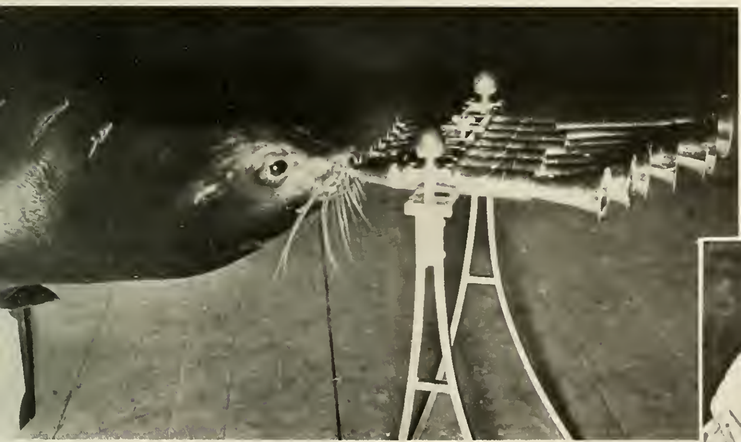
The famous German biologist, Dr. Konrad Lorenz, found it a simple matter to substitute himself as the foster parent for a brood of goslings. Robbing a goose of her eggs just before hatching, the scientist made certain that *he* would be the first creature the newly-hatched birds would see. From the very beginning he regularly called them to food and saw to it that provisions were available when his "children" responded. The young birds appeared to accept the experimental situation with perfect equanimity and seemed to develop a strong, filial feeling for their foster parent.

When Professor Lorenz walked briskly about the farm, his feathered charges followed in single file, waddling ludicrously from side to side in a desperate effort to keep up with their benefactor. When a barrier appeared in the path, goslings too small or timid to leap the hurdle ran back and forth, uttering plaintive calls and showing every indication of profound disturbance. If the scientist launched his canoe and paddled across the pond, the little geese unhesitatingly took to the water to follow. As soon as they were old enough to fly, they even attempted to pursue their foster parent when he took off in an airplane.

Teaching Rodents to Imitate

There are many animals that show little or no "following behavior" in nature, but at least some of them can be taught to play "follow-the-leader" in the experimental laboratory. One psychologist at Yale University noted that a laboratory rat rarely pays much attention to what others in its cage are doing, except that males follow a female in heat and resident rats investigate a newcomer.

Dr. Neal Miller conducted an experiment in which hungry rats were rewarded with food when they followed another rat and were punished with an electric shock if they failed to do so. Under these conditions, the rats learned to imitate and would faithfully follow the leader when he made a right-hand turn at the end of a long, straight runway. In another test, imitation was punished and non-imitation



A. F. Sozio, from Gendreau

▲ A FEW CIRCUS SEALS have been taught to play "My country, 'tis of thee . . ." on horns, though the performance is sometimes interrupted by a burst of self-applause. They are playing "by position" rather than "by ear" and would do as well if every horn made the same sound

Keystone photo

➤ PARROTS, mynas, and various other birds can be taught to "talk," but they don't know what they are saying. They learn by imitation. A phonograph makes the task easier, according to Walter Holbrook, an English bird trainer

Ann Rosener, from Pix

▲ A CHILD will learn to walk without instruction in almost the same length of time it would take with instruction. The advantage of early teaching soon ceases to be apparent, because untaught children of the same age attain equal proficiency through the "school of hard knocks"

was rewarded. The rats then learned to take a left turn if the leader took a right, or to turn right when he turned left.

Little Sir Echo

Vocal mimicry is a natural element in the behavior of some amphibians, nearly all birds, and many mammals. In its simplest form, this type of imitation seems to reflect a strong impulse to reproduce certain instinctive calls when other individuals are heard to produce them.

One May evening I was walking along the shore of a pond in which I was sure there must be hundreds of the tiny tree frogs called Spring Peepers. Although it was their breeding season, not a single male was sounding the "sex call." I gave a few very high whistles which I hoped would sound like a lovelorn tree frog, and sure enough, one frog began to call, and soon a chorus of dozens was going bull blast.

In the course of an experiment conducted several years ago at the Department of Animal Behavior of the American Museum of Natural History, we had occasion to make a recording of the sounds produced by a bellowing bull alligator.* When the record was played on a phonograph beside the reptile's tank, he lashed the water to foam with his powerful tail and gave vent to an ear-splitting series of answering roars. Field naturalists believe that the bellowing of the adult male serves to announce his pre-emption of a breeding stand and perhaps to discourage other males from entering his territory. In the Everglades during early spring, one can hear old bulls roaring back and forth at each other over distances of a mile or more.

Singing Lessons for Birds

Everyone knows that each kind of bird has its characteristic repertoire of songs. Ornithologists have debated whether the distinctive calls are learned when young birds hear older ones sing or whether the song is "instinctive" and appears exclusive of learning or imitation.

It might easily be that the situation differs in different species, and the question is far from answered; but half a century ago, Professor W. D. Scott of Princeton University attempted to settle the problem by rearing various song birds in isolation or with foster parents.

It was quite obvious that some birds were strongly influenced by the songs they heard while growing up in Dr. Scott's avian nursery. Baltimore orioles were taken from the nest as fledglings and hand-reared where they could hear no other birds. When they were old enough to sing, the orphans first produced short call notes quite similar to those of wild orioles, and this suggests that at least this aspect of bird song is not dependent upon imitation. However, as the full song developed, it grew into

Harold M. Lambert, from Frederic Le

➤ ALMOST ANY DOG can be taught to sit up and "beg," but close association with another dog which has mastered the trick does not hasten the learning process. The dog does not learn new tricks purely by imitation

*Frank A. Beach, "The Saga of Oscar the Musical 'Gator," *Natural History*, LIII, (Dec., 1944) 456 something entirely unique and quite unlike that of the free bird. The next year a new brood of orioles was brought into the laboratory and kept in the same room with the older, hand-reared birds. As they matured, the younger birds adopted the new melody sung by the older captives. Professor Scott concluded that orioles will learn by imitation to reproduce a particular song but that with no "model to guide them," they will hit upon and perfect a song of their own.

Young, hand-raised birds reared in close proximity to adults of another species may sing more like their neighbors than their parents. In Scott's experiments, Rose-breasted Grosbeaks kept in cages adjacent to those of Green Bulbuls sang so much like the latter that it was necessary to look closely to see which bird was singing. Ordinarily the difference is apparent to even a casual listener.

Vocal mimicry occurs in nature as well as in the laboratory, and everyone is familiar with the mockingbird's ability to duplicate the songs of other birds. It may be less generally recognized that free birds of several species occasionally imitate the barking of dogs, the croaking of frogs, and even mechanical noises produced by machinery.

The ability of some birds to imitate sounds produced by human beings has been recognized for centuries. In certain parts of the world the bullfinch is cultivated for its ability to whistle musical airs, and canaries are also able to learn and whistle simple tunes. Starlings rival the parrot in reproducing short, spoken sentences; and jays, magpies, and crows have been taught to pronounce words and to whistle in particular ways.

The late Dr. Frank Lutz, for many years Chairman of the Department of Insects and Spiders at the American Museum of Natural History, was very proud of his pet crow, which had learned to repeat several short words. But Dr. Lutz forgot that pride goeth before a fall, and he proceeded to teach the crow to imitate the whistle that sometimes breaks the stillness when an attractive girl passes. The bird quickly learned this "wolf whistle" and often gave it spontaneously. The unfortunate fact was that the whistle often occurred when people were walking along the sidewalk bordering the back yard. Dr. Lutz assured me that each time a comely young lady passed, he held his breath and prepared to dive behind the nearest rosebush.

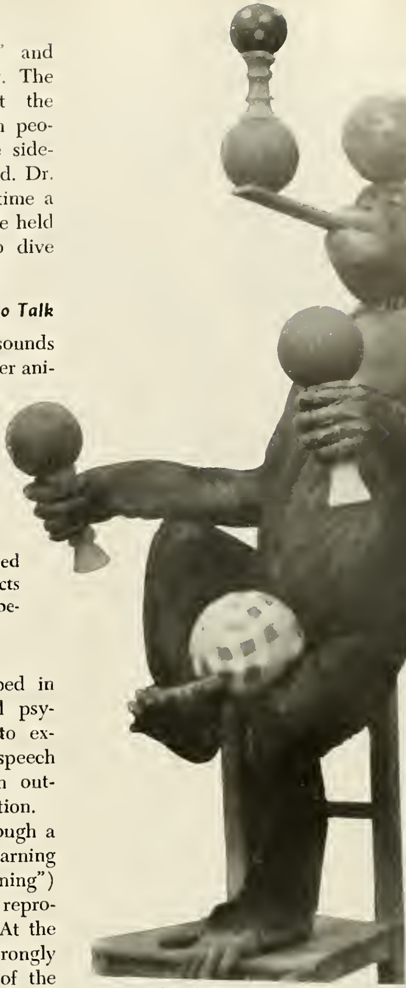
Imitation Helps Babies Learn to Talk

The impulse to reproduce sounds is by no means limited to lower animals. It is strongly developed in human beings. Some social psychologists have attempted to explain the development of speech in the human infant as an outgrowth of simple vocal imitation.

The theory holds that through a rather elementary form of learning (technically called "conditioning") babies start early in life to reproduce the sounds they hear. At the same time, the infant is strongly impelled to vocalize much of the time. Hearing the sounds that his own voice produces, the very young child promptly repeats them. The result is the almost universal babyhood habit of uttering the same sound, such as "da-da-da-da-da," over and over again.

Each time the baby says "da," his ears receive the sound. Nerve impulses pass along the auditory nerve to the "hearing area" of the brain, and new impulses are dispatched from there to the "speech area," which controls the vocal muscles. The "endless chain" thus set in motion may continue until fatigue sets in or something distracts the infant's attention.

This practice in repeating sounds helps to strengthen the imitative tendency and at the same time enables the child to reproduce various types of sound with greater and greater fidelity. As the developing infant begins to pay increasing attention to people, he starts to reproduce the noises they emit, still making use of the syllables perfected in the course of his earlier babbling. Through a long period of time, control over the vocal muscles becomes more delicate and precise, and words are articulated more clearly. Eventually intellectual development progresses to a point where actual speech (as contrasted to the imitation of vocal sounds) is possible.



➤ COULD YOU DO IT? Reward for success is the key to most animal training, but animals differ widely in their desire to please. This chimpanzee at the Budapest Zoo attained considerable proficiency in acts quite foreign to its natural behavior pattern

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Do Animals Use Speech?

Talking birds do not actually use speech. Their performance, like that of very young children, consists

Continued on page 370

Apache

DEVIL (CROWN) DANCER

Costumes OF THE SOUTHWEST INDIANS

By Andre de Dienes

THESE remarkable photographs by Andre de Dienes give a glimpse of the native Indian life anyone can see on a trip across northern New Mexico and Arizona. Following the well-traveled transcontinental artery known as Route 66, one passes through one of the richest concentrations of Indian culture to be found in America. Particularly between Santa Fe and Flagstaff, Arizona, is one beckoned to both sides of the highway by opportunities to observe the modern life of a people whose ancestors occupied this continent centuries before our own forefathers set foot on it.

In view of the oppression suffered by these people during the four centuries since the first Spanish explorers visited the arid Southwest, it is somewhat surprising that they have retained any of their cultural identity. The natives with whom Coronado passed the winter of 1540-41, not far from the present city of Santa Fe, were at first friendly. But the explorers offended them by constant demands for food and clothing and by mistreating their women, and the Indians rebelled. Their village was attacked, and prisoners were taken. When the Spaniards prepared 200 stakes on which to roast them alive, the Indians renewed the fight. They escaped the torture that had been prepared for them but were all killed in other ways. Two monks who remained behind to preach to the natives were soon killed.

The ensuing decades saw the establishment of Christian missions among the Pueblo Indians and tribes farther west. Many worthy men labored in the cause of Christianizing the natives, but the white man already had a bad reputation. The vanguards of "civilization" contained many adventurers who were unscrupulous and cruel. In contrast to this motley company, the missionaries must be credited with having given the native some assurance that the white man was not devoid of human decency. However, it can also be argued that their zeal to enforce immediate conversion resulted in the suppression of many colorful native practices, which often were no more harmful than a children's Halloween celebration.

Many forces have worked to rob the Indian of his cultural heritage. He has been made to feel ashamed of his most cherished traditions and has been induced to adopt conventional habits that are no more permanent than this year's hat styles. Meanwhile, he has lost beyond recovery many things that were his alone.

Happily, the trend has now begun to change. The ancient arts are being revived, and ceremonials like the ones represented in these pictures can be witnessed at Gallup, New Mexico, any summer at the time of the "Ceremonial," which attracts Indians of many outlying tribes.

It behooves the visitor among these Indians to remember that he can learn from them as well as they from him. And if the tolerant and receptive attitude is difficult, one might recall the story of the Indian who was imported to New York in full costume to advertise a motion picture in front of a Broadway ticket office.

People gathered to stare at him.

"How do you like our city?" asked one, more patronizing than the rest.

"Big city all right," replied the Indian. "How do you like our country?"

HOOP DANCER

Jemez

BUFFALO DANCER

Zuñi

GIRL IN COSTUME WITH SILVER AND TURQUOISE JEWELRY

Taos

Pueblo

OLLA
BEARER

Laguna

SHIELD DANCER

Hopi

WHITE
BUFFALO
DANCER

Zuñi

DANCER WITH
HEAD TABLET

The Worm THAT RUINED A NATION

How the life cycle of the blood fluke has for centuries brought lethargy and death to the sons of the Nile

By JOSEPH BERNSTEIN

ALMOST half a century ago, an obscure student of parasitic worms made an unusual discovery. He had been examining a number of Egyptian mummies of the twentieth dynasty (1250-1000 B.C.) when he suddenly discovered in the shriveled remains a number of tiny ellipsoid bodies with prominent terminal spines. There could be no doubt about their identity. They were the eggs of that peculiar worm, *Schistosoma,* the blood fluke, known to be responsible for a dangerous disease still prevalent in Egypt.

This discovery tied in remarkably with findings in an entirely different type of investigation. Scholars poring over medical papyri from the very earliest days of recorded Egyptian history had repeatedly come across references to a disease characterized by bloody urine, a condition science now calls hematuria. Hematuria is the most striking symptom of Egyptian blood fluke disease.

The grandeur of ancient Egypt now survives only in monuments and in tomb relics on the shelves of museums. The once proud Egyptians, whose nation was the center of culture and civilization, have yielded their position of world leadership. The modern Egyptians labor humbly in the shadow of their ancient glory; but they have one thing in common with their illustrious forebears: they, too, are infected with blood flukes.

Schistosoma has certain traits not ordinarily found in other members of its class. It lives exclusively in the veins of its host, and it has separate sexes. Nearly all the other flukes are hermaphrodites, both sexes being combined in one body.

There are two other equally common and equally harmful blood flukes in tropical countries, which do not live in the vessels of the bladder but rather in the blood vessels leading from the intestine to the liver. The one under discussion here is called *Schistosoma haematobium.*

The male is perhaps the most outstanding model of husbandly devotion to a mate in the entire animal kingdom. He rarely lets his wife out of his grasp, much less out of sight. Cylindrical in shape, and about a half-inch in length, the underside of his body is folded into a groove in which the female lies clasped, with only the front and rear portions of her body protruding. In this manner they live in the veins, devouring the red blood cells of their unfortunate host.

In the veins blood flows toward the heart, but the coupled worms steadily migrate against the current into the smaller and smaller veins, until they reach the tiniest venules of the urinary bladder. There they press forward until the bore of the vein will not permit them to move farther. Here, at last, the thinner female separates from her spouse and squeezes into the narrow venule, depositing one egg at a time. And as she gradually withdraws, meticulously spacing the eggs along the length of the blood vessel so that they resemble a string of beads, the distended wall of the vein closes back—to be punctured by the sharp spines at the end of each egg.

In this way the eggs succeed in working their way out of the veins and into the cavity of the bladder, where they are voided with the urine, thus gaining access to the outside world. In water the eggs hatch into larvae covered with a thick coat of exceedingly tiny hairs, the whiplike lashing of which propels them through the water. They have to move very fast, these larvae, for they are engaged in a strange quest which must be completed in 48 hours, or they perish. What are they looking for?—for a certain species of snail, which they need for the completion of their next stage of development. Unless they can find such a snail promptly and bore into its tissues, the parents of these larvae will have wasted all the ingenuity and labor necessary for the journey thus far, for they can develop no further.

Let us assume, however, that they find such a snail. (Later we shall see how the ancient customs of the Egyptians almost conspired to bring the larvae and the snails together.) Having bored deeply into the snail's tissues, the larva transforms itself into a "sac" full of minute balls, which eventually produce a number of free-swimming larvae with forked tails. In turn, these new larvae, known as "cercariae," swim away from the snails to hunt for the next and final victims—human beings.

The cercariae are astonishingly well adapted for penetrating human tissues. Powerful suckers located at the mouth and underside assist the larvae in attaching themselves, and their bodies contain glands that pour out secretions capable of digesting flesh. The ducts of these glands open at the anterior tip among spines that assist penetration. Once the cercariae have passed through the skin, they work their way to the lymphatics and blood vessels, which transport them to the heart and lungs and later to the liver, where they develop into mature worms. At long last, after such a wearisome and roundabout journey, they return to the blood vessels of the bladder, where they will spend the remainder of their lives placidly feeding on blood cells and laying eggs in the minute venules of the bladder walls. There the elaborate cycle will begin again.

But were it not for the time-honored habits and customs of the Egyptian people, it is doubtful whether *Schistosoma* could have conquered their country. It would appear that these lowly worms could not have devised a more successful method for exploiting their own advantage than that provided by the foibles and unsanitary practices of the Egyptians.

For ages the Nile has been the great sewer into which millions of peasants have almost daily voided their excreta—and blood fluke eggs. But also this historic river has always been the major source of water for the country's irrigation system. And as the water, laden with *Schistosoma* eggs, flows sluggishly through the ditches and canals, it becomes clogged with vegetation upon which snails feed. Children playing in the water stand barefoot in these ditches and canals, women wash clothes in it, and men do their work in contact with it, their skin exposed to water infested with cercariae, which bore into their bodies. Soon after the penetration of these worms, the skin shows eruptions where the parasites entered. Usually the victims pay scant attention to such a slight annoyance. Only later, when the parasites start their migrations throughout the body, will they suffer from headaches, loss of appetite, fever, and difficult breathing.

Gradually and insidiously the other symptoms appear—weakness, pallor, hematuria, and anemia. The death rate is appallingly high, running into hundreds of thousands a year. It has been estimated that 60% to 85% of the entire population in Egypt is infected with blood flukes. One prominent authority, Dr. John B. Christopherson, asserts that this disease, more than anything else, is responsible for the indolence of spirit, want of character, and backward condition of the Egyptian peasant. "It is almost certain," he says, "that Egypt will never be able to take her proper place among the nations of consequence until she has got rid of the parasites which are poisoning her blood and consuming her energy."

The standard treatment for blood fluke disease has been the administration of antimony compounds, which have been of considerable use but not effective to the point of wiping out the disease. Actually, the only suitable remedy would be to overhaul the sanitation system completely and to establish habits of cleanliness among the people. But by a bitter coincidence, it appears that the present agricultural program will spread the disease even deeper into the country. For, in an effort to eradicate the appalling poverty of the Egyptian farmer, the government is engaged in a plan to improve and extend the amount of arable soil by expanding its irrigation system. This may improve the economic conditions, but it will also increase the cases of blood fluke disease.

Historians are generally loathe to attribute the decline and fall of a civilization to a single factor. The eclipse of Egypt as a mighty world power undoubtedly resulted from a complex interplay of a variety of causes. But there can be little doubt that prominent among them was the lowly blood fluke, which steadily devitalized the people through the ages.

Blood flukes have more than an academic interest to people on this continent, however. At a recent meeting of the American Association for the Advancement of Science, Dr. Norman R. Stoll, parasitologist of the Rockefeller Institute for Medical Research, made the dire announcement that over 1,000 American servicemen have returned from the Pacific area suffering from one of the blood fluke diseases. If there are snails in this country suitable for the development of the blood flukes, it is possible that the disease may secure a foothold on this continent. Health authorities will have to be exceedingly vigilant against any new outcroppings of this disease. The example of what happened to Egypt should serve as ample warning.

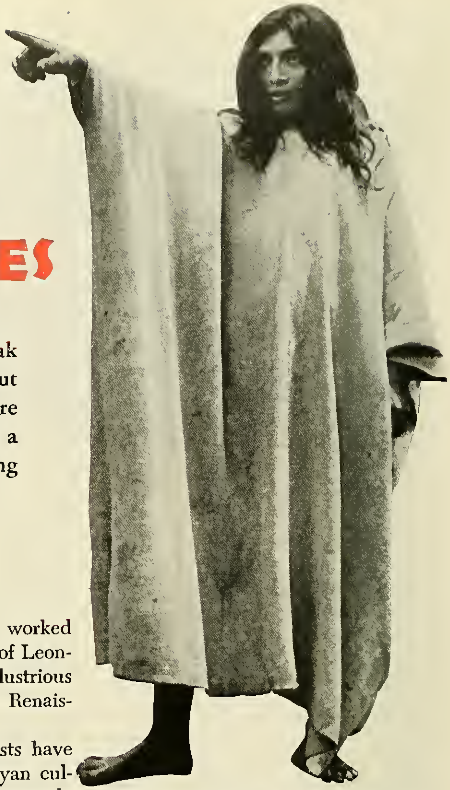
Drawing by Shirley Lapp

BACKWARDS A DOZEN CENTURIES

Recent discovery of the ancient Mayan center of Bonampak ("Painted Walls") and inquiries among a tribe of about 200 extremely primitive Lacandone Indians who are descendants of the great Mayas of old, opens a way to a greatly improved understanding of one of the outstanding early American civilizations

By Charles Morrow Wilson

All photographs by Giles Greville Healey



▲ A Lacandone man wearing the same type of dress that his forebears wore fifteen centuries before. These modern representatives of the Mayas finally agreed to guide Mr. Healey to the ancient shrines, where they still worship like the people of old

BONAMPAK, although it may have been founded much earlier, was in its prime during the seventh century, according to date glyphs. It includes a group of eight standing temples, which the Lacandones continue to use as places of worship. In the same area are ruins of at least 17 other ancient ceremonial centers dating from the first great empire period of the fabulous Mayan civilization.

The discovery was made during 1946 by Giles Greville Healey, who recently led an official Carnegie Institution expedition to the site. High lights include three roomfuls, or approximately 1200 square feet, of superbly preserved and brightly painted murals or frescoes, significant and elaborately carved altar stones, and three highly revealing carved record stones. One of these stones, about 21 feet high, 8 feet wide, and weighing at least 4 tons, is exceeded in size by only one known Mayan stela.

The newly discovered painted murals, which have been photographed by Mr. Healey and copied in detail in water color by skilled artists, are probably the most revealing aspect of the new discovery. Much of the painting is on sloping or overhead stone surfaces and shows remarkable skill in perspective on the part of the Indian mural artists who worked many centuries in advance of Leonardo da Vinci and other illustrious mural artists of the Italian Renaissance.

In the past, archaeologists have been obliged to study Mayan culture and history with extremely little help from records in color. Until the Healey discovery, only a few specimens of Mayan paintings had been found, the largest previously known being the Santa Rita murals in British Honduras. At the Uaxactun ruins, there was another only a yard and a half long, which is now destroyed. The well-known paintings in the "Temple of the Warriors" at Chichen-Itzá, Mexico, are fragmentary, as are others at Tulum, Chakmultun, and Tzulá, in Yucatán. Accordingly, the greatest part of what archaeologists have thus far been able to learn about the Mayas has been based on the study and interpretation of glyphs, architectural forms, pottery, and stone carving, the latter in either two or three dimensions.

The newly discovered roomfuls of 1200-year-old murals show elaborate ceremonies, battle scenes, and stately and colorful processions of nearly life-size figures. Skillfully painted on stucco superimposed on hard limestone, they illustrate the ceremonial bars, which were the ancient Mayan scepters of authority, and also the musical instruments used by the Mayas of 1200 to 1500 years ago. These include long horns, similar in shape to Tibetan horns; large, turtle-shell rattles; and drums of wood or clay. The types of fabrics worn by the ancient Mayas are revealed in detail.

For the most part the costumes of the priests or rulers are pictured as being made of jaguar or deer skins richly ornamented with jade. The cloths, apparently made of cotton, are interwoven with numerous figures, glyphs, and planetary symbols. The colors most used are red on white, dark green on brown, dark brown on white, and bright red in sashes. The ancient Mayas, to judge by these paintings, were robust, strong featured, and handsome.

The two carved limestone altars discovered in the newly found Mayan sites are likewise of great archaeological importance. One is a medallion altar ornamented with a row of glyphs, which have not yet been deciphered. The other is considered one of the best examples of Mayan sculpture yet discovered. Its lines are at least as good as those of the stone carvings at Palenque, which are commonly regarded as the finest examples of Mayan sculpture. The Mexican Government's official representative on the expedition, Dr. Augustin Villagra, an associate of the Mexican Government's Department of Pre-Hispanic Monuments, states that his Government will endeavor to fly the larger altar to the National Museum in Mexico City. The three upright record stones, or stelae, also awaiting final appraisal, are similarly regarded as exceptionally valuable.

Like so many important archaeological finds, Healey's discovery of Bonampak was, in a way, accidental. His original purpose in penetrating the little explored Chiapas jungle was to secure motion pictures of the Lacandone Indians for a film that would record Mayan antiquities and living descendants of the ancient Mayas This educational motion picture is being made for the United Fruit Company. Healey had already photographed the Mayas of Yucatán and those of the Guatemalan highlands, who, although interesting and picturesque people, have been in contact with their Spanish conquerors since the sixteenth century and have adopted many European crafts and beliefs. This time Healey decided to record the life and customs of the much more primitive Lacandones.

In the matter of blood, the Lacandones are unquestionably the purest descendants of the builders of the great ruined cities of Yucatán and Peten. Their forefathers, stubbornly resisting every attempt to bring them under Spanish rule, fled to the most inaccessible part of their former realm, and for four centuries they have kept themselves aloof from every outside contact. During that time they have lost all knowledge of the astronomical science and hieroglyphic writing of their remote ancestors. A hand-to-mouth existence in the depths of the tropical forest has stripped their culture to the barest necessities.

Gradual encroachment by chicleros and mahogany cutters has driven the Lacandones farther and farther back from the main rivers. Always shy and fiercely averse to mixing with outsiders, some of the more remote groups occupy the least-known frontiers of present-day Mexico.

To study and photograph these fast-vanishing people, Healey set out from his headquarters at San Cristobal las Casas, an old colonial town in the Chiapas mountains, near the Guatemalan frontier. He flew to the farthest outposts of the Miramar area and there, with a pack mule and an interpreter who spoke the little-known language of these Indians, set out to find the white-robed, long-haired Lacandones.

After a week of searching in the far frontiers of Chiapas, Healey

▼ PART of the second largest known Mayan stela, or inscription stone, discovered at Bonampak. Giles G. Healey, the discoverer, is seen here beside a Lacandone Indian

◄ Sr. A. Villagra, Mexican Government archaeologist, with his reproduction of a section of the Bonampak murals

▼ A panel of a Mayan mural reproduced by Antonio Tejeda. Its hieroglyphic date has been deciphered by Sylvanus G. Morley as Maya 9.13.0.0.0., or A.D. 672

▼ J. Eric S. Thompson, Carnegie Institution glyph expert, at entrance of Bonampak temple with a group of Lacandones

▲ One of the smaller ruins at Bonampak

came upon a family group or clan of eleven of the Indians, whose thatch-roofed village is called Getja. He stayed with the clan to record in motion pictures their everyday life—how they prepared their corn fields, hunted, fished, made bows and arrows, and wove their traditional togas from tree bark or cotton, which the Lacandones grow, spin, and weave.

He learned that the Lacandones were practicing an attenuated form of the ancient Mayan religion as described by Landa and other historians at the time of the Conquest, though they no longer built stone temples or made human sacrifices. He learned, too, that the Lacandones were exceptionally honest and refreshingly truthful. Theft was unknown among them. They could not avoid saying exactly what they thought. For example, Healey said to his interpreter, "Ask that man with the glum face what he is thinking about." Back came the answer, "He's wondering when you people are going to get out of here!"

The Lacandones remained diffident, even though Healey plied them with many dollars worth of presents such as knives, mirrors, combs, fish hooks, axes, and salt. Since salt is the scarcest necessity in the area, their children eat it as eagerly as American children eat candy. Even so, the elders remained standoffish.

Having finished his photographic work, Healey proceeded to explore farther into the almost trailless forests until he succeeded in finding another settlement of about twenty Lacandones. This group, the Cedro clan, had rarely before seen a white man. Only four years ago, they had for the first time seen a chiclero, or wild chicle harvester—an Indian-Spanish cross. They had apparently never heard of Mexico, taxes, or voting; of autos, airplanes, or any other wheeled vehicles.

Healey observed that the Lacandones have none of the artistic or architectural skills of their distant ancestors and that they have long since lost the Mayan knowledge of astronomy. But he was impressed by the reverence with which these remote people referred to the ancient temples. He noted, too, that at recurring intervals the men vanished into the dense bush and remained absent for several days. They told him they were making pilgrimages to worship in the ancient temples of their fathers. But they would not permit any outsiders to follow them.

Healey left and came back with several shotguns. These he presented to the Lacandones, showing them how to use the white man's weapon and emphasizing the superiority of shotgun over bow and arrow as a hunting implement. Then he departed again to complete his photographic census of the Lacandones. When he returned to the Cedro clan, the Indians plied him with requests for more shotgun shells.

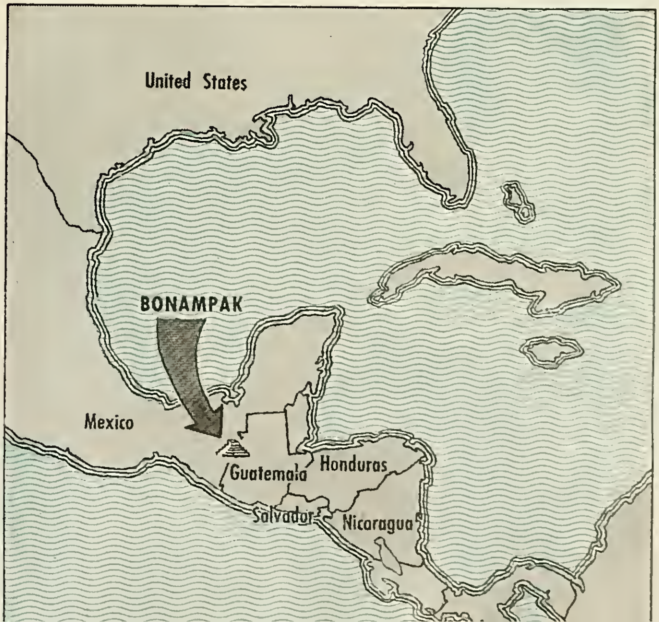
"Show me the way to the temples," Healey bargained, "and I'll give you all the shells you want!" That worked.

Finally, two of the Lacandone men led him by mysterious and hard-to-follow trails to Bonampak, where eight ancient temples lay hidden in the jungle. As he entered the biggest one, which the Lacandones call "El Tigre," a jaguar bounded out. The Lacandones were highly pleased at seeing the faithful guardian on the job. Within one year the Lacandones had shown Healey the way to 17 different sites with a total of 48 standing ruins.

Healey describes his grand adventure as follows:

"These temples were beyond anything an archaeologist or explorer could have imagined. It took days to get to these ruins on foot through rivers, jungles, and over hills where one climbs until absolutely exhausted. Sometimes I became so utterly worn out in following the Lacandones that I thought I would collapse. But the sight of one more ruin was a life-restorer to me.

"The greatest thrill of all was when the Lacandone Indians led me into a temple made up of three rooms. Each room was painted with frescoes from the floor to the ceiling. A parade of Mayan priests or chieftains is painted on the wall, flanked by their attendants holding fans and umbrellas, and with their musical attendants blowing on long horns, beating drums, and playing flutes. The more important personages are painted in their full regalia, showing great detail of embroidery, jewel insets, feathered headdresses, and so on. The fabric designs show great skill both in weaving and in the use of native dyes. Handsome feather plumes are worn by the notables. For the first time we had a true picture in



color of what the ancient Mayas actually looked like. Books and books have been written about them with only a slight indication of what they looked like and wore . . . and here on this wall was revealed for the first time authentic evidence of the glorious Mayas of the first empire period . . .

"Here is the work of the great, almost incredibly skillful mural painters who lived and worked centuries before Michelangelo; or four hundred years before the Battle of Hastings. Here is the perfect answer to those who bewail America's lack of a cultural age . . ."

Healey promptly reported the unparalleled find to the Mexican Government, the United Fruit Company, and the Carnegie Institution of Washington. Technical experts from Carnegie are supervising the educational film, which will be distributed internationally and without cost to schools, colleges, and educational authorities.

Beginning in February, 1947, the Carnegie Institution of Washington, through its department of Historical Research, organized, and the United Fruit Company financed, an official expedition to record and appraise the Bonampak discovery.

On February 5, 1947, Healey led J. Eric S. Thompson, epigrapher for the Carnegie Institution, to Bonampak. Thompson, English-born authority on hieroglyphics and student of many previous Mayan finds, worked until March 14 to make a preliminary appraisal of the glyphs.

During March, the four other experts comprising the expedition arrived by mule train. The executive officer was Karl Ruppert, Carnegie Institution specialist in pre-Hispanic architecture, who has previously explored and mapped many Mayan ruins in Campeche and Quintana Roo, Mexico. The Guatemalan artist, Antonio Tejeda, Director of the National Museum of Guatemala and staff artist for the Carnegie Institution, went along to make drawings and water color paintings of the murals and will return next year to complete the record. Sr. Tejeda had made the official copy of the Mayan painting found at Uaxactun.

The expedition's engineer was Gustav Stromsvik, a noted Norwegian specialist, who began his archaeological career as a helper for Carnegie exploration parties and has participated in most of the important Mayan "digs" since 1925.

While mapping the Bonampak area, Stromsvik came upon a Mayan sculpture of a jaguar, a limestone figure about eleven feet long, two feet wide, and a foot high. He also reassembled the five pieces of the great stela, which fortunately had fallen face downward and therefore could be put together with all its significant carvings intact.

Sr. Villagra, who represented the Mexican Government, is an associate of the National Institute of Anthropology and History of Mexico and a renowned archaeologist who has previously participated in important finds in several areas of Mexico. He has done notable work in copying pre-Hispanic murals. He states that the Bonampak find is of such outstanding importance that the Mexican Government is faced with the choice of removing the paintings from the walls and preserving them for the ages to come, or building a landing field

▼ ON HIS PILGRIMAGE for worship at the ancient Mayan shrines: a Lacandone man following the river bank to Yaxchilan, mecca for present-day Mayas as it was for the ancients

▼ AT THE SHRINE, the Lacandone performs the ancient Mayan ritual of burning incense in a "god pot"

near the remote location so that all interested scientists may have access to the discovery. The other temples must be protected from the weather and safeguarded from vandalism.

While the explorers were photographing, surveying, and copying the murals, the Lacandones remained aloof, repeating that the mountainside temples of their forefathers must remain holy places. They accompanied the archaeologists cautiously, acted with great reverence within the temples, and flatly refused to join in any of the excavation work, build shelters, or carry water. The contemporary Mayas do not permit their women to come near the ancient sites and believe that to invade or work in the temples is an invitation to death.

Under Healey's guidance the expedition performed its work successfully and without casualties. After the explorers had left, the Lacandones set fire to the party's thatch shelters, presumably to appease the old Mayan gods.

The Lacandone Indians of today show considerable evidence of a changing world beyond their extremely remote homelands. None of the present-day Indians are able to decipher the glyphs of their forefathers. Though they speak the ancient language and devotedly abide by the simple rites of the ancient Mayan religion, some of the individual families of Lacandones show clear evidence of degeneration. In some instances they have lost, either through lack of use or deliberate abandonment, their ancient handicrafts. Some have acquired shotguns or rifles and therefore have given up the bow and arrow as their stand-by hunting implement. The art-craft of pottery is conspicuously on the wane in many of the households and villages. In some instances Lacandone women may be seen wearing garments made from hammock cloth obtained from the chicleros. J. Eric S. Thompson, the Carnegie epigrapher, reports having seen Lacandone wives making tortillas with maize ground in small iron coffee grinders.

The Lacandones are a diminishing people. A half-century ago their population was estimated to be about 600. A painstaking census recently completed by Healey that no more than 200 of them survive. All are in Chiapas, Mexico, except four who live in Guatemala.

Significantly, some groups of Lacandones have not succumbed to outside influences, and Healey paid particular heed to these, the ones with whom this article deals. These less-changed Lacandones do not cut their hair, and they still wear the ancient Mayan robe resembling a nightgown. Among these Indians, hunting and farming remain the man's essential work. The men and boys hunt with bows strung with agave fiber string and arrows tipped with flints. Deer, monkeys, birds, and peccary are the principal game. At five or six, the boys are provided with miniature bows and arrows, and they learn archery as they grow up. At the same time little girls begin to grind corn and help with household tasks.

Worship links the Lacandones most closely with the great Mayas of old. They use the ancient temples at Bonampak as shrines. At prescribed intervals each able-bodied Lacandone makes a pilgrimage or

➤ A MODERN MAYAN GIRL fondles a pet wild pig, totem or chosen animal of her clan

sends at least one member of his family to the ancient Mayan metropolis at Yaxchilan, a renowned ruin, which he believes remains the spirit-home of the great and ancient Mayan god, Nohatsakyum.

There the Lacandone prays, burns incense in a "god pot," and carries home a small stone from the ruin, which in turn he places in a god pot within his local temple. The ruins at Yaxchilan remain the holy of holies. The full moons of April and May are the times for pilgrimages. The former Mexican Government custodian of the ruins declares that during twenty years at the location he actually saw only one group of Lacandones. But every year he collected scores of god pots which Lacandones, unseen by him, had left there.

The Lacandone's ritual of worship apparently follows an ancient pattern. He kneels or stands before an earthen god pot or a row of them. He "feeds" the pots primarily with corn, which is the staff of life for the Lacandones (as it was for their Mayan forefathers) but also with home-grown tobacco or game and sometimes with homebrewed liquor to assuage the particular god which a given pot represents.

The Lacandone's liquor is called *baltche*. It is made from the bark of a native tree of that name and fermented with wild honey and corn. The liquor is slightly alcoholic and has a flavor that makes a white man shudder.

But like his illustrious forebears, the Lacandone drinks the brew for religious purposes only. He believes that ceremonial drunkenness enables him to communicate better with his gods. Except for ritualistic purposes, the Lacandone is an uncompromising teetotaler.

The men, women, and children bathe daily or several times a day. The thatch-built homes are cluttered with homemade pots, pans, and buckets made of giant squash rinds, and hammocks woven of native fibers. When a house becomes polluted by sickness, it is sometimes burned. If an unwelcome visitor comes, homes are frequently burned—presumably to appease the gods.

Recently these people have been harassed by venereal diseases brought by roving chicle hunters. Leishmaniasis, or "turkey fly disease," is a disfiguring malady which inflicts distressing flesh lesions on the sufferer. Indian mothers blow backwards on homemade cigars to

▲ A LACANDONE KITCHEN

▲ PLAYING A HOMEMADE FLUTE, favorite musical instrument of the remote Lacandones

◄ SOME of the Indians had never seen guns until the explorers brought them. This Lacandone is showing how he holds the bow and arrow when shooting game rid their small children's hair of lice.

The Lacandones are especially afraid of respiratory diseases—beginning with the common cold. Hence the greatest faux pas is to sneeze or cough inside a home. The Lacandone burns his thatched house after the sneezer or cougher has left.

Apparently because of the tribe's extreme isolation, epidemics have been avoided. But the birth rate is low. Multiple wives are permitted when there are more than enough to go around, and children are betrothed in infancy. Indeed, Giles Healey reports meeting affianced couples in which the boy was five and the girl three.

In many respects the Lacandones show traits common to many other primitive peoples. Lacandone women are enormously fond of necklaces, which they shape from the teeth of game animals (particularly jaguars or mountain lions), seeds, and small shells from local streams. More than any other outside merchandise except salt, they covet glass beads, and sometimes they travel long distances to trade their tobacco, which they raise and cure, for cheap beads. Lacandone mothers carry their children astride or in nets tied securely about their shoulders. Babies and young children play with dolls made of clay.

Grinding corn, the Mayan staff of life, is the most arduous of household chores. Working with homemade pestles and mortars of scooped-out volcanic rock, the women and girls spend many laborious hours every day pounding meal for tortillas and broth. Oddly enough, the less-changed Lacandones do not make round tortillas but shape them into squares.

Like the Mayas of old, the men folk offer the first harvested ears of corn to the gods, so that the forthcoming seed may be blessed with fertility.

During March they fell or kill the trees and standing bush with cutlasses or machetes or with narrow-bladed hand axes; then, during the April drought, they burn off the residue. With the first rainfall they plant the corn by punch-

▲ The Mongoloid spot on a Lacandone baby. This mark is seen occasionally among widely different peoples of the world, but its prevalence among the Lacandones, in combination with other physical traits, indicates probable Asiatic ancestry. The spot ordinarily disappears within a few years

ing holes in the ground with pointed sticks. Into each hole they drop a few grains of corn, filling the holes with soft earth by means of their bare feet. But they do not fell, burn, or plant their garden fields without first appeasing the gods.

The miniature cornfields are general farms, for along with corn the Lacandones also plant calabashes or squashes, cotton, yuca, and at least ten varieties of edible peppers. When the corn is ripe, the ears are turned downward for protection from rain and the ravages of birds. Each clan has its "totem" or mascot animal, such as wild pig or monkey, and each cherishes at least one live representative of its totem as a household pet. Thus one sees a Lacandone child affectionately fondling a grizzly wild boar or a well-fed monkey.

The home life of these people is a unique mixture of primitive simplicity and ingenuity. Artistic talents are largely concentrated in spinning, weaving, and the making of pottery, particularly god pots and bizarre, strongly conventionalized clay dolls.

Homemade cigars, hand shaped of home-grown tobacco leaves, are smoked eagerly despite their almost devastating power. Women shape attractive hair-braid ornaments of small and colorful bird feathers.

The men hew boats from logs for use in catching fish with bow and arrow and in some instances for traveling on the religious pilgrimages to Yaxchilan.

Wild honey is plentiful in the flowery forests and is a dependable source of sweets. The weaving is women's work. The looms are homemade and of the primitive, hip-level type, but they are operated with outstanding skill.

The Lacandones are immensely fond of music. Their favorite instrument is the simple, four-hole flute, played by blowing lightly into a side vent at the larger end. After coming upon his first clans of Lacandones, Healey found them excessively camera shy. But when he brought out his fiddle and played waltzes, the Lacandones crowded about to listen and presently permitted him to photograph them.

The toil of clearing the jungle and raising enough food is partly offset by the ease with which the "modern Mayas" build their homes. Most of the men and some of the women are masterly thatchers. Building a home requires a mere day or two of community work. The people hew and drive down corner posts and wall sticks, raise center pole and limb rafters newly chopped from near-by forests, lash together the crude framework with bark strips or leather thongs, and roof the structure with thatch made of palm fronds.

Thus there is never any serious housing problem, and any family that tires of its home can quickly and easily build a new one. Whatever its location or size, a family's home belongs to the family. Otherwise lands and incidental properties are communally owned by the clan and ultimately by the tribe.

Such was the way of the Mayas of old. One notes other continuations of an ancient and glorious past. In ancient Mayan empire days, when a man died, his dog was killed and buried at the master's feet—presumably so that the dog could awaken the sleeping man on the approach of the "great spirit—from across the river." The Lacandones continue to keep and cherish their mongrel dogs. But instead of ceremoniously killing the deceased's dog, they now place a wicker image of a dog at the foot of the grave.

Those who have observed the Lacandones have learned to respect their calm, precise intelligence. The Lacandones shun the maze of superstitious fears common to many Mexican Indians and to almost all of the half-caste chicleros. The latter will tell you graphically of having seen such amazing things as two-headed serpents. The Lacandone listens quietly, shakes his head, and demurs in Maya, "There are no such serpents."

It remains to be seen how much these people can assist scientists in solving the mysteries surrounding the people who once developed a glorious civilization in these remote jungles.

▲ Most whelks have the opening on the right side of the shell; this one spirals in the opposite direction. The egg case (below) is sometimes two feet long. Note that several clusters of eggs have been attached to it by another creature—a marine snail known as the Tulip Shell

A Contrary Shell

The left-hand whelk defies custom and builds its house in reverse

By Hugo H. Schroder

Photograph by the author

The general principle among the whelk shells and other marine univalves is to have the opening on the right side of the shell. One of the common whelks found in Florida is the left-handed whelk, or lightning shell, *Busycon contrarium*, which reverses the usual pattern by having the opening on the opposite side of the shell. Formerly known as *Fulgar perversa*, it will be noted that both the older and the present Latin name indicate its contrary make-up. Occasionally, though rarely, the left-handed whelk will be found with a right-hand opening.

One of the strangest features of the left-handed whelk is the unusual and very long egg case it produces, which extends two or more feet, depending upon the size of the shell. I found numbers of the

 Continued from page 359

solely of vocal imitation. It is true that "Polly" sometimes utters words that seem appropriate to the circumstances. She may bid the departing guest good-by or address the family cat in suitably profane terms; but these are relatively simple associations which the bird has learned in much the same fashion as Fido learns to scratch at the door when he wants to go out. They do not represent the use of spoken sounds as symbols for objects or ideas.

If any type of animal had a true language, we would expect to find it among the more intelligent mammals such as the great apes; and natives living in gorilla or baboon country sometimes insist that these beasts are fully capable of speech. In fact, they claim these animals are so intelligent that they carefully refrain from speaking within human earshot, knowing that if they did, the government would compel them to pay taxes and serve in native labor battalions!

So far as I know, there is not a single authentic record of spontaneous imitation of human speech by any of the other primates, even though chimpanzees, gorillas, and baboons have spent years in close association with men. Some animal trainers and a few scientists have tried to teach chimpanzees to talk, but most attempts have been totally unsuccessful. The best ape students have mastered no more than one or two very simple words, and in no instance has there been proof that the meanings of the words were understood.

Careful examination of the nerves and muscles controlling vocalization reveals that apes possess all of the *physical* equipment necessary for the articulation of words, although one authority suggests that if they spoke at all, chimpanzees might be expected to do so with a "slight brogue." The real reason for absence of speech is almost certainly the absence of a degree of mental development high enough to support the complex intellectual activities essential to true language.

Can Animals Learn by Imitation?

Mrs. Jones and Junior are strolling through the park one fine spring day. An adult swan glides majestically across the pond, and in her wake follow five little cygnets. "See, Junior! The little ones are learning how to swim by watching their mother. Now why can't you pay attention when I try to show you how to do things?"

Misinterpretations of this sort are very common. To say that one animal imitates another is quite a different thing from saying that the imitator learns through imitation. The descriptions of gregarious behavior in sheep and of singing in birds certainly suggest that animals of several species are capable of forming a few simple habits as a result of imitation. However, isolated birds sing even in the absence of any opportunity to imitate; and when such opportunity is present, imitation can do no more than modify the type of song that is developed. Similarly, sheep or geese quickly acquire the tendency to follow other animals, and the experiments indicate that imitation serves at most to determine the type of animal that is going to elicit the "following behavior."

Limitations of Imitative Learning

This conception of the role of imitation in animal life is considerably simpler than those expressed by many writers. Some naturalists and psychologists believe that through imitation animals frequently learn to perform acts completely foreign to their natural repertoire of behavior. For example, it has often been stated that some domestic or tame species learn to do new things simply by watching human beings do them and then

strange looking egg cases washed up on the Gulf Coast beaches before I discovered they were produced by a mollusk that was quite small in comparison with the size of the long string of capsules.

During years of nature photography in Florida, I have seen these egg cases much more frequently than those of any other mollusk. They have varied greatly in the length of the string and in the diameter of the individual capsules containing the eggs.

At various times, while walking in Gulf Coast tidal flats. I have come upon left-handed whelks with a partially completed egg case still attached. The other end of the string was anchored in the sand. Such was the situation with the specimen photographed here—the egg case was nearly complete. When I picked up the whelk, it separated from the string, which consisted of about 125 individual capsules of quite large size.

Each segment is attached to a tough cord running along one side of the string of cases. The leathery covering of each individual capsule protects its complement of eggs until the tiny mollusks are ready to emerge. This protection is quite necessary, for the string is buffeted by the waves during the period when the eggs and young are confined in the capsules.

Small *B. contrarium* shells have a series of zig-zag markings, which account for the name "lightning shell." As the shell grows larger, these markings fade out. The shells grow up to twelve inches in length and are inhabited by a black mollusk.

When I photographed this specimen and its egg case, it was necessary to remove both from the shallow water in which they were found. The whelk closed its operculum as a matter of protection, and I had to wait some minutes before it opened and the mollusk made its appearance.

An inspection of the twisted string of capsules revealed that a certain marine snail—one of the fasciolarias—had come along and attached several of its clusters of egg cases to the long string. The fasciolaria found the string a convenient anchorage for her own eggs, regardless of the fact that the left-handed whelk had not released it.

applying "rational imitation." Experimental psychologists have tried to discover any such ability in lower animals, but the results have been almost uniformly negative.

In last month's NATURAL HISTORY, there appeared an article entitled "Open the Door, Richard!" which described psychological experiments dealing with the ability of various animals to open doors by the manipulation of simple mechanical devices such as sliding bolts, thumb-latches, and the like. These laboratory investigations were undertaken in an attempt to verify or disprove the common belief that pet animals learn to open doors by watching and then imitating the behavior of men. The general conclusion was that such is not the case.

When a cat or dog learned to open a door, it did so as a result of trial-and-error behavior involving neither imitation nor reasoning. The first success seemed to occur purely as a matter of chance and was usually accompanied by a great deal of inappropriate behavior. In successive tests the correct responses appeared to be "stamped in," whereas the ineffective reactions gradually weakened and died out. None of the experiments gave the experimenter any reason to believe that animals solved such problems in a rational or "intelligent" manner.

Watch Me Closely, Please!

After psychologists had become convinced that a cat probably does not solve door-opening problems by the use of reason, they attempted to discover whether animals could learn more easily if they were given a little help in the first few lessons.

Professor Edward Lee Thorndike, one of the pioneers in this field, tried to teach cats how to operate a latch by carefully putting them through the necessary acts. First a cat was confined within a "problem-box" from which it could escape by moving a lever that opened the door. Then the Professor reached through the bars, grasped the animal's paw, and gently pressed it down upon the lever. The door swung open, and the "student" emerged to receive a bit of fish as its reward. This procedure was repeated many times with several different cats, but none of them appeared to "get the idea." When they were then left to their own devices, the animals had to learn how to open the door in the hit-or-miss fashion characteristic of untutored individuals.

Other scientists studied the problem-solving ability of rhesus monkeys. Without human guidance these animals learned to unlock doors more quickly than dogs or cats, but the method of learning was about the same. In some tests the experimenter repeatedly showed the monkeys how to open the door by doing it himself. Never was there the slightest sign that such demonstrations were of any assistance to the animals.

Professor R. M. Yerkes, dean of animal psychology in this country, once had a tame orangutan named Julius. Julius seemed to be an intelligent beast, and his master tried time and again to teach him to open a padlock with a key; but though he was shown many times, Julius never "caught on." Another of Professor Yerkes' primate pets liked to play with a carpenter's saw, although his methods were a little unorthodox. He held the tool between his feet with the cutting edge uppermost and solemnly drew a stick back and forth across the teeth. Despite this auspicious beginning, the animal never passed beyond the apprentice stage, because he failed to profit from the instruction of a master carpenter, who tried patiently to demonstrate the way in which the union expects its members to handle the tools of the trade.

If it be argued that the chimpanzee's own method of handling the saw may have involved imitation, I will readily concede the possibility. But to establish the point, it would be essential to show that the animal had observed men using a saw and that the behavior had not developed spontaneously. The point is irrelevant, however, for the thesis here is not that imitation can never occur but that it is relatively rare, of little consequence in the serious business of the animal's daily life, and not an effective method of instruction.

Monkeys Monkey; They Don't Ape

We ordinarily think of our primate cousins as being highly imitative, but it seems likely that our impressions are based upon a few isolated instances and that most monkeys and apes almost never imitate human behavior. In any event, this was the conclusion reached by Herr Pfungst, a German scientist who observed more than two hundred apes and monkeys over a period of years. Still more surprising, Pfungst even doubted that these animals imitated their own kind except in very rare instances.

One famous student of chimpanzee behavior has said that apes will imitate each other in the solution of complex problems if the imitator understands how the imitatee achieved his success. This is, of course, true of mankind as well. We cannot learn to do something by watching others unless our observations reveal how the results are achieved.

Did You Say "Copy Cat"?

There are other workers who dispute Pfungst's conclusions regarding primates, but the case against problem-solving by imitation in lower mammals is very strong. In one investigation, a psychologist put untrained cats in cages adjacent to a problem-box and gave them many opportunities to watch while the door was opened by other cats that had previously learned how to operate the locks.

In other tests he put two cats in the problem-box at once. One was the "pupil," and one was potentially the "teacher," an animal that had mastered the problem and could open the door without difficulty. No matter how many times the naïve animal observed its companion open the door, and no matter how many bits of fish the beginner received as a result of his cage-mate's exertions, no indications of imitative behavior appeared. When the "pupil" was locked in the box by himself, he showed no sign of having profited from his chance to learn "the easy way." Instead, learning progressed in the same laborious fashion as would have been expected if the cat had never been in the box before.

Occasionally someone tells the story of a pet that suddenly began to do tricks it had seen another animal perform. However, all experimental attempts to duplicate this type of imitation have failed. One dog was taught to jump onto a box when a signal was given, and it was then rewarded with a tidbit. Another dog watched the trained animal perform its act 110 times; but although he obviously wanted the food, the untrained individual never made the slightest move to climb onto the box where the reward would have been offered.

Imitation of *behavior already learned* can and does occur. If two animals have learned separately to go through a certain set of acts, then one of them may imitate the other in this behavior at some later date. For instance, let us assume that you have two dogs and that both of them have been taught to "beg" for food. Now, if Fido sees Rover beg and receive a biscuit, Fido may promptly begin to do a little begging on his own. The point is that unless Fido already knows how to beg, he is very unlikely to copy Rover's performance.

"The School of the Woods"

If psychologists are correct in saying that most animals cannot learn by imitation, what becomes of the popular belief that this sort of learning forms an essential part of the education of many young animals?

Animal parents are said to instruct their offspring by showing them the proper way to do things. Many authors appear certain that young fishes have to learn how to eat, that wart hogs must teach their young the art of self-defense, and that birds cannot even fly until their parents have given them a practical demonstration. The following quotation from a book entitled *Social Life in the Animal World* illustrates the uncritical sort of thinking followed by some writers:

> Male and female falcons teach their young to capture prey. One parent on the wing drops the prey, and the young must catch it in full flight; if they miss it the other parent, flying under them, catches it before it touches the ground, carries it up again and lets it fall once more from above the young birds.

Anecdotes of this sort are worse than useless. They actually hinder our progress toward a genuine understanding of animal psychology, because they represent an inextricable mixture of doubtful observation and easy interpretation.

Consider more familiar examples of parental guidance such as the ever-popular story of the mother cat who brings live mice to her kittens *in order that they may learn how to catch and kill them.* The italicized words represent what human observers "read into" the cat's behavior. The unitalicized words describe the behavior that actually has been seen. If we are ever to reach a true appreciation of animal mentality, the separation between observation and interpretation must be rigidly enforced. As a psychologist, I am quite willing to grant the accuracy of the observation in this case, even though I did not witness the behavior; but for various reasons I seriously doubt the validity of the interpretation. The capacity for deliberate instruction calls for a degree of intellectual development far above that of the brightest cat.

Whether or not the kittens learn anything as a result of playing with live mice is another matter, but even if some learning does take place, this in itself is no justification for casting the mother in the role of a teacher. Accidental opportunities for learning occur constantly, and although "the burnt child dreads fire," we do not think of the flame as having "taught" the toddler.

Men who have spent most of their lives hunting big game often tell thrilling tales about the school of the wild. African lions are supposed to spend more than a year teaching their cubs how to track, stalk, and kill game. When a veld stockman finds a heifer with long, shallow claw-marks on her rump, he "knows" that some immature lion, under its parent's guidance, has been trying for a kill and fumbled because of inexperience.

Now, the question is not whether such evidence *might* be explained in terms of parental instruction plus imitative learning but whether this is the simplest possible interpretation. Can the facts be explained without assuming pedagogical intent on the part of the parents and ability to learn by imitation on the part of the cub? I believe they can.

There is little question but that young beasts of many species tend to follow their parents as soon as they are old enough to walk. There is also sufficient reason to believe that predatory animals will spontaneously pursue and leap upon smaller creatures, even during infancy.

Now, imagine a moonlit night on the African plains. Mother Lion is just leaving the den on a hunting foray, and by this time the cubs have grown strong enough to follow her for long distances. After a half-hour's trek, the strong scent of wildebeeste is borne to the nostrils of the hunters. No one need tell the cubs to follow that odor! Both their inherited tendencies and many early experiences with eating wildebeeste provided by Mother impel them to move in the direction of the prey. The stalking behavior—creeping with belly close to the earth—comes naturally to all members of the cat family.

Perhaps the adult female makes the kill, and the entire family feasts; or possibly some impetuous youngster charges too soon, and, forewarned, the frightened object of the hunt bounds away to safety. In either event, a perfect learning situation is set up without the mother or her offspring doing any more than following its natural tendencies. The crucial point is that each cub will learn by its own mistakes and successes and not by copying the more perfect performance of any experienced adult that happens to be along.

Imitation in Human Learning

Anyone who insists that animals learn a great deal purely by imitation is revealing his own ignorance, not only of animal psychology but of human behavior as well. We fondly believe that we teach our children many things by showing them how or by putting them through the act; but the truth is that in many cases the child would learn just as quickly if left entirely to himself.

In the famous Child Development Clinic at Yale University, Dr. Arnold Gesell and his co-workers have studied the development in pairs of identical twins of such skills as walking, stair-climbing, and block-building. He finds that behavior of this sort appears in normal children at a fairly predictable age without any instruction whatsoever. Furthermore, all of the guidance in the world has very little effect upon the proficiency of performance. The child must be its own teacher and learn by making mistakes.

Before crediting other animals with a highly developed ability to learn by imitation, we would do well to look closely at ourselves and to recognize that imitative learning plays a much smaller role in human life than we sometimes imagine. The accumulated wisdom of many human generations is sometimes expressed in popular sayings, and one of the oldest of these is, "Experience is the best teacher."

BOOKS

Continued from page 343

behavior to any mammal he can recognize. The author does not give extensive data on the appearance of his subjects; he tells you what they do from birth to death.

The book is written in simple terms. This simplicity is not a "writing down" but rather the straightforward expression of a naturalist who likes his work and talks about it in everyday language.

Mr. Cahalane has had extensive field experiences with many of the animals he biographs. These firsthand observations give warmth and authenticity to his pages. Furthermore, he has posted himself on many intimate details that one seldom sees in literature and that must come, in part, from notebooks and similar unpublished sources. The book should prove invaluable as a reference for answers to all sorts of questions, such as number and size of young, longevity, speed, diseases, etc.

But the volume is much more than a static reference book. It is something to read for sheer interest and enjoyment, a revealing insight into the public lives of our North American mammals and, even more than this, a very good peek into their private lives and the causes that make them act as they do.

Francis Jaques has been markedly successful in capturing the significant characteristics of the mammals in his bold black-and-whites. His work is a splendid complement to a splendid text.

H. E. Anthony.

LETTERS

Continued from page 337

his life is nothing new. It is probably of Old World origin and sounds to me like Pliny, but I find no reference to it in the index to his writing, nor is it in his section on the dolphins. However, this story is, of course, clearly a mythological superstition, for there is no evidence that a porpoise will intentionally do what is implied.

It is a well-known fact that the porpoise is an extremely inquisitive creature and loves to sport and play. Anything floating on or near the surface of the sea will attract his attention. His first action on approaching the object of his curiosity is to roll under it. In doing so, something partly submerged, like the body of a drowning person, is nudged to the surface of the water. The sea does its part and automatically drives floating objects toward the beach. It is therefore within the realm of possibility that on some remote occasion a porpoise did happen to assist unintentionally in the rescue of a drowning person. An observer watching the procedure from a distance might well have assumed that the action of the porpoise was intentional. No doubt it was from some such an incident as this that the story originated.

It is true that when a young porpoise in the tank at Marine Studios, Florida, died, its bereaved parent was found the next morning supporting the young one at the surface, presumably so it could breathe if life yet remained. But to suppose that a porpoise would do this for a human being, except in a spirit of play, is more than we can believe.

George G. Goodwin.

Sirs:

As a loyal citizen of Montreal, I simply have to draw your attention to a factual error in the letter from Mrs. Percival M. Sax appearing on page 289 of the September issue. She states that Caughnawauga, Canada, cannot be located on any map.

Dance Programs at
The American Museum of Natural History

Free to Adults: 2.00 to 3:00 P.M. Thursdays

October 16	**DANCES OF INDONESIA** *(Bali, Java, Sumatra)* *Devi Dja and Members from her Company*
November 13	**DANCES OF SPAIN AND MEXICO** *Alda Cadena and Teresa Zayas* *Josefina Garcia and Gustavo Sosa*
December 11	**OLD CATHAY IN DANCE AND SONG** *Averil Tam and Stars from* *The Chinese Cultural Theatre Group*
December 18	**DANCE WAYS FROM SPAIN TO THE PHILIPPINES** *Juana with Salvacion, Leonor Orosa, and Matilda Rivera*
January 8	**FOLK DANCES OF NORWAY AND SWEDEN** *Norwegian and Swedish Folk Dance Groups*
January 22	**ARTS AND DANCES OF THE AMERICAN INDIAN** *Reginald and Gladys Laubin*
February 5	**MUSIC AND DANCE OF INDIA** *Wasantha Wana Singh with his Group and Gina*

Sir William Osler had described it as a beautiful suburb of Montreal.

Caughnawaga (as it is usually spelled) certainly does exist and is well known to tourists who visit Montreal. It is, as Sir William stated, "just across the river" and is the main village of the Iroquois Indian reservation. Its location is shown on every large scale map of this region. Sir William's statement that it contains "charming residences" may be somewhat grandiose, but of the existence of Caughnawaga there can be no question . . .

E. RUSSELL PATERSON.
Montreal, Canada

* * *

SIRS:

Tree hoppers (Membracidae) were called "Insect Brownies" by Comstock, not leaf hoppers (Cicadellidae), as on page 319 of the September issue. Leaf hoppers do not resemble spines or thorns.

W. D. FUNKHOUSER.
University of Kentucky,
Lexington, Ky.

Quite a Woodpecker

SIRS:

This beech tree, photographed on Tongue Mountain, Lake George, New York, was obviously attacked by an animal of some sort. The cavity, which is about three feet from the ground, is about four feet in height and extends through the trunk almost to the bark on the other side. Notice the quantity of chips on the ground and also the size of the individual chips. I would be interested to learn just what kind of an animal, in your opinion, would cause such damage.

G. P. DALTON.
Scotia, N. Y.

Three scientists at the American Museum concur in the opinion that no other creature could have done this except a Pileated Woodpecker (or an army of them!). None of these scientists had ever seen or read of so extensive an operation. The indication of worm holes near the margin lends support to the belief that the excavator was after borers.—ED.

* * *

SIRS:

We feel that NATURAL HISTORY improves with each issue. Congratulations. Today, when there seem to be so few publications that are free from nature fakers, a magazine like yours is a real pleasure.

H. E. JOHNSON.
Orange, N. J.

NEW EXHIBITS

SPEED PHOTOGRAPHS OF ANIMALS EXHIBITED

An unusual exhibit of the work of one of the country's foremost animal photographers will be on display at the American Museum of Natural History until October 12. This selection of pictures, entitled "High Speed Photography of Animals," includes conspicuous examples of the photographic art of Henry B. Kane, such as striking shots of birds and insects in flight and animals in their native surroundings. Readers of NATURAL HISTORY are already familiar with Mr. Kane's work, which has won admiration both on the cover of the Magazine and inside it.

NEW BEAVER EXHIBIT

Seven specimens of the Michigan Beaver recently arrived at the American Museum of Natural History for a new habitat group for the North American Mammal Hall. This will be the first group in the hall to show a typical wildlife scene in the state of Michigan. The scene will depict a pond in the Gladwin area of northern Michigan at sunset, with the beavers beginning their evening's work. To carry out the idea of a perfect replica of nature, trees cut down by the beavers and "teeth shavings" were brought back for the exhibit.

CHARLES FRANCIS PRESS
NEW YORK







November **NATURAL HISTORY** 1947

Little Dinosaurs · Hunting Porcupines · Fish Drives

Cliff City · Iguana · Golden Eagle · Elephant Seals

VOLUME LVI, No. 9

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L E T T E R S

SLAUGHTER

in Lower California

Sirs:

Lower or Baja California is a sizable point of land extending for a thousand miles in a southeasterly direction from our southern border. Its average width is about 75 miles, and it is bordered on the west by the Pacific and on the east by the Gulf of California. A few high mountains form its backbone, but aside from these it might well be termed a desert area. Until the present decade it has remained in a primitive state, owing to a complete lack of roads and other facilities needed by most Americans when "roughing it."

In twenty years of extensive exploration on this arm of land, I have seen game trails remade into roads, flat meadows converted into air fields, and small water holes (formerly frequented by quail and deer) changed into cement troughs surrounded by cattle.

I realize that such changes are inevitable, a part of the inexorable progress of civilization. But since the war new elements in the form of plane-borne hunters are creating irreparable havoc. If unhindered, they will exterminate the big game of the peninsula in record time. Four-wheel drive military vehicles are also opening up territory that was previously inaccessible; and as each far-flung water hole which supports a limited number of deer, sheep, or antelope is discovered, the hunters move in. The disappearance of game over large areas is already alarming, and with the present-day trend of hunting, it will take but a few years for the complete extermination of the surviving remnants.

Except in a few pine-covered ranges, water holes are indispensable to big game in Baja California. Some areas of several hundred square miles are watered by a single spring. A hunter in wait can slaughter every animal for miles around without moving from the spot. Owing to the arid nature of the country, where desert valleys or dry mountains act as impassable barriers, these animals are not replaced by others wandering in, as they would be in regions of plentiful rainfall. The antelope of Lower California have diminished so rapidly that most of my Mexican friends believe they are already too far gone to make a comeback.

Forty years ago antelope were found sparingly between the Cocopah Mountains and the Colorado River, within 30 or 40 miles of Mexicali. A sizable herd existed on the flats on the east side of La Provodencia (Lower California's highest mountain) until about six years ago. Now friends in San Felipe say that the animals have not been seen there for several years. Forty miles south of San Felipe a small band still exists. But on a recent

Continued on page 431

▲ Facing a Perilous Future: one of the young mountain sheep of Lower California whose wilderness home is being overrun by hunters

Photos by Lewis W. Walker

▲ Wanton killing, hastened by mechanized transport, will soon deprive Lower California of its mountain sheep and antelopes

▼ In Former Years, every water hole had its quota of sheep; now only the small, remote springs retain a dwindling number

NATURAL HISTORY

The Magazine of the American Museum of Natural History

FREDERICK TRUBEE DAVISON, President — ALBERT E. PARR, Director

VOLUME LVI—No. 9 — NOVEMBER, 1947

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You will find NATURAL HISTORY Magazine indexed in *Readers' Guide to Periodical Literature* in your library

THE COVER THIS MONTH

PRICKLY PEAR CACTUS

Though many think of cactus plants as drab and unlovely, the flowers they produce are extremely diversified and colorful. The example chosen for the cover this month is one of the prickly pears (*Opuntia*), photographed in Kodachrome by Josef Muench.

(*Opuntia*), photographed in Kodachrome ture to achieve striking effects. Among the cacti, the fragile beauty of the short-lived blossoms is most remarkable when seen against the drought-resisting and uncompromising leaf pads. Here the prickly pear is seen with a corsage of gorgeous orange flowers at its belt, so to speak.

The prickly pears are one of the large groups of cacti, some 250 species having been listed. All of these were originally American, but some have been introduced abroad. The spines differ widely in color, rigidity, and number per cluster. Their arrangement is useful to some extent in distinguishing one species from another.

PUBLICATION OFFICE: American Museum of Natural History, Seventy-ninth St. at Central Park West, New York 24, N. Y.

EDITOR: Edward M. Weyer, Jr., Ph.D.
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ART AND PRODUCTION: Robert E. Williamson.
Jean Bruck, *Assistant in Art and Production.*

Magazine subscriptions, Membership applications, and Advertising inquiries should be sent to Charles J. O'Connor.

NATURAL HISTORY is published monthly (except July and August) at New York 24, N. Y. by the American Museum of Natural History, Seventy-ninth Street and Central Park West. Subscription price $4.00 a year, single copies fifty cents. Subscriptions to Canada, Newfoundland, and all foreign countries $4.50. Entered as second class matter March 9, 1936, at the Post Office at New York, under the Act of August 24, 1912. Manuscripts and illustrations submitted to the Editorial Office will be handled with care, but the publisher cannot assume responsibility for their safety.

The American Museum is open to the public every day in the year without charge

YOUR NEW BOOKS

ROY CHAPMAN ANDREWS • KIERAN • LOVERIDGE
DARK COMPANION • MULTITUDE OF LIVING THINGS

AN EXPLORER COMES HOME
- - - by Roy Chapman Andrews

Doubleday & Co., $3.00
276 pp.

WHAT do explorers do when they come home? Some have been knighted, others brought back in chains. Our own Roy Andrews, as he said in an earlier book, was born *Under a Lucky Star*; accordingly he was elected President of the Explorers Club and became Director of the American Museum. Good fortune continued.

After his brilliant career in the wilds of Asia, Roy found life trying in a great city. Then he and his talented wife sought a haven in the country, and found Pondwood Farm, with 150 acres of woods in hilly northern Connecticut. This book contains historical notes on the region and a glowing account of doings at the Farm.

Four years passed, and Roy was ready to retire after 35 years of strenuous service to the Museum. At the lunch table we heard of his enthusiasm for the woods, the ducks, grouse, and woodcock at Pondwood. Now we learn much more. For sport Roy and Billie tried skiing, but found deeper satisfaction in fishing their trout streams and following bird dogs.

Queen, the English setter, and Lord Jitters, the white Persian cat, are exceptional characters. Indeed, their master proudly "sticks his neck out" by exploring their minds without benefit of the Department of Animal Behavior. The supposed remarks of Lord Jitters reveal more of human reactions to cats as pets than of feline psychology. Expressions of gratitude by a bullfrog will baffle the experts.

Roy Andrews has painted a most enjoyable picture of gracious living in New England, a deserved reward for an outstanding explorer. Blessed with perfect servants, fine Republican neighbors, and memories of distant lands bereft of all comfort, he must thank his lucky star that he has settled at Pondwood Farm, rather than on that slope high in the Altai Mountains which tempted him in 1925.

JAMES P. CHAPIN.

ONE DAY AT TETON MARSH
- - - - - - - - by Sally Carrighar

Alfred A. Knopf, $3.50
239 pp., 25 illust.

THIS second book of Sally Carrighar's follows closely the pattern of her first, *One Day on Beetle Rock,* except that this time the locale is a beaver pond in the Jackson Hole country of Wyoming instead of a height in the Sierra Nevada Mountains.

The day of the equinox has been selected to illustrate the lives of the animals of the book. The principals are an otter, a trout, an osprey, a mosquito, a scud, a mink, a varying hare, an American merganser, a moose, a leech, a leopard frog, a snail, a trumpeter swan, and a beaver. A chapter is devoted to each. The author describes the reactions of the animals when they first feel the effects of the approaching winter. She shows how each is dependent upon the beaver pond and how their lives were changed when a strong wind blew down a dead cottonwood tree whose roots were part of the foundation of the beaver dam.

Miss Carrighar has again proved that she is a keen observer of the too frequently unnoticed ways of the wild creatures, and she has afforded most interesting reading in the same literary style that has already won her great acclaim.

The attractive drawings that illustrate this book are by George and Patritia Mattson.

T. D. CARTER.

DARK COMPANION
- - - - - - by Bradley Robinson

Robert M. McBride and Co., $3.50
366 pp.

WHEN Matthew A. Henson came to lunch at the American Museum last August, on his eighty-first birthday, it was hard to believe he could be over sixty. This man, who for eighteen years accompanied Peary in the Arctic, was still spry and bright.

Henson's life story had just appeared, written by Bradley Robinson, and based on the recollections of its hero. The story is not new; Matt is the Negro who stood at the North Pole with Peary and four Eskimos on that historic day in April, 1909. Members of the three great races of mankind had struggled together to victory under Peary's leadership.

This will be a controversial book. Any man dictating his autobiography expects to have the spotlight focused on him, and Mr. Robinson is not sparing of that illumination. He must have foreseen that Arctic experts will compare it word for word with the records already published.

The book is thrilling; the dangerous episodes are already classic examples of daring exploration. In some cases Henson's account is at variance with that of the leader to whom he proved his devotion. Certain incidents, too, in Henson's youthful seafaring are magnified beyond belief. Doses of croton oil should be measured in drops, not by the cup.

Yet who would deny such a man the right to have his story told in his own way? Peary was generous in his praise. Matt was physically tough, the best man he had at working with Eskimos, driving dog teams, and repairing sledges. No wonder he went to the Pole. Henson did leave an extraordinary reputation among the Eskimos. Of material reward there was little; he worked in the New York Custom House till he was seventy, to earn only a modest pension. Whatever the exaggerations, his is truly a great tale.

James P. Chapin.

Footnotes on nature

- - - - - - - - - - by John Kieran

Doubleday and Co., $3.00
279 pp., 20 illust.

Mr. Kieran's book has three appealing elements: it is a record of a lifetime of enthusiastic observation of nature, an account of human companionship, and a reflection of the author's sensitive response to poetry. These three qualities are so happily blended that the book takes on a dimensional quality not shared by all nature studies. And there is more than a dash of the Kieran humor.

John Kieran is many-sided, as we all know. His interest in nature began in boyhood when he was fascinated by the birds that graced the region of the family farm in Dutchess County. Birds are still his main interest—rivals, indeed, of Shakespeare, Keats, and Masefield—but he writes many generous tributes in this book to trees, flowers, and animals.

For those of us who are not specialists in nature, Mr. Kieran's approach is most welcome. He writes not as the fully-stored authority speaking out of omniscience but as the eager learner who wishes to share his delights with us. Nor does he attempt too much. He gladly leaves some fields comparatively untouched. Insects are not for him. "They are marvelous," he says, "but there are too many of them." Mammals do not loom large in *Footnotes on Nature*, and for fishes and fishing, Mr. Kieran has only gentle toleration.

He does much of his nature prowling in the company of others—chiefly, "the Artist," "the Astronomer," and "Herman the Magician." One often finds the well-voiced likes and dislikes of the Kieran group as arresting as their observations on nature.

Footnotes on Nature is aptly illustrated with 20 excellent wood engravings by Nora S. Unwin.

Forrest Izard.

Chippewa village

- - - - - - by W. Vernon Kinietz

Cranbrook Institute of Science,
Bloomfield Hills, Michigan, $3.00
259 pp., 53 illust.

Katikitegon, the conservative Chippewa Indian community that is the subject of this book, is situated on Lac Vieux Desert on the boundary between Michigan and Wisconsin. From the oldest inhabitants of the village, Mr. Kinietz, who is a historian of the midwestern Indians, obtained valuable information about the ancient way of life, now fast disappearing. In addition, the author has supplemented his own material with considerable data drawn from historical sources and from the eye-witness accounts of early traders, priests, and explorers, which lend color and flavor to the narrative.

The book is written in a simple, nontechnical style, and is well-illustrated with excellent photographs. It begins with an account of the post-Columbian movements of the Chippewa, the founding of the village, the early relations of the Indians with the whites, and goes on to describe the traditional culture of the tribe. Although the avowed purpose of the book is the description of "present customs and remembered discontinued customs," the emphasis is overwhelmingly on Chippewa culture of the nineteenth century and earlier. The picture of the present-day Indian is, unfortunately, less satisfactory, and some aspects of the contemporary scene—such as the social and economic life of the community—receive only the most summary treatment. The outstanding section deals with curing and medicine, including the famous Midewiwin ceremonial, which is still occasionally performed.

Originally roving hunters and fishermen, the inhabitants of Katikitegon village are now half-hearted farmers who lead a hand-to-mouth existence. Save for isolated survivals, the Indian way of life has all but disappeared as a coherent body of beliefs and practices. The villagers of today present a pathetic picture of a disintegrated culture, where old values have been largely destroyed and new ones are not yet fully accepted.

HARRY TSCHOPIK, JR.

FREE GOLD

- - - - - - - by Arnold Hoffman

Rinehart and Co., $5.00
420 pp.

THE importance of Canadian mining during the war years and the really significant amount of gold that Canada has produced tend to exaggerate one's impression of the length of time that country has been a large metal producer. Hence, it is somewhat of a shock to read this fascinating account of the development of such proven camps as Porcupine, Noranda, Sudbury, Cobalt, and Kirkland Lake and realize that the youthful author, with his brother, actually participated in many of these rushes. Since 1922, Arnold Hoffman has worked with his brother Robert, who preceded him through

Continued on page 429

Little Dinosaurs OF GHOST RANCH

In a remote section of the New Mexican desert, American Museum scientists discover the largest deposit of ancestral dinosaurs ever found in North America

By EDWIN H. COLBERT

Curator of Fossil Reptiles, Amphibians, and Fishes, The American Museum of Natural History

Photographs by the author

GHOST RANCH lay dreaming in the brilliant sunlight of a morning in mid-June—a patch of soft, verdant color quite unexpected in the New Mexican desert. At the edge of the fields the low houses nestled among large trees, all but hidden from sight.

To us, the cool shade of this green oasis was a luxury not to be enjoyed during the day, for we were after fossils, and fossils would be found in the flaming red and yellow and orange cliffs. All morning we had climbed up and down and back and forth, searching along the foot of the cliffs and up the talus slopes for fragments of fossil bones. It was hot and tiring work and for the most part unrewarding. We had found only a few scraps of fossils, none of them very promising.

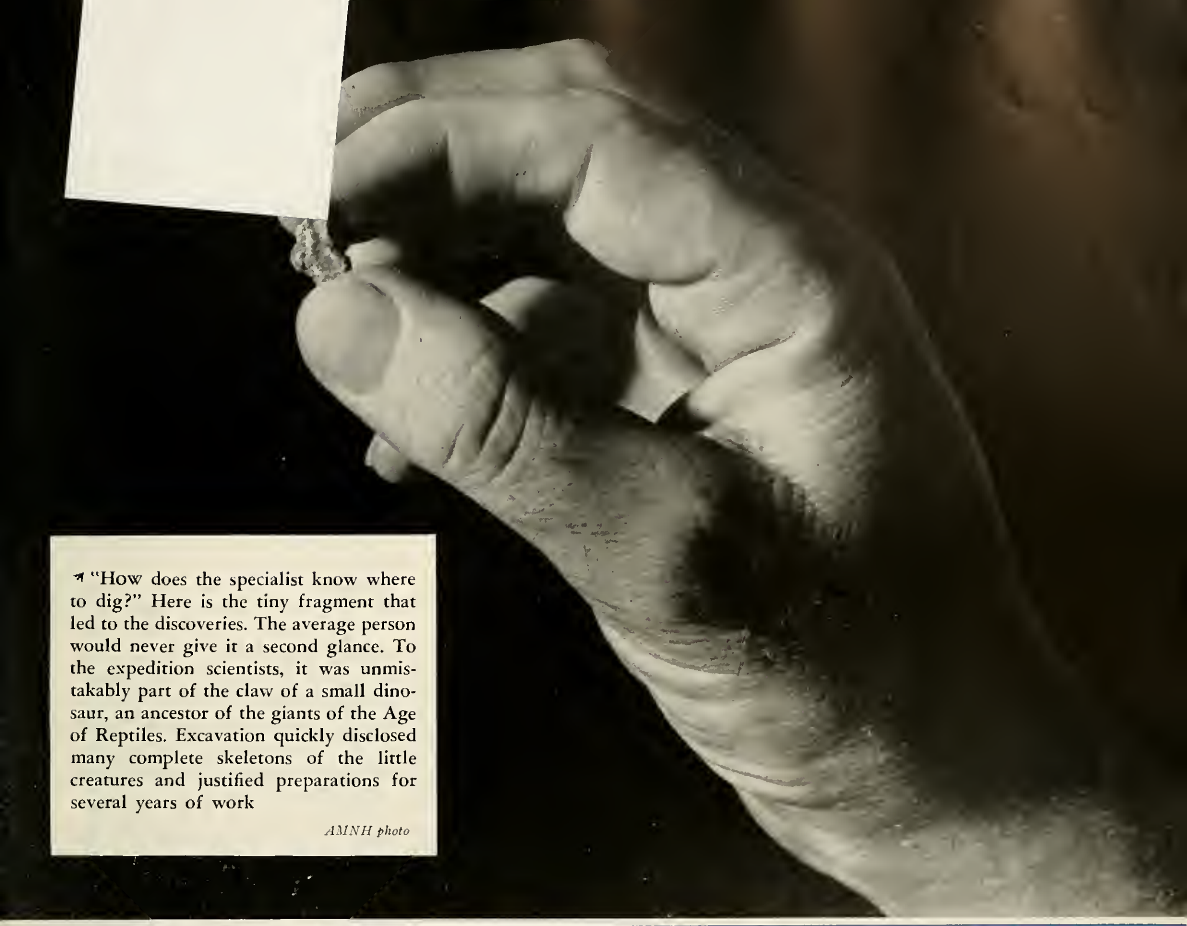
So as lunch time drew near we made our way back to the jeep with our thoughts centered more on food and a refreshing rest in the shade than on fossils.

As Thomas Ierardi, a member of our expedition, and I approached the jeep, we saw the third member of our group, George Whitaker, sitting in the car waiting for us. He had been up one of the canyons exploring all morning while we had been up another, so there was information to be exchanged. We certainly didn't have much to offer. Our main consolation for several hours of tramping and climbing was a certain amount of geology and a powerful lot of colorful scenery.

But Whitaker had some interesting fossils to show us. As we drew

▼ A PAIR of the six-foot dinosaurs as they would have appeared in life: *Coelophysis* amid the verdure of its day

Drawing by Margaret M. Colbert



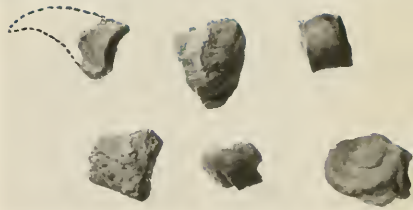
↗ "How does the specialist know where to dig?" Here is the tiny fragment that led to the discoveries. The average person would never give it a second glance. To the expedition scientists, it was unmistakably part of the claw of a small dinosaur, an ancestor of the giants of the Age of Reptiles. Excavation quickly disclosed many complete skeletons of the little creatures and justified preparations for several years of work

AMNH photo

near, he hauled them out of his pocket and held them in the palm of his hand. To a casual observer, they didn't look like much—a few small fragments, none of them larger than a walnut. Yet they were strange, not at all like the fossils we had been finding in these rocks. There were some pieces of small vertebrae and a few sections of limb bones. One of the pieces, no bigger than the end of your finger, was to determine our entire season's work and lead to a program that will require several years to complete. This piece could only be the articular end of a compressed claw belonging to one of the earliest and smallest dinosaurs.

As I looked at it, I felt the excitement that comes to one who glimpses treasures in the earth. For years we had hoped to find traces of these primitive little dinosaurs, and the features shown by these fossils could not be mistaken. The bones were small and delicate, and they were hollow. And the little piece of claw, by reason of its size and compressed shape, could have belonged to no other animal.

The Triassic period in earth history, to which these animals belong, is of particular interest to students of organic evolution. It began some 200 million years ago and lasted about 35 million years. It was the opening phase of the Age of Dinosaurs, when various lines of large reptiles were becoming established as the dominant land animals. It was a period of changes in the landscape and climate of the earth. Intense geological forces were in action, and life forms were becoming adapted to the new environmental conditions. Certain lines of evolution that were hold-overs from earlier periods were in the last stages of their decline. And many comparatively new evolutionary lines that had had their beginnings in the preceding Permian period were becoming well established and



▲ The claw and other fragments of prehistoric bones found on the surface. Black line approximates missing portion of telltale toenail

◄ A COLORFUL LANDSCAPE to the layman: million years of earth history to the studen prehistoric life. The rocks exposed here re sent most of the Age of Dinosaurs, with oldest, of course, at the bottom

were setting the general direction that evolution was to take during the later portions of the great Age of Dinosaurs.

For these reasons, we had decided some years ago to conduct a strong program of field work in rocks of Triassic age in order to build up our collections and knowledge of the animals of this period. Ghost Ranch was a good place to look for these fossils.

Fossils had been found here before. Indeed, there is some reason to think that Ghost Ranch may have been named because of an early encounter with fossils in the great cliffs near by. A half century ago a Spanish shepherd had a terrifying experience while riding in a large rincon, a sort of natural amphitheater formed by the huge cliffs just east of the present ranch houses. It was a hot day in the middle of summer, and perhaps he was a bit drowsy. At any rate, his lethargy was suddenly shaken by the sight of a huge rattlesnake coiled on the side of the cliff, its head weaving to and fro, its scaly body pulsating in the brilliant sunlight. This was no ordinary snake; it was the king of all snakes, 30 feet in length and as big around as a barrel!

That was enough for the horseman. He immediately whirled his mount and rode out of the place at a good gallop, and when he reached the nearest little town, he had a great tale to tell. Thus the legend of a giant serpent, a sort of "ghost," grew and took on color as the years passed.

More recently paleontologists came, especially from the University of California and the University of Chicago. One day, Mr. Arthur Newton Pack, the present owner of Ghost Ranch, rode out to watch one of the parties excavating a prehistoric skeleton. It was a big phytosaur, an animal of considerable size, that had been preserved in a coiled position, with the head pulled around toward the tail. As Mr. Pack and his companion approached the excavation, they could see the skeleton in the rock; and as it was a hot day, the heat waves distorted things so that the skeleton seemed to shimmer and move in the bright sunlight. The thought immediately came to Mr. Pack's mind that perhaps this was the original serpent seen by the old Spaniard.

As with many picturesque names, there are other tales to explain the origin of "Ghost Ranch," but we liked this one because we could easily imagine that we were living among the ghosts of animals that had died many millions of years before, when the landscape was quite different from our present camp site.

Whether or not their spirits hung over the place, we did know that fossils were to be found here. For instance, phytosaurs, large crocodilian-like reptiles that were common during Triassic times, had inhabited this region. And *Typothorax,* a queer, elongated reptile covered with a fantastic array of armor plates, had been found at this place. But most important to us now were the "pocket-size" ancestors of the great dinosaurs, and it was with high hope of finding them that we returned to the spot where Whitaker had found his fragments.

It was a long sloping cliff, largely covered with loose rocks—a most unpromising place to look for fossils. High up on the cliff we found the level from which the specimens had come, a layer of bones in the Triassic clays making up the Chinle formation. At first, the bones were not very apparent, but as we brushed away the loose, weathered dirt, the fossils began to appear. The more we brushed, the more of them we saw. It was evident that this was more than a sporadic occurrence of isolated fossil bones.

It was especially exciting, as we proceeded to uncover the bone layer, to discover that the fossils were almost entirely of the little dinosaur. The prospects looked better by the hour.

Until now, Triassic dinosaurs from this part of North America had been known from only the most fragmentary kinds of fossils—scraps of vertebrae, pieces of limb bones and hip bones, isolated portions of skulls. Nor was the material from other parts of North America much more abundant. Here we were finding almost complete backbones and legs. After a day or so of exciting prospecting, we knew it would be necessary to begin operations on a

⮝ AGAINST a background of Triassic, Jurassic, and Cretaceous rocks, the quarry from which the little dinosaurs were removed can be seen at the foot of this photograph

⮝ FIRST DISCOVERY at the quarry site: George Whitaker at left, Thomas Ierardi at right. Roof of house (expedition headquarters) can be seen among trees

⮜ THE HEADQUARTERS at Ghost Ranch afforded unusual comforts for a paleontological expedition

big scale. We would have to settle down here for a long stay, for lots of digging and a great deal of heavy work. Ghost Ranch was the ideal place to have made such a discovery.

Mr. Pack, the owner of Ghost Ranch, has for many years had an active interest in natural history and conservation, and he is seriously concerned with the work of the American Museum of Natural History. He most graciously made many facilities at the Ranch available to us and helped in some of the more difficult parts of our work, so that our labors were lightened and shortened to a great degree. Thinking back over the summer, we wonder how we would have completed the job without his assistance.

He sent one of his men with a big bulldozer to build a road to the base of the cliff below the quarry. This enabled us to haul supplies to the quarry and, when the time came, to remove the big blocks of fossils to the ranch.

It became apparent that we would need additional assistance from the Museum's Paleontological Laboratory, so we telegraphed for Mr. Carl Sorensen, one of the expert technicians. He made flying preparations and joined us in record time, and his work through the remainder of the summer was invaluable.

Meanwhile, we began to excavate a big hole in the cliff to expose a considerable expanse of the bone layer. Most of the hard clay above

▲ Breaking ground. Left to right: Carl Sorensen, Thomas Ierardi, and Edwin Colbert

▲ A roof was built over the quarry for protection from sliding debris and the desert sun

the bones was removed with heavy picks and shovels, but in the last few inches above the bone layer, it was necessary to work carefully with light equipment. Small awls and fine brushes were used whenever there was danger of damaging any of the fossils, for these were delicate and brittle, and unless treated properly as soon as they were exposed, would go to pieces. So we shellacked the bones as they were uncovered, and a chart was made showing their position in the rock. The shellacked and hardened fossils were then covered with thin, Japanese rice paper that was shellacked to the fossils to give added strength and protection.

When the entire bone layer within the limits of the quarry was exposed, we were stirred with mixed emotions—joy at such a rich deposit and dismay at the prospect of trying to get the material out of the quarry and to the Museum. The bone layer was almost a solid mass of dinosaurs!

These were not isolated and disconnected bones as is so frequently the case in a fossil deposit; they were completely articulated skeletons piled one on top of another. The skeletons were frequently intertwined in a most confusing way, making it difficult to distinguish clearly each individual animal. In the surface we exposed, we counted eighteen skulls, which gives some idea of the abundance of the remains throughout the extent of the quarry.

The task of removing the bones from the rock can be properly done only in a museum laboratory, so the problem was to cut channels through the bone layer and thus separate it into blocks of a size convenient to handle. And here we were faced with a decision reminiscent of Solomon's. Wherever we placed our line, we would cut right through the creatures to get them. Yet there was no alternative.

We began the job, and it proved to be the most difficult of the whole operation. As we cut down into the deposit, we found there were not merely skeletons on the top but more of them underneath, layer after layer. We would start a channel at a likely looking place, only to find a valuable skull or pelvis underneath. This would then have to be extracted or by-passed. All the fossils were carefully removed from the channels as we progressed, and careful records were made so that these parts could be restored to their proper positions when the fossils were finally prepared in the laboratory.

The cutting took a long time, and after it was completed, we were ready for the final stages of excavation. The large blocks were encased in strong bandages of burlap dipped in plaster of Paris and strengthened with heavy sticks and boards plastered to the block. When this had hardened, each block was undercut and turned over with the aid of an improvised derrick equipped with chain and rope hoists. We had kept the blocks as large as possible, and they were all very heavy. Turning them required a great deal of pulling and hauling and propping, with an accompanying background of shouts and gesticulations. After we got them over, we plastered the bottom of each block and braced it as we had done with the top and sides.

How, now, were we to get these heavy chunks of rock out of the quarry, down the cliff, and to the ranch? This would have been a major undertaking if we had not, once again, had the aid of Mr. Pack's bulldozer. Mr. Herman Hall, the operator of the bulldozer, pushed his way from the road he had built right up to the quarry. There the blocks were loaded one at a time onto a heavy sled and hitched to the giant, panting machine. It was then child's play for the big bulldozer to haul the sled with its heavy block down to the road and thence to the ranch. Once there, it was merely a case of loading them onto a truck and shipping them to the Museum, where the remains of the animals will be painstakingly removed from the rock for study.

From what we have seen of them, we feel that these finds will prove to be particularly valuable and perhaps even spectacular. They give us, for the first time, a fairly well-rounded picture of the earliest and most primitive dinosaurs known from North America. Moreover, since these animals are among the earliest and most primitive dinosaurs known throughout the world, their importance in advancing our knowledge of the ancestry and the early history of these prehistoric reptiles can hardly be exaggerated.

This early dinosaur from New Mexico was named *Coelophysis* (pronounced Seel-o-FY-sis) by the great American paleontologist, Edward Drinker Cope, in 1889. Cope described the animal from various fragments that had been collected by his veteran field man, David

▲ CLOSE TO THE BONES, awls and brushes replaced the heavier tools

▲ DIAGRAM showing position of exposed bones and channels cut to divide the rock. Eighteen skulls were evident simply on the surface, indicating an almost solid mass of dinosaur skeletons. The line of cut had to be changed often to by-pass valuable remains

▲ AS SOON AS EXPOSED, the bones were protected from injury and disintegration by a coating of plaster, followed by layers of rice paper and shellac

▼ THE MOST DIFFICULT PART of the job was cutting through the almost solid mass of dinosaurs to make blocks small enough to transport

Baldwin, in the same part of the state where we found our quarry. Various additional fragments had been discovered from time to time, especially by parties from the University of California. Still it can be said that until now our knowledge of *Coelophysis* and, in general, of all primitive dinosaurs from North America has been based upon very fragmentary fossils.

Most people think of all dinosaurs as veritable giants, as long as Pullman cars and almost as heavy. *Coelophysis* was only about 6 feet in total length and so lightly constructed that he probably did not weigh more than 40 or 50 pounds. As a matter of fact, there were many small dinosaurs throughout the his-

◂ UNDERCUTTING A BLOCK to extract it from the ground

tory of these interesting reptiles, and the truly primitive types at the beginning of the Age of Dinosaurs were quite small. Evolution among the dinosaurs was, in part, a process of development from small ancestors to giants.

Thus *Coelophysis*, one of the earliest and now certain to be the best known of the primitive dinosaurs, was a slightly built animal with hollow bones like those of birds. (In fact, *Coelophysis* means "hollow structure.") Many of the bones, particularly those of the skull, were exceedingly thin, so that as fossils they are very fragile.

Coelophysis walked in a semi-erect position on his hind legs, which were comparatively strong. Its feet were three-toed and armed with strong, sharp claws. As a matter of fact, the hind legs and feet of this reptile strongly remind one of the legs and feet of a long-legged ground bird. The hips were strongly constructed because they had to act as a fulcrum for the support of the entire body. The tail was very long and slender, and it served to counterbalance the weight of the body. The fore limbs were very small, with tiny, three-fingered hands armed with sharp claws, which served as grasping organs to aid the animal in catching and holding its prey. The neck was moderately long, serving as a noble support for the head. The eyes were large, and the mouth was armed with numerous, sharp, recurved teeth. We cannot know what the skin was like, but it was probably leathery, perhaps somewhat scaly, like the skin of a small alligator or crocodile.

This is the picture of a very active and predaceous animal, a carnivorous reptile that hunted other small reptiles and amphibians and probably even fed on insects to some extent. Though strikingly small in comparison with its gigantic relatives of a later day, it was one of the aggressive predators of its time.

From ancestors such as *Coelophysis* all of the later dinosaurs evolved. Some of them continued to prey upon other creatures, and of these meat-eaters a few retained the small size of the early ancestors. But most of them became giants. By far the greater number of Jurassic and Cretaceous dinosaurs, which lived between 60 and 155 million years ago, were plant-eaters and as such became adapted to a widely varied environment. It is among these later plant-eating dinosaurs that we find the great diversity in form and structure so characteristic of the dinosaurs as most people know them. Yet when we trace back the separate lines of these highly advanced dinosaurs, we find them converging toward ancestral forms of which *Coelophysis* is a typical example. Therefore, the discovery of complete and beautifully preserved skeletons of *Coelophysis* enables us to reverse the evolutionary process, as it were, and to journey back through time to become intimately acquainted with the first dinosaurs.

What was the land like when *Coelophysis* was alive? Obviously quite different from today. This region was a low, flat, tropical land—not the land of high, colorful cliffs and mountains and desert that we now know as northern New Mexico. It was a land of jungles and swamps, of sluggish streams flowing barely above sea level through a great, monotonous expanse of green growth above which rose occasional volcanoes.

Everywhere reptiles dominated the scene. They lived on the uplands and down in the swamps; they inhabited the river bank and the river itself. The crocodile-like phytosaurs were the largest and

◂ THE BLOCKS had to be reinforced with splints, turned over, and treated on the bottom most predaceous of the reptiles, and it behooved *Coelophysis* to stay out of reach of their powerful, heavily-toothed jaws. *Typothorax,* the strange looking, heavily-armored reptile mentioned earlier, was protected against the rapacious phytosaurs by its strong body-covering. On the uplands, a large plant-eating reptile, *Placerias,* walked on strong legs, with two long tusks protruding from its skull.

The reptiles dominated the land, but the amphibians, which had been supreme ages before when the reptiles were beginning the course of their complex evolution, were still maintaining some show of competition. There was a giant amphibian, *Buettneria,* an animal some eight feet in length, that inhabited the streams and watercourses of the land in which *Coelophysis* lived. There were many fresh-water fishes, too—lungfish and ganoid fish with heavy, shiny scales.

But there were no birds. The first bird was still many millions of years in the future. And there were probably no warm-blooded mammals, even though some of the reptiles were at this time becoming so very like the first mammals that it is difficult for us to know whether they should be classified as reptiles or as mammals.

It was in many ways a strange world to our eyes. And there are many questions that we cannot yet answer fully. Why, for instance, were the bones at Ghost Ranch concentrated in such abundance? Why is this deposit made up so completely of dinosaur skeletons; why were not other reptiles of the time included? True, a few scattered phytosaur bones were encountered during the quarrying of the dinosaurs, but, practically speaking, we found dinosaurs almost exclusively. Just as remarkable is the complete preservation of the skeletons. Usually we expect to find a hodgepodge of random bones. What accounts for this?

It is evident that something must have killed great numbers of *Coelophysis*. Perhaps it was a volcanic eruption, for there was much volcanic activity in those days. Perhaps it was something else; we can only guess. What we can say with relative certainty is that the *Coelophysis* carcasses were deposited en masse, perhaps in some sort of an eddy or backwater. The sediments in which these dinosaurs were found appear clearly to have been laid down on a stream bottom. There was probably some process of selection whereby the dinosaur carcasses were concentrated in one spot. Since these were very light animals, their bodies may have drifted farther than did the bodies of other reptiles that may have died or been killed at the time. And whereas the bodies of other animals might have been rolled over and over and thus broken up, the little dinosaurs may have floated on to survive the vicis-

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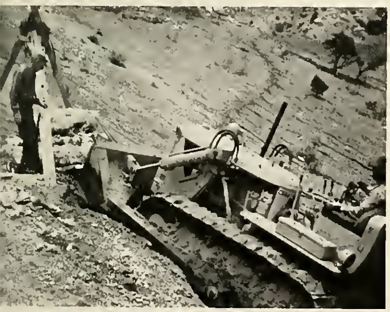
▲ EDWIN H. COLBERT, Carl Sorensen, George Whitaker, and Thomas Ierardi beside a block of prehistoric remains ready for transportation



▲ THE BULLDOZER had to make a road to the quarry. The blocks were then carried down the slope. Beside the load is Mr. Arthur N. Pack, host to the expedition at Ghost Ranch

➤ HAULING THE BLOCKS to the ranch houses, whence they were trucked 2000 miles to the Museum

A South Sea Fish Drive

The excitement and drama of ceremonial "stone-fishing" make this remarkable Polynesian custom an event of supreme interest and traditional importance

By Wilmon Menard
All photographs by the author

▲ Mighty blasts on a conch shell mark the get ready, get set, and go signals that initiate the fish drive

The herding of fish at the Island of Bora-Bora, in the Leeward Islands of the far South Pacific, is a Polynesian custom that has descended from generation to generation, its origin and inventor forgotten in the long march of years. It existed in eastern Polynesia long before Captain James Cook explored this section of the South Seas and is still carried on without change—an exciting event of supreme traditional importance, for which men, women, and children turn out en masse in gala attire.

Tautai-taora, or "stone-fishing," is in some ways the aquatic counterpart of a cattle or reindeer drive. During my sojourn on Bora-Bora in the Society Archipelago, I had the opportunity to be a participant in one of these fish drives.

One morning, a stalwart youth of Vaitape blew a loud, resonant blast on a conch shell, which awakened me and Roo, my Man Friday. The sun had not risen, but dawn had dispelled the darkness, and the vast dome of the heaven held an ethereal, pearly hue. Quiet as a millpond, the great lagoon of Bora-Bora, reflecting the sky, changed in color swiftly with the flooding of light in the east, until it was opalescent. Quickly snatching our *pareus* (flower-figured waist cloths) and fixing them snugly about our mid-sections, we hurried down the palm-canopied lane toward the beach, where the fish drive was to start.

"It will be a great day for *tautai-taora!*" cried Roo, as we ran along with the group of Bora-Bora natives toward the lagoon. "Many fish have come in through the reef pass and are feeding greedily upon small mullets!"

The whole village of Vaitape had turned out for the fish drive. Countless canoes were drawn up in line on the beach, ready for the sport. In the coconut grove the natives were singing, dancing, and still feasting. Roo and I joined them, waiting for the great tropic sun to rise over the summits of Bora-Bora.

Then another note on the conch warned us that the *tautai-taora* was to begin. Accompanied by a brisk rolling of drums and tom-toms, we went to our canoes, inspected our paraphernalia to see that everything was in order, and then stood by the boats, ready to launch them at a given signal across the lagoon. A venerable native, the district chief of the village, stepped slowly down to the beach and, closing his eyes and raising his arms to the sky, blessed us and prayed in a fervent, clear voice for the success of the fish drive. Then the head fisherman of Vaitape trotted quickly along the line of canoes and natives, counting us off and designating our positions in the drive.

Another signal sounded on the conch! A hundred canoe keels grated across the sandy beach and splashed into the shallow shore water of the lagoon. A momentary pause, tense with excitement! In each canoe were two men, with paddles poised for deep thrusts. Their women stood in the water beside them, talking encouragingly. Women never enter a canoe to par-

◂ PRELUDE TO ACTION: canoes take formation in the lagoon; paddles are poised for action

▾ AT THE SIGNAL from the leader, natives in the rapidly converging canoes lash the water with stone-weighted ropes, churning the surface of the lagoon to a boil

ticipate in stone-fishing. They are permitted to take part in the *tautai-taora* only at its climax, when the fishes are herded in close to shore by the contracting formation of the canoes. This has been a strict tabu since heathen times.

The conch blower raised his marine trumpet to his mouth again, and a long blast galvanized every man to action.

"*Haere! Hoe! Hoe! Manuia!*" cried the women and children left behind on the beach. "Go! Paddle! Paddle! Good luck!"

Fifty of the canoes, approximately twenty feet apart, swept quickly off to leeward, while the other half shot in the opposite direction, a mile to windward. The lines of canoes soon touched the edge of the reefs. The leader, a tall, strong, handsome native, holding a white flag fluttering from a long bamboo pole, was paddled along in the center of our formation. He controlled the moving lines of canoes and their formation by frequent blasts on the conch.

In the stern of each canoe, a man paddled expertly, keeping the frail craft in position. In the bow stood his companion, poised in readiness and holding a stout rope to which a coral boulder, ten pounds in weight, was attached. It is from this stone that the name "stone-fishing" originated. *Tautai* means "an object for fishing," and *taora* is defined as "something thrown," so in this form of fishing, where a stone is thrown, we have "stone-fishing."

The leader of the fish drive suddenly stiffened, shot a quick, approving glance across the canoe-dotted lagoon, and then shouted and waved his flag to the left. In that instant, a mighty cry rose from 200 throats, to be echoed by the spectators on the beach; and the forward figures in the canoes to the left smote the water with their stone beaters. Quickly they drew them up for the next signal to strike. Then the head fisherman's flag dipped to the right, and the stone-throwers in this line struck the surface of the lagoon.

First left, then right. Right! Left! Right! Left! The fishermen barely had time to haul their stones up before the flag signaled for them to strike again. With the concussion of their stone-weighted lashes, each line was making the surface of the lagoon boil as if in eruption. They were quickly approaching to meet in an impregnable circle around the mass of startled fishes, which were dashing madly toward the shore, their escape to the open sea cut off.

Crouched in the bow of the canoe with my eyes fixed on the leader, I smote the water in unison with my companions. Once the stone slipped from the noose of my rope, and in a twinkling I was over the side for it, catching it before it

◄ The canoes converge to herd the fishes closer to shore

▼ A net of palm leaves is held by the women and girls to reinforce the palisade and tighten all lines of escape

sank to the bottom and clambering back into the canoe without losing our position in the formation.

"Maitai! Good!" approved Roo, paddling the canoe.

It was Roo who had taught me this trick of catching a stone as it drops through the water, without allowing it to reach the bottom.

The ends of the line of canoes at the reef moved swiftly, converging, while those inshore moved slowly as the circle formed. They finally met, and the circle around the fishes began rapidly to contract. The fishes were leaping above the surface of the lagoon in panic-stricken flight.

The leader signaled on his conch to the women and young girls on the beach, and they dashed swiftly out into the lagoon, moving in ahead of the lines of canoes. In a single file they walked far out into the water, forming an inner circle ahead of the advancing formation of canoes, their legs and bodies preventing the frightened fishes from making a rush toward the gap in the coral reef. The tallest women and girls were farthest out, and, save for those close to shore, they stood in the lagoon with the water up to their breasts.

The circle of canoes contracted until they were welded together, outrigger to outrigger, in a stout barricade. There was a sudden lull. Then the conch sounded. A large canoe streaked out from shore, following the converging line of canoes. The native in the stern paid out a long screen of coconut fronds, which the women and girls grasped and held before them. The work of the beaters and the canoes was over, and the boatmen sprang out to assist in reinforcing the contracting line of bodies.

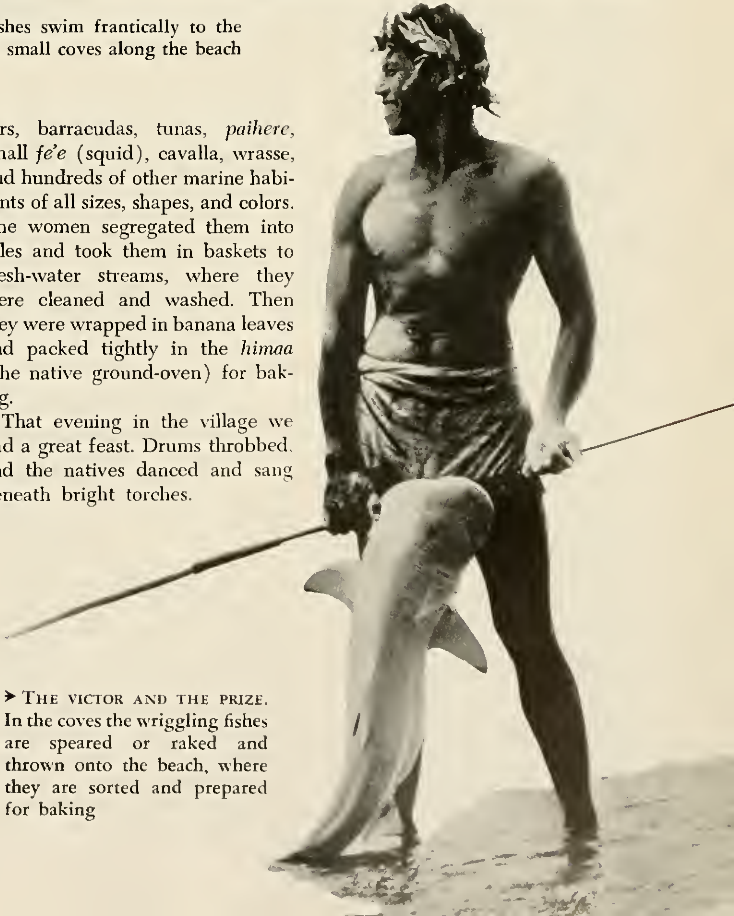
⮝ ESCAPE to the sea cut off, the fishes swim frantically to the shore, where they are trapped in the small coves along the beach

The fishes, trapped in a small space, churned the lagoon to a silvery froth, frantically milling and rushing futilely against the palisade of bodies. In the rear, swimming slowly and with my *tavero*, or spear, poised for a thrust, I watched for any fishes that might overleap the line of palm leaves and natives.

The fishes were herded quickly into the beach and debouched upon the strand. The men, under the direction of the leader, speared or raked the captured fishes out of the coves. Old grannies, infants, and even dogs assisted in throwing them from the pools onto the beach, unmindful of the small sharks that might have been caught in our drive. Roo and I leapt into the lagoon among the wildly wriggling fishes and used our fish spears to good advantage.

It did not take long to clear the coves of the herded fishes, and we found we had caught every kind, from a mullet to a half-dozen or so small sharks. There were groupers, blue and green parrot fish, puffers, barracudas, tunas, *paihere*, small *fe'e* (squid), cavalla, wrasse, and hundreds of other marine habitants of all sizes, shapes, and colors. The women segregated them into piles and took them in baskets to fresh-water streams, where they were cleaned and washed. Then they were wrapped in banana leaves and packed tightly in the *himaa* (the native ground-oven) for baking.

That evening in the village we had a great feast. Drums throbbed, and the natives danced and sang beneath bright torches.



➤ THE VICTOR AND THE PRIZE. In the coves the wriggling fishes are speared or raked and thrown onto the beach, where they are sorted and prepared for baking

➤ QUILLS as much as 18 inches long form the luxuriant crest of the African porcupine, *Hystrix galeata*—an animal two feet long to the root of its ridiculous tail

Hunting Porcupines with a Witch Doctor

A naturalist who passed many years in Africa describes his adventures with a large relative of our familiar "quill-pig" and with a medicine man who helped him find the animal

By ARTHUR LOVERIDGE
Curator of Reptiles and Amphibians at Harvard's Museum of Comparative Zoölogy

ONE day, when I was camped by the Sipi River on the northwest slopes of Mount Elgon, in Uganda, two men arrived with a porcupine (*Hystrix galeata*) that they had speared among their maize. Its stomach was distended with corn gnawed and ground to a flourlike consistency by the animal's teeth. The Gishu called the porcupine *isegesi,* though it is widely known throughout East Africa by its Swahili name of *nungu.*

The African crested porcupine is a much larger animal than its North American relative, for it measures over two feet from the end of its blunt muzzle to the root of its ridiculous little five-inch tail. The forest of brown and white quills rising from a porcupine's back are so striking that one is apt to overlook the fact that the animal's body is almost wholly black or a very dark brown. From the crown of the head to the shoulders is a luxuriant crest of stiff bristles that coarsen along the back till they merge into the true, sharp-pointed quills. Many of these measure eighteen inches, and although they are much shorter on the tail, they are still long enough to conceal a tuft of modified quills that, having lost their points in early life, have become open-ended, hollow cylinders. It is these short, stout quills that make the rattling noise when an agitated porcupine wags its little tail.

African porcupines are exclusively nocturnal; at least I have never met one in daylight. At night they are surprisingly noisy—intentionally, perhaps, to advertise their untouchableness. Once, when I was spending the night in a tree, two big porcupines came trotting along the path beneath me, grunting as they went. I heard them long before I saw them.

When captured young enough, porcupines are said to make good pets; perhaps it was my misfortune never to meet so young an animal! True, at Mombasa I heard of one that came when its master called. By day it slept beneath a pile of straw in an open shed, to which it never failed to return; at night it went foraging on its own, with no restraint imposed on its movements.

Another, owned by Captain H. F. Kidd, a district commissioner in the Sudan, lived in his garden but refused to use the hutch provided for it. Each evening at sundown this porcupine would come to the veranda, climb on Captain Kidd's knees, and accept bananas from his hand. Nor would the animal leave till it had eaten all it wanted. It countered any attempt to remove it by raising its quills. When completely satisfied, it would clamber down and amble back to the garden.

Very different was the behavior of a young porcupine I kept in a cage—one so young that it had an inordinate liking for milk. But woe betide the kind hand that put the bowl into the little beast's cage, for the sharp-toothed rodent was ever ready to bite. More often it seized the bowl with its incisors and, suddenly backing away, spilled the milk. On the rare occasions when, with my hands protected by stout gauntlets, I attempted to handle this porcupine, the little furioso stamped its feet, erected its quivering quills, and made explosive noises to an accompaniment of rattling. Altogether, he was an unpleasant "pet" to handle, though he was little larger than a domestic cat.

Another porcupine was half-grown when sent to me by a friend. I kept it in an empty room and fed it chiefly on corncobs and potatoes; but as for coming when called . . . ! The moment I entered the room, the animal invariably left its food and rushed to a corner, into which it thrust its bewhiskered muzzle. Then, with shaking quills and resounding rattle, it dared me to approach. When I did, the animal would suddenly spring or swiftly run backwards with the intention of driving some spare quills into my shins. For that is how they attack; they do not throw their quills.

Several grown porcupines that shared another cement-floored room with a pair of jumping hares proved just as unsociable. They devoted much of their spare time to gnawing the stout wooden door of their prison—a strong cage that could long resist a porcupine's persuasive teeth. In addition to corn and potatoes, I fed them pumpkins and ground nuts. Perhaps I should have added salt to this diet, for after they had lived with the springhaas for two months, I found one porcupine eating the brains of a hare it had killed. With water they were well provided, though it is said that wild porcupines need not drink for long periods, provided they can find plenty of succulent roots or vegetables.

That so picturesque an animal should be destructive to native crops is unfortunate. To reach the coveted corncobs, a porcupine habitually gnaws through the maize stems; and this naturally brings the animal into conflict with African and planter alike. I was lunching with a settler near Nairobi one day when his bull terrier came in bristling with quills. Blood was running from the dog's shoulder, and his right forefoot was lame. This was not the first time my host's dog had brushed with a porcupine, so then and there it was decided to unearth the offender, the location of whose burrow was known.

The planter summoned some of his men and, after preparing four drums of disinfectant, had the fluid poured down one entrance of the burrow while, shotgun in hand, he and I waited near another. When no porcupine emerged, a few boulders were tumbled into each entrance to close them. Then, taking up a position that commanded a fairly good view of the approaches, my host sent a dozen Africans to halloo and beat through a patch of thick scrub near by, where the porcupine might be taking its siesta.

For nearly twenty minutes we waited tense and expectant; then, just as we were relaxing, there came a sudden, wild rush through the undergrowth. The porcupine, with two terriers so close at its heels that my friend held his fire, dashed past and dived into the closed earth, the dogs on top. There was a deafening pandemonium of growls, yelps, and squeals. Dogs and quills appeared to be flying in all directions. We ran to the spot, but before we reached it the porcupine came scrambling out and, taking to some impenetrable cover, made good its escape. The reluctant dogs were called off for examination, and the fresh quills they had collected were removed.

The futility of our method was inferior to the technique of an African witch doctor, whom I met in the Mwanza Province of Tanganyika Territory. Sleeping sickness had broken out at Sagayo, so I went to obtain blood films of the many different kinds of animals found in the neighborhood to determine which species, if any, were harboring the causative trypanosomes.

While following the game trails, I occasionally saw an odd quill lying beside the path and asked my Sukuma guide if anyone knew where the porcupines concealed themselves. He replied that their witch doctor understood the ways of porcupines better than anyone else, so I requested the chief to send for the man. He arrived at my camp with half a dozen small boys tagging after him, two of whom were his own sons. When I explained that I wanted to shoot the porcupines myself in order to take samples of their blood, he replied that it would first be necessary for his youthful assistants to locate the occupied burrows. The youngsters, unencumbered by any clothing, darted off to do his bidding.

In the afternoon they returned, each boy's eyes ringed with a chalky-white paste, "to enable them to see in the dark," explained the witch doctor solemnly. We set off across the plain, following footpaths that wound at first through sun-scorched *shambas* and later through a wilderness of thorn scrub and dead grass. On reaching the burrows, I noticed a wart hog tusk stuck in the entrance of one. I was about to pick it up when my gunbearer restrained me. The medicine man explained that he had placed it there to prevent any animal that might be in the earth from breaking out while he was away. At the other entrances were the horns of antelopes, roan, topee, and Thomson's gazelle. Like the tusk, each had been filled with a pitchlike substance in which many small beads had been embedded before the material hardened. This medicine (*dawa*), said the "doctor," would deprive any animal in the earth of ferocity, making it disinclined to attack the boys when they approached —a very necessary precaution, he added, for at times jackals or hyenas were encountered in the burrows.

Whenever one of his countrymen was plagued by a porcupine in his *shamba*, said the *mganga*, they sent for him. After the animal was killed there were always plenty of people to eat it, for a roasted porcupine is quite a delicacy. Once he had dug out four porcupines and at another time had come upon two females, each of which had two young. It is said that the mother gathers roots, leaves, and grasses in the burrow to form a nest for the young. A young porcupine's spines are soft and lie close to the body, for at birth the animal has not the power to raise them.

As we talked, some of the youngsters disappeared down near-by burrows. The extent of the warren was astonishing, for a boy popped up from an entrance fully *thirty feet* from the one he had gone into. The original excavating had doubtless been done by aardvarks. The children seemed to enjoy their work, treating the whole affair as if it were a game; they turned somersaults on the dusty earth piled at the entrances and played hide-and-seek in the galleries. Their woolly heads and naked bodies were soon covered by the friable, red soil.

Meanwhile, one of the lads located a porcupine at the terminus of a burrow and signaled us by knocking on the roof of his tunnel. A companion who had been listening for this called the witch doctor, who replied in similar fashion by stamping on the ground. After a little adjustment, the spot was marked to his satisfaction, and he ordered a shaft sunk about six feet beyond. So well had he judged the position that after digging down five or six feet, we broke into the gallery within a foot of the porcupine, which was backed up at the end of the burrow. Nor was this accuracy accidental, for the performance was repeated twice more that afternoon. During the digging operation the boy remained in the tunnel, singing and shouting to deter the animal from breaking back —as if small reliance was placed on the virtues ascribed to the tusk and horns.

The witch doctor declared that he was immune to injury by porcupines, but a few minutes later one of the animals gave a spasmodic jerk that drove four quills into his palm. He responded like any other mortal and lost no time in scrambling out of the shaft. One disciple promptly sucked the wounds while another gathered some green leaves, which he chewed vigorously, expectorating the resulting paste on the wounds to allay the pain.

My gunbearer remarked that a member of his tribe (the Kami) had once followed a porcupine down its burrow and was pierced with so many quills that he was ill for three months. Since then, none of his people would enter a burrow but contented themselves with setting snares at the entrance when they wished to rid themselves of a particularly pestiferous porcupine.

Even the boys who prepared the skins had been pricked a few times, although they disliked the job for another reason. Fleas (*Periodontis riggenbachi*), peculiar to porcupines, dwelt among the forest of quills where their host could not reach them. In such a situation smallness is of no particular advantage, so porcupine fleas grow to twice the size of cat and dog fleas, whose days are spent under precarious conditions and consequent nerve strain! But the big fellows were not at all choosy and would transfer themselves to the skinners —very much to the men's discomfort.

The next morning, while the skinners were still wrestling with their onerous task (the careful skinning of four full-grown porcupines is no sinecure), the witch doctor called. Financially he had done rather well the previous day, for the work had been on a commission basis. So, when I looked up and said, "Good day," I was surprised to see a very doleful countenance. He complained that he had slept but little on account of the pain in his hand. I asked if the paste had proved as ineffective as the *dawa*, which had failed to protect him from injury by porcupines.

He replied that the medicines were effective under natural conditions, but we had carried guns. This shooting business. . . . He shook his head, and I gathered that his magic could not be expected to cope with it.

"Do you want some more porcupines?" he asked.

I did not need any more.

Was there anything else he could get me?

Just then one of my boys, who had approached to eavesdrop, broke in with a grin:

"He could catch you some snakes. He's been telling us that he has powerful *dawa* to protect him from their bites."

"Really?" I asked the *mganga*.

"Truly," he replied.

Taking him at his word, I rose and opened a box of live snakes, grabbed a couple, and, holding them out, suggested he give a display for the benefit of the many natives in camp. Instead of seizing this opportunity to enhance his prestige, the "doctor" backed away, exclaiming that the reptiles were not from his district but from the lands of another tribe. This palpable excuse, accompanying his obvious discomfiture, caused considerable merriment among the sophisticated servants and skinners who had gathered to see what was happening.

"You are ruining your reputation," I said and asked to be shown the *dawa* of which he had been telling the boys. At first he demurred, but when I dismissed all the boys except one and told the *mganga* I might be willing to buy some of his medicine, he changed his mind and unslung the two bags he was carrying. One was made from the skin of a hyrax (*Procavia johnstoni matschiei*), the other of a dikdik (*Rhynchotragus kirki nyikae*).

Besides the horns and tusk I had already seen, the bags held many gourds, each about the size of a small orange. These gourds, corked with wads of dry banana leaves, contained a variety of powders, whose names and alleged powers the witch doctor proceeded to explain. I transcribed the Sukuma names phonetically, as in Swahili, the "e" being pronounced like "a," the "i" as "e," and the "u" like a double "o."

First there was *mkulungu* which, if placed on the head, will prevent tree snakes from biting if you should happen to pass beneath the branches on which they are resting. The witch doctor explained that after you have bought goats, oxen, or other animals, you should put *mtusia* in their drinking water, and they will remain contentedly in your kraal, having lost all desire to return to their former home. *Muma*, placed outside your door at night, will protect you from thieves, for if any have set out with the intention of robbing you, they will lose their way and wander about in the darkness. You need not be taken unawares by an evil spirit entering your hut at night to work you harm if you make incisions on your arms, hands, chest, and back and rub *kitalala* into the wounds. *Kitalala* is guaranteed to banish sleep, for it irritates "like insects biting."

Should wizards in the guise of hyenas come around your hut at night, throw *wal'uhubwa* on the fire; it will drive them away. When a wizard brings powerful medicines to use against you, employ *ushuluki*, which will not only render his potions powerless but may even cause them to rebound upon himself. After a quarrel, rub *ruhaga* on your face before setting out the next morning; then, should you chance to meet your enemy during the day, you will find that his anger has vanished, and he will greet you with a laugh. On the other hand, if you are still revengeful, you can use *lukagolulabuta* in conjuction with *ruhaga*, which must be rubbed into incisions on your arms. Then, upon meeting your adversary, all you need do is point a finger at him, and he will be smitten with sickness.

The effects produced by *msagagna* are similar to those of *ruhaga*, but the mode of application differs. *Msagagna* must be placed on the tongue, mixed with saliva, and rubbed over the face! The procedure for *nguberu* is the same, but it must be applied to the whole body before going to a dance; perhaps it should be classed with cosmetics. *Etemero*, thrown on a fire by the witch doctor before he comes to a dance, will announce his attendance to the people, who will rejoice by exclaiming, "Our witch doctor is coming!"

Perhaps I should point out that among white men considerable confusion exists in the distinction between witch doctors (*waganga*), whose functions are supposedly beneficial, and the wholly nefarious wizard (*mchawi*), whose schemes the witch doctor is supposed to counteract. There are charlatans in every profession, and to what extent this Sukuma *mganga* believed in the efficacy of his drugs to alleviate the fears and worries of a primitive society, I cannot say.

To the dance the witch doctor takes an effective rattle consisting of hard grains of maize (corn) imprisoned between two walls of porcupine quills, and this he shakes as he dances. But one more of his wares deserves mention, and that is *muhalimba*. This is a powder that is cast upon the fire when you concentrate on a friend or relative who is far away; it will cause the absent one to turn up unexpectedly.

"How much will you take for the lot?" I inquired when he had finished. As he could not make up his mind, he asked what I would offer.

"The taxpayer will be making his annual visit next month," I reminded him. "How much is your tax here?"

"Six shillings [$1.50]," he replied.

"Have you got it ready?"

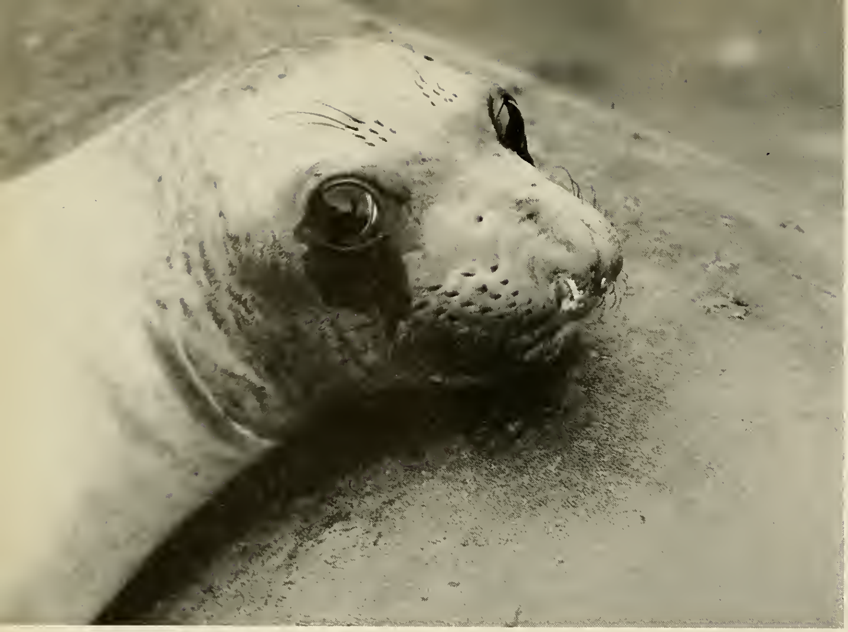
"No."

"Then suppose I give you six shillings for the bags and drugs?"

To this he agreed, and so I acquired the stock-in-trade that would have enabled me to establish myself as a *mganga*—had I not turned it over to a museum.

▼ "HANDLE WITH CARE!" Though they sometimes make good pets when taken young, even the witch doctor's "medicine" failed to protect him from their sharp quills

Photo by Hugh S. Davis



◀THE YOUNG ELEPHANT SEAL shows none of its father's grotesque "trumpet nose." Note the photographer mirrored in its large eye

➤A YOUNG BULL ELEPHANT SEAL, whose total length would be about fifteen feet. The spectacular nose seems to act as a resonator when the seal roars. It alternately falls into the mouth and becomes inflated by the breath

Return of the SEA ELEPHANT

On the threshold of extinction, one of the most curious mammals of the sea shows signs of coming back—a lesson in conservation with a climax clothed in irony

By LEWIS W. WALKER

All photographs by the author

IF Guadaloupe Island had remained as it was about two centuries ago, it would now be a veritable fairyland for naturalists and no doubt would have been set aside as a spot for the study of evolution in isolation. Now its barren and desolate terrain, eroded into deep gullies, can only be used as a warning of the consequences to be expected when the balance of nature is upset.

Native plants and birds by the score formerly inhabited this 4000-foot mountain peak, which protrudes from the Pacific 225 miles south of San Diego. Early voyagers described it as a paradise. Before cats and goats were introduced by whalers and created havoc, each bird or plant collected had a better than fifty-fifty chance of being new to science.

Those days, however, are past. The goats, released in the 1700's to provide a meat supply for the whalers, increased to over 40,000; and except for a few bushes that cling to cliffs, the small, edible plant life was devoured. The trees—majestic oaks, pines, and cypresses—had their branches nibbled as high as an upright goat could reach. Some botanists have even made the statement that the ravenous goats have not permitted a seedling to take root in over a century. Although the plight of the plants is discouraging, there are still a few isolated spots where some that are unique to Guadaloupe may still be found.

The demise of the birds, however, is definite. They can never come back. A list of those exterminated throughout the world would be interspaced with a constant repetition of the word "Guadaloupe." Flickers, caracaras, petrels, and others too numerous to mention bore the island prefix. All but a mere handful are gone, and some of the extinct species are not represented by a single museum specimen.

Several marine mammals inhabited the shore line. If the polished rocks may be used as a yardstick for the fur-seal population that once had its rookery here, these seals must have been as numerous as their publicized relatives of the Pribilofs. Aleuts were imported from the north to aid in the slaughter. The extermination, to all intents and purposes, was so rapid and complete that the animal was scientifically named from a bleached skull retrieved from the old killing grounds in the late 1800's.

Approximately 70 years after their supposed extermination, a small band was found and then lost once more. About six parties have attempted to relocate these potentially valuable animals. After

◄A PEELING NOSE does nothing to beautify the physiognomy of this Cyrano of the Sea

the rookery disappeared for the second time, we occasionally saw singles; but of late even these have been entirely missing.

Although the history of the life that was solely Guadaloupe's is a tale of gloom, one bright spot stands out amid the wreckage. A single beach on this tiny bit of land was the last outpost for the northern elephant seals—animals that have now spread their range to several additional islands.

On my first visit in 1930, there were several dozen of these tremendous animals on their chosen beach. Some of the old bulls had deep scars—probably mementos of the days when their kind were harpooned and rendered for oil. In this small group there were no cows, and as I now recall that early visit, only two or three young animals were in evidence. It seemed that in spite of the protective laws instigated by the San Diego Zoo and other organizations, the species was dying out, that conservation measures had come too late.

But in 1935, we were surprised to find not only a noticeable increase in numbers but also that another beach, previously barren, was occupied by a new rookery. Each year since then the elephant seals have pyramided, the highest count running close to 1500 animals in a single herd. Some of the overflow have spread southward to the San Benito Islands, where they are now well established. Finally reports were received of individuals in American waters; and one, wastefully harpooned out of curiosity, was towed into San Diego Bay.

Via a naturalist's grapevine we learned that some were to be seen in a small cove on one of the Channel Islands, off the coast of California. This was really good news —the first report in over a century of a hauling ground on American soil. This extension of range both to the north and south eliminated a hazard of landslides on the Guadaloupe beach, over which the best-meaning conservationists had no control. The original rookery is composed of black volcanic sand, and visitors are constantly bombarded with tiny particles of lava from the 1000-foot cliff that backs the beach. Each end of this restricted shore line is hemmed in by the debris of ancient landslides, which makes the bare area a precarious spot for the last of a species. For a period of many years, one good earthquake could have written finis for the species.

Every landing made on this beach has its thrilling moments. Sometimes it is the waves, whipped up by the constant trade winds, that cause the small dories to pitch and buck and occasionally capsize. Sometimes the damage is done by the carelessly flipped tail of a massive bull, rudely aroused from slumber in the second line of breakers. It is a rare event for an entire party to land without the dunking of at least one boatload.

From a distance the partially submerged animals look more like rocks than living creatures. Their specific gravity must be much greater than that of sea lions, which bob around buoyantly. The elephant seals almost seem to settle on the bottom and hold a fairly rigid position, despite their bulk and the battering force of the surf.

Their sense of fear seems to depend upon whether they are on land or in the water. Until man came into the picture, their only enemies were killer whales, and throughout the ages foes on land were non-existent. As a result, they consider the beach a perfect sanctuary, where they may sleep devoid of all fear. In the water, however, any strange, moving object will cause them to submerge. I have seen them come up to the side of a boat, practically within reach of the guard rail. If we remained motionless their attitude was one of curiosity; but if there were the slightest movement on board, they would sink from sight and not return. The moment they made a landing on the beach, fear of a person as a possible enemy vanished, and we almost had to step on their flippers to keep from being completely ignored.

Small animals, often used as stepping stones by the larger ones, would back up a yard or so when touched, sometimes without even opening their large, soft eyes. And repeated proddings were necessary to arouse the big bulls that were sleeping away the daylight hours. Many grunts and groans always preceded the actual awakening.

Once dislodged from the arms of Morpheus, they could be kept awake by gently tapping the proboscis, the peculiar trunk that adorns the male and earns him the title "elephant of the sea." This enlarged snout is not known to have

< A cow and a roaring bull in the surf. The cow lacks the pendulous proboscis of the bull

any practical use. When the bull seal roars, it seems to act as a resonator, alternately falling into the mouth and becoming inflated by the exhaled breath. The cow elephant seals have a nose which, although not Roman in any sense of the word, is closer to normal.

Up to the present, very few animals examined had food in their stomachs. The few animals collected on the beach for scientific use have been completely empty. Examination of the one harpooned off San Diego disclosed the remains of about 30 kelp sharks, a rock bass, and a few beaks from small squid.

Post-mortems performed on elephant seals that have died in the San Diego Zoo have revealed an odd situation of especial interest to parasitologists. Most of the animals have succumbed within a few years after capture—strangely, soon after they have "gotten on food" and apparently become contented with the easy life of captivity. When dissected, open ulcers and worms were found in the intestines. At first the ulcers and worms were presumed to be products of captivity, but then, by special permission, a few wild animals from the Guadaloupe beach were examined. They, too, were found to have ulcers; but something about their Pacific Ocean diet had nourished and kept healthy a colony of small worms, which knotted into tangled balls and lived within each ulcer. In this strange way the parasites plugged the lesions and made a long life possible for their ulcer-ridden hosts. In captivity, the worms generally died off and allowed the ulcers to progress.

When this peculiar situation was discovered, there was some talk of using the same system to render innocuous the ulcers of other animals. If ever perfected, it would be worthy of a good "Believe It or Not." First we persecute the elephant seals until they are on the verge of extermination; then we pull them back from the brink of the grave and stumble upon a fact that may help all mankind, thus giving aid to Man—the worst enemy that elephant seals have ever known.

< Elephant seals have no fear of man, their worst enemy. Continual prodding is necessary to rouse the bulls on their beach, but in the water any moving object frightens them

∨ Paul Bonnot, California Fish and Game investigator, and a large bull

▲ THE FIRST VISIT to the nest in La Costa Valley was in early April. It was at the end of a limb 35 feet out from the trunk of a live oak. The ten-day-old eagles were bunches of snow-white down the size of half-grown chickens

At home with *The Golden Eagle*

Put on your tree-climbing spurs and follow these bird-loving adventurers as they study the private life of the King of the Air

By TELFORD HINDLEY WORK, *in collaboration with* ALBERT JOHN WOOL

All photographs by Telford H. Work

NOTHING could come much closer to an eagle's paradise than the rolling hills of the Mount Hamilton range northeast of San Jose, California, where we studied Golden Eagles for eight years.

The country is comparatively open, with clumps of oaks, scrub bushes, and digger pines scattered over the hilly, grassy terrain. Between the beautiful green slopes, streams dash through wooded canyons on their ceaseless journey to San Francisco Bay. The region is abundant in squirrels and other small mammals, for which the magnificent Golden Eagle soars on tireless wings, seeking food for himself and his young.

In the distance looms an occasional cliff, suggesting a possible home for the high flying Prairie Falcon or Duck Hawk. And Great Blue Herons are often seen perched on rocks along the streams, fishing for trout, which are large and plentiful.

Al Wool, whom I met as another student shortly after I began premedical training at Stanford University, lived on a ranch in the heart of this country. We soon combined our interests in ornithology and photography and began an eagle-studying project. Early each spring this region welcomed us. We observed the birds week after week throughout the spring and early summer, from the time they laid their eggs until the young were fully grown and had left the nest.

There are only two eagles native to the United States—the American Bald Eagle and the Golden Eagle. Either might serve as our national symbol, for both embody the spirit of freedom for which we stand. But there are differences between the two birds that might well be summarized.

The American Bald Eagle was chosen as the national emblem in 1782 by the Continental Congress. This eagle is not really bald but appears to be when observed from a distance because of its snow-white head.

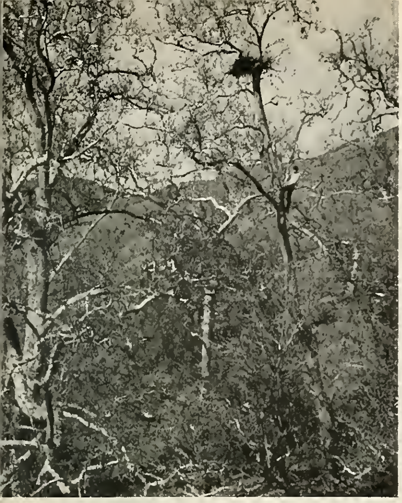
The Golden Eagle, which has a cap of golden feathers on its head, is circumpolar in distribution, being found in Siberia, Europe, and North America. If the two birds were to engage in a life-and-death struggle, the Golden Eagle would win nine times out of ten. Although they are both about the same size, with a wingspread of about seven feet, the Golden Eagle is the stronger and more ferocious.

Benjamin Franklin, among others, argued against selection of the Bald Eagle as our national emblem, pointing out that it lives by "sharping and thieving." (It is a somewhat lazy bird, which steals much of its living from the hard-working osprey or fish hawk.) But it is strictly American, so it is natural that it should remain our national emblem.

The large number of Golden Eagles that inhabited the region of the Mount Hamilton range made this an ideal location for our study. We were able to visit several nests in one day, and an exhilarating adventure it was.

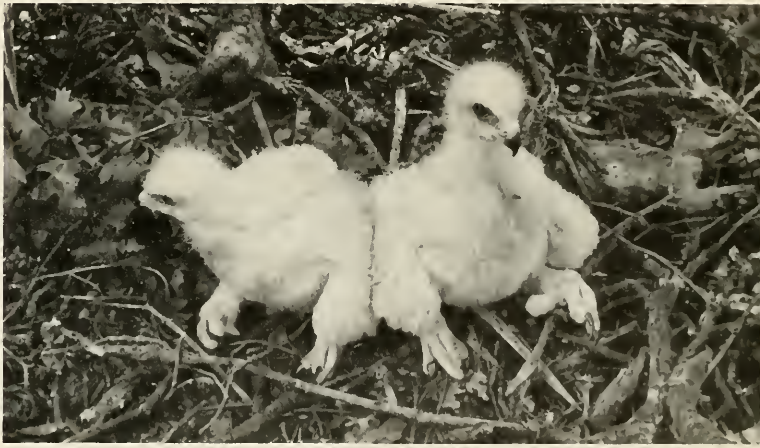
As A. C. Bent has so aptly said of this king of birds, "It is majestic in flight, regal in appearance, dignified in manner, and is crowned with a shower of golden hackles about its head." During the Middle Ages the Golden Eagle was flown only by kings for falconry. It is a strong flyer, with speed, agility, and endurance. If unharmed by man or its natural enemies, it lives 75 years or longer. It is monogamous but will choose a new mate if the first one dies.

One spring we chose four of the best situated nests to study and photograph periodically. There were usually three of us on these expeditions: Albert Wool, his cousin Wilbur Wool, from San Jose State College, and I. Wilbur is such



▲ THIS NEST was 55 feet high in a huge sycamore. Here you see Willy Wool pausing to rest in his eager climb to examine the eggs

▲ TWO LARGE EGGS lay in this nest, which had been built many years before. Heavy sticks two or three inches thick were crisscrossed between two limbs and the trunk. Smaller sticks and finally a lining of straw and leaves completed it



▲ AT 25 DAYS the eagles were larger than ordinary chickens. On close examination the primary feathers were found to be just bursting from the tips of their sheaths

a small fellow, stretching six feet four inches in height, that we nicknamed him Willy.

Willy's Model "A" Ford furnished most of the transportation over the roads and cattle paths leading into the eagle country. Our procedure was to travel by car whenever we could in order to cover as much territory as possible in our limited time. When our destination was in an area where there were no roads, we attached anti-skid chains to the rear wheels and traveled across country, over the hills and through turbulent creeks, to the various nests. Two of the nests contained young eaglets five days apart, so visits at ten-day intervals enabled us to photograph five-day stages of development.

The first week of March, we visited a nest that was deep in the eagle country, several miles from the nearest cattle road. This pair of eagles had worked on three nests that we knew about. Some Golden Eagles occupy the same nest year after year (over 34 consecutive years in one recorded case), others move from one location to another, but they always seem to build within sight of fresh water.

As the pair in question had nested for the past three years in the same place, we thought they might do so for a fourth, so we headed for the nest. It was a tough pull up the hill. Fifteen minutes were needed to climb a distance that later required only five to descend. But we had made a fortunate guess, for as we approached the hilltop, the male eagle soared overhead to watch us.

The nest was 55 feet overhead in a huge sycamore tree. From the ground, it appeared empty, but we knew from previous experience that the female was a tight sitter. It took several minutes to flush her. All three of us were eager to climb to the nest, but since I was the photographer, I was given first

▲ EXPERTS AT PLAYING 'POSSUM. As the men approached, the 45-day-old youngsters lay flat with their eyes open. Only after the observers had been there 20 minutes and had actually stirred their tail feathers did the birds move

▲ TWO AND ONE-HALF INCH TALONS with great striking power made the seven-week-old birds dangerous. They had changed into handsome specimens and would soon have all the magnificence of adults

opportunity. The tree was five feet in diameter, and tree-climbing spurs were needed to ascend it. These are three-inch spikes attached to a piece of iron that straps to your leg, with a stirrup-like hook at the bottom for your foot. The spurs have to be about three times as long as those used by telephone linemen in order to bite through the papery bark into the wood. You might think that when climbing a tree of large diameter you would need a rope around the trunk to keep you from falling backward. We find it better, however, to get along without this, because the roughness of the bark of a large tree makes it difficult to hike the rope up after each step. We depend solely upon the friction hold of our hands and arms. The climber must remember to keep his body arched outward away from the tree, so that the spurs will bite into the trunk at an adequate angle rather than straight down.

When I am halfway up a tree I still sometimes recall the first tree I ever "spurred" in search of a hawk's nest. Twenty-five feet above the ground I looked down. Panic-stricken from the height and exhausted by the climb, which had only taken me two-thirds to the first limb, I "bear-hugged" the tree. When I flattened my arched back, the angle of my climbing irons was straightened and the spurs were pried out of the bark. I landed in a painful heap at the base of the tree! I was lucky to escape without broken bones or severe lacerations from the sharp spurs.

The most difficult part of the climb is from just below the nest up into it. An eagle's nest looks small from the ground, but as you climb, it becomes larger and larger. This one spread out above me six feet in diameter and four feet thick. There was nothing to grasp except parts of the nest, and these are so apt to be undependable that you hesitate to trust them with your weight. How the act was accomplished is hard to say; in the do-or-die struggle, the panic-stricken climber cannot remember all the details. Anyhow, I presently found myself in the nest, panting but eager to take inventory of its contents. In it lay two large eagle eggs, which brought shouts of approval from Al and Willy on the ground below.

This nest had been first built many years ago. The birds had gathered heavy sticks two or three inches thick and crisscrossed them between two limbs and the trunk of the tree. As the nest was built up, the sticks became smaller, and finally it was lined with straw and leaves to accommodate the eggs and setting bird. Eagles repair their nests from year to year, building them up and adding new lining.

Golden Eagles in Southern California are partial to cliff nesting sites. On a trip to the Mojave Desert to photograph some of these nests, we found two occupied cliff nests in remote, rocky ridges south of Victorville. The Mojave Desert is a great barren expanse of sandy land covered with the barest vestiges of scrub bushes and dried grass. Every few miles a rocky ridge rises several hundred feet from the desert sand. These ridges are composed of tremendous red sandstone boulders, and it is in suitable niches near the top of these boulders that the Golden Eagle sometimes nests.

We discovered the eyries by watching the adult eagles flying to the nests. Both nests had northern exposures for protection from direct sunlight. The blazing rays would have killed the young birds in a short time if the nest were not shaded throughout the day. In general, the construction of these nests was similar to that of the tree nests to the north. They were made of heavy sticks with a lining of dry grass, but they lacked the fresh greenery that is found without exception in nests in more wooded areas. The northern diet of ground squirrels is supplanted here by jack rabbits, which are plentiful and easily hunted in the open spaces of the desert.

On the nineteenth of March, we were "covering our eagle locations" to see what nests were going to hatch out this year. Curiosity led us to a nest that had not been used for seven years. From the top of a ridge near the Calaveras Reservoir, we could see it in a huge sycamore tree in the bottom of the arroyo. Not expecting to find anything, we did not look closely at first, but on second examination we saw what appeared to be a large brown rock in the nest. As we hiked down the hill for a closer look, the brown rock seemed to move. When we were about opposite the nest, we could see that the "rock" was an eagle. What looked like two fluffy balls of yarn, half-covered by the eagle, surprised us, for we knew that young birds were unusual so early in the year.

Before Al and I had recovered from our astonishment, Willy was halfway up the 50-foot tree trunk to the eyrie. The bird did not stir. Even when Willy was within ten feet of the nest, she was still reluctant to leave. Finally she stretched her wings, soared down the canyon, and disappeared.

Many people believe that eagles will attack human beings. It might better be said that these wise birds know enough to keep their distance. A touchy trigger finger and a lust for mantel trophies have made life perilous for eagles. It is doubtful that there is an unprotected eagle over a year old in this country that has not been sighted for a pot shot.

Willy called down to us that the young birds were about three days old. It was twilight when I reached the nest to take photographs, and the young birds were already shivering without their mother. So after a couple of wide-open camera shots, we left the nest.

Five miles to the north as the eagle flies, or ten miles by dirt road, we came within hiking distance of another eagle nest in La Costa Valley. Each pair of eagles has its own territory or location, and although the birds may fly fifteen or twenty miles to find food, no other pair of eagles will nest within a radius of over a mile of this territory. This rule seems to be a common understanding among the birds, for we have never seen an eagle encroach upon the domain of another.

Our first visit to this nest in La Costa Valley was made early in April. It was situated at the end of a limb extending 35 feet out from the trunk of a live oak tree, and it overhung a gully 35 feet below, which was full of granite rocks and poison oak. Ten feet above the branch was another limb, 25 feet long, which ended in a crotch. This offered a natural perch from which to photograph the young eagles.

Our first glimpse of the birds showed them to be about ten days old, for they were the size of a half-grown chicken and completely covered with a snow-white down. Willy was elected to crawl the 35 feet out to the nest for a closer examination of its contents. He counted 22 freshly killed ground squirrels that the parents had brought to the nest. The young birds behaved as if they were doped, hardly lifting their heads. Examination of the young revealed the reason: they were stuffed full of fresh meat.

▼ Nearly full-grown, "Little Brother" weighed about ten pounds. He looked like a true prince of royal blood, with his shiny brown plumage, fierce, gleaming eyes, and crown of golden feathers

The Golden Eagle's main benefit to mankind is in conservation. In this region they feed largely upon ground squirrels, which destroy valuable crops and in some sections of the country carry bubonic plague. The pile of dead ground squirrels in this nest testified to the great usefulness of a pair of these birds.

Another nest we observed that spring was situated 50 feet high in a sycamore tree on the western slope of Mission Ridge. Although it was some distance from the two nests already under study, it interested us because its location commanded a view of San Francisco Bay from San Jose to San Francisco, 60 miles to the north. On a clear day, the eagles could gaze upon hundreds of square miles of beautiful scenery. This pair had nested a month later than the other two pairs, causing their young to remain in the nest far into July.

A continual downpour of California's "liquid sunshine" prevented our return to the nests until one pair of eaglets had reached the age of 25 days. We arrived at midday, and the sun was shining for a change. As soon as we came within sight of the nest, the parent bird left. We watched the fluffy, white young birds from the hillside before climbing to the nest. At first they moved about a little, probably because of the sudden exit of their mother; but soon they became exhausted and lay flat, belly down, in the nest.

Willy is always our vanguard in visiting nests; he clears the way and then arranges a rope to lift the equipment from the ground. On this particular trip, he ran into trouble. When he was about halfway to the nest, he found himself in the midst of a swarm of bees, which he had aroused from their residence in a cavity in the trunk. Poor Willy was in a predicament; he could neither go up nor down to escape the bees, and there were no limbs upon which to rest. His extraordinary size, which had helped him out of many difficult situations, only offered more surface upon which the bees could alight. I am ashamed to say that Al and I only gave shouts of laughter. But being strong and of cool temperament, Willy managed to cover his head with his sweatshirt and slowly proceed to the nest.

At the age of 25 days, these birds were larger than the average full-grown chicken. They still hugged the bottom of the nest and raised no objection to our intrusion. Close examination showed that the primary feathers were just bursting from the tips of their sheaths. Otherwise the birds were covered with a thick, white down. Young American Bald Eagles would have been sooty gray at this stage.

The nest contained the left-overs of recent meals. There were several ground squirrel carcasses, one gray tree squirrel, and the shanks of a Great Blue Heron. Rainy weather keeps ground squirrels underground, where eagles cannot hunt them. But young, growing eagles need a constant supply of fresh meat, and it is the parent eagles' task to supply it. Finding no ground squirrels, the eagle had probably ranged beyond its usual hunting territory and found a nesting colony of Great Blue Herons about three miles away. This would account for the heron shanks in the nest, and although brutal, it is one of nature's methods of providing food for young eagles in times of scarcity. During our entire visit with these eaglets, they were lethargic and could only be induced to pose for a picture by a "stirring up" process.

Eagles 34 days old show the first striking changes that are destined to transform a ball of fluff into a fierce fighter of the air. The primary feathers of their wings have had ten days' growth out of their sheaths, and the blackness of the feathers contrasts strikingly with the snow white of the down. A difference between the sexes is also first seen at this time. In contradiction to the rule in mammals, the female in birds of prey is always larger than the male and usually develops more rapidly. This difference in size and stage of development is first noticeable around the end of the first month.

The 34-day-old eagles were lazy and loafing. Indeed, this behavior is typical of young eagles during their first 40 days. They just eat, sleep, and grow. After this period, they show a little vitality and an interest in the world around them. They are strong enough to hold up their heads and even to sit up on their haunches for short periods. The feathers on their wings and down their backs are numerous and long enough to identify them as feathered creatures.

The 40-day-old birds in the big sycamore tree surprised us by their new vitality. Although they were still a little wobbly, their talons had grown enough to serve as weapons against us. The rapid development of the sharp beak and talons is characteristic of these birds, and it was during this visit that we learned to respect these instruments of violence.

Willy reached to pick up the young eagle in the same way as always, but instead of gathering in a docile bird, his hands encountered a flurry of talons which drew blood. From then on, we treated these birds with the greatest respect and caution, but even then, they would get in an occasional strike with their beaks or talons.

With strength, size, and a few feathers, the 45-day-old eaglets also showed an effective instinct for self-preservation. This was well illustrated one day when we approached the nest in the oak tree from above. The eaglets lay flat in the nest with their eyes open and failed to move as we approached. We were immediately alarmed for fear some inhumane hunter had shot them. It was a full 20 minutes before we saw them move and then only after their tail feathers had been stirred. These youngsters had acquired the technique of "playing 'possum," and they did such a perfect job of it that not an eyelid blinked during the entire performance.

At seven weeks Golden Eagles stand on their own two feet for the first time. From then on, it is wise to be continually on the alert to avoid injury by the talons, which are now about two and one-half inches long. The points of these weapons are almost needle sharp and can easily penetrate the flesh, causing a dangerous and painful wound.

In addition to this great striking power, the birds have become handsome creatures with long feathers and wings that stretch four and one-half feet across. The head, however, still retains its youthful down, giving the appearance of a white nightcap.

When the eaglets were 55 days old, we decided they were old enough to be banded without ill effects. When Will climbed out on the limb, the female became overexcited and prematurely jumped out of the nest. We watched her settle feebly into the gulch below and then proceeded to band her little brother.

The bands, made of aluminum, are issued in several sizes by the U. S. Fish and Wildlife Service to fit all kinds of birds. On each band is a serial number. When a bird is banded, the number is sent to Washington, D. C., with information as to the species and the location and the date of banding. There the information is recorded and filed for future reference. If the bird is captured, killed, or found dead, the finder is instructed on the band to send all the information about the bird along with the serial number to the Fish and Wildlife Service in Washington. The information is written on the card corresponding to the number and then refiled. By this method we learn much about the age, migration, feeding, and other habits of our birds.

After banding the male, we pushed him out of the nest to join his sister. Although this was the first flight he had ever taken, we were sure that he could do as well, if not better, than his sister. It surprised us to see him level off a short distance below the nest and soar almost a quarter of a mile before landing in the valley below.

We descended the tree and found "big sister" in the gulch, again "playing 'possum." Al made the capture by wrapping her up in a jacket to avoid injury from her talons. We quickly banded her and then set out to find the male and return him to the safety of the nest. He was lying flat in the grass in the shade of a bush, but as we approached, he broke into a sprinter's pace for the wide open field. Although he could not rise from the ground (his wings were not yet broad enough), he eluded us in typical quarterback fashion. We were winded when we finally captured him. We wrapped him in another jacket and returned both of them to the nest.

A few days after their two-month birthday, we returned to check up on the banded birds. When they saw us coming from far away, the female pitched out of the nest and soared overhead. "Little brother" stayed home until we reached the base of the tree. Then he, too, left the nest. However, we captured him on the hillside a short distance away and carried him back to the tree for portraits.

Eagles two months old are fierce birds. Their downy white caps are supplanted by goldish feathers, and their behavior shows a restless desire to make their own way in the world.

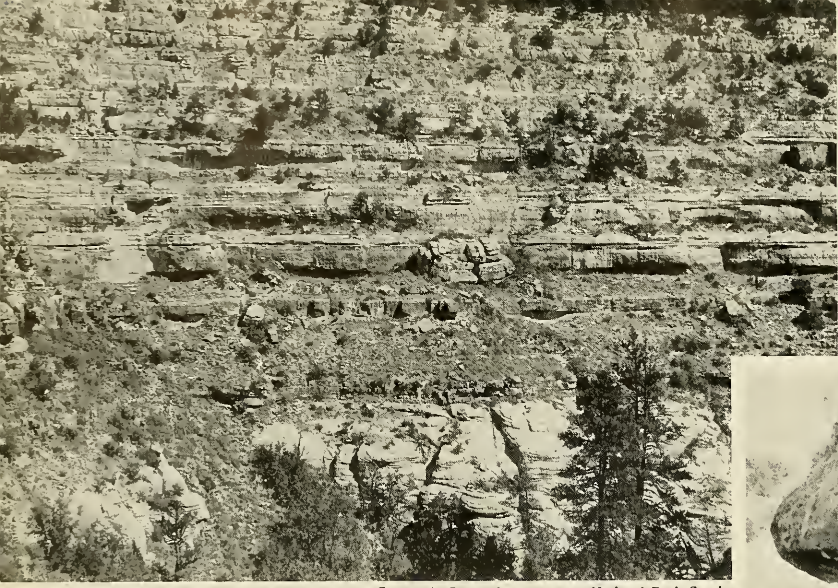
Nearly full-grown, this one weighed about ten pounds. As he sat upon the dead limb of the tree, he looked like a true prince of royal blood, with his shiny brown plumage, his fierce, gleaming eyes, and the crown of golden feathers on his head. His mouth hung open, panting, and his tongue protruded as if in a deliberate attempt to insult us. This time it was unnecessary to replace him in the nest, for he would fly there if he wished. Consequently, we turned him loose; and he hobbled through the grass, over the ridge, and out of sight.

We visited the birds in the large sycamore tree when they were 72 days old. The fog was so low we could hardly see the nest from the ground, but we could discern the dark form of an eagle poised for flight on a limb above the nest. The other bird had already flown to a tree farther down the draw. We set up our cameras to photograph the first eagle as it took its maiden flight, and when all was ready, Willy began to climb slowly up the tree. The higher he went, the more nervous and restless the eagle became. Finally it stretched its shaky wings and took off. The wings steadied shortly, and the bird glided around the hill.

We had not banded these birds as yet and had not thought we could capture them again. Our method of catching these eagles on the ground was to approach uphill from below, for their wings were not sufficiently powerful to lift them except from a down-grade

Continued on page 428

➤ Even in juvenile plumage at three months the Golden Eagle, with its vicious and stately beak, commands more admiration than its cousin, the American Bald Eagle, though the latter's head is bulkier



George A. Grant photo, courtesy National Park Service

◀THE ANCIENT PEOPLE honeycombed the canyon wall with masonry houses, utilizing natural crevices and ledges. Earlier settlers lived on the plateau above

▼Two of the ancient cliff dwellings. Each family seems to have occupied one room. The doors were mostly "T-shaped," so that when the wider part above was closed with skins or mats, the narrow, lower portion provided a draft for the fire

Photo by Nell Murbarger

The Cliff City OF WALNUT CANYON

The haunting story of a remarkable prehistoric community in central Arizona, which flourished for half a millennium and then mysteriously vanished

By NELL MURBARGER

ON the white ribbon of pavement that is U. S. Route 66, a stream of traffic pours madly across northern Arizona. Of these thousand of persons, all speeding from Somewhere to Somewhere Else, comparatively few have heard of Walnut Canyon National Monument, a few miles east of Flagstaff. Fewer still are willing to travel the thirteen miles of unimproved dirt road that separates the ancient village from civilization.

Personally, I have yet to encounter thirteen miles of road that could prevent me from visiting a deep, rocky gorge honeycombed with 1000-year-old cliff dwellings. So we were on the lookout for the small, brown sign three and one-half miles east of Flagstaff, which people told us was easily overlooked.

There it was. The side road meandered off to the southeast, a primitive affair, not too wide and not too smooth. Its shortcomings were quickly forgiven, however, in the engrossing beauty of the countryside through which it passed.

Although it was mid-May, white frost still lingered in sheltered places, for summer comes late at this elevation of over 6000 feet. White-faced Hereford cattle grazed in the mountain meadows, lifting their heads curiously to watch us. And we passed a few old log cabins with wide, stone fireplaces and some barns with moss-grown shake roofs.

Although we had been told that deer and occasional bands of antelope may be seen in this region, our wildlife observations were limited to birds, squirrels, and chipmunks. Wild flowers were blossoming on every available inch of ground along the road. The morning sun was pleasantly warm, and the sky was twice as blue as any turquoise jewelry sold in Flagstaff.

Soon we reached the Monument boundary—a split-rail "snake" fence that looked as though it might have been built by Honest Abe himself. After paralleling it for a mile or so, our road divided, the left branch continuing on to rejoin Route 66, four miles west of Winona. The right-hand fork passed through a gate and stopped at a small building, the Monument headquarters.

No one was on hand to welcome us; Ranger-Custodian Aubuchon had evidently been called elsewhere on some of his various field duties. We registered and passed through the building to a rear balcony.

Here, for the first time, we found ourselves looking upon Walnut Canyon, whose strange and tragic story had long intrigued us.

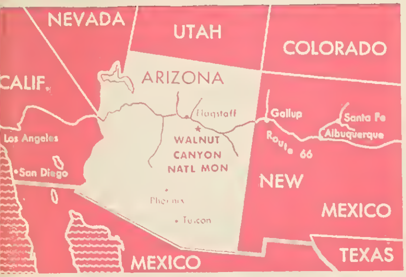
It was like viewing the stage of a long-deserted theater. Its scenery was formed of rocks and sky, flowers and trees; its props were the ancient cliff dwellings; its players, the people who left one day long ago never to return. We could only conjecture at what drama had been enacted, for we had arrived late. The actors had answered their last curtain calls nearly six centuries before the first white men set foot in Walnut Canyon.

No one knows exactly who these players were or from where they came. No one can say precisely when they left or why. Thus, both the prelude and the finale are shrouded in obscurity.

The groundwork for this drama was laid several million years ago when nature set about preparing the stage. The people, however, did not enter the scene until comparatively recent times. Archaeologists believe it was during the eighth century.

These First Comers, whoever they were, must have been surprised to look upon this great slash in the pine-forested plateau. A tumbling stream then coursed through its bottom—a creek since blotted out by an upstream dam at Lake Mary—and this supply of water must have been a welcome sight. And farther up the canyon walls, wherever a few handfuls of earth clung to the rock, they saw growing herbs and other plants that could be converted into bread and drink and tribal potions.

Primitive man asked for no more than food and water and a shelter in which to live. They immediately started to build crude pit houses on the plateau above, the only type of home with which they were familiar.



That is about all we know of Act I. These surface ruins can still be seen along the rim of the canyon, though some 1200 years have reduced them to inconspicuous heaps of earth and rock.

During the century that followed, some of these upland dwellers—or perhaps it was another group of immigrants—came to realize that there were advantages to living within the canyon rather than on its windy rim. This would put them closer to the water supply, and the sunny north wall would give protection from frigid winter blasts. Jutting ledges in the cliff provided shelter from the rain.

The tree-ring system of dating, evolved by Dr. A. E. Douglass of the University of Arizona, has given archaeologists their closest estimate of when the first cliff dwelling in Walnut Canyon was built. This shows that the older dwellings in the canyon date from A.D. 888, if not earlier. People probably lived in the canyon throughout the tenth century, because some of the buildings were constructed around 911 and 933.

The great majority of the canyon's more than 200 cliff houses, however, apparently belong to what is termed the Pueblo III Era, often referred to as the "Great" or "Classical" Period of the American Southwest. Beginning about A.D. 1050, this Era lasted until shortly before A.D. 1300. At that time, many large Indian settlements in the San Francisco Mountain region were abandoned, possibly as a result of the same 26-year drought cycle that depopulated the great cliff city of Mesa Verde, in southwestern Colorado.

By twentieth century standards, these tenth and eleventh century cliff dwellings would fall far short of what would be called model homes. Yet, in comparison with anything these ancient people had previously known, they were little less than elegant. They were delightfully dry; and the stout masonry walls that formed three sides of each dwelling repulsed the most violent wind. These walls were two to four feet thick and built of roughly squared stones laid snugly together with yellow clay mortar. The rear wall, ceiling, and floor were of natural rock.

Here in Walnut Canyon, primitive man had more firewood than his ancestors and a rich crop of nuts from the luxuriant groves of piñons, oaks, and black walnuts on the floor of the canyon. Wild currants, elderberries, serviceberries, snowberries, grapes, junipers, cacti, and yuccas all yielded material for the cooking pots.

In small natural clearings among the junipers on the northeast rim of the canyon, there was plenty of good agricultural soil. The cliff dwellers brought this into cultivation by means of digging with sticks and stone hoes. They produced good yields of corn (maize), beans, pumpkins or squash, and sunflowers. Even today, broken hoes and other farming implements of a people who were living in the Stone Age are not infrequently found in these fields.

Of meat there was no lack. The land abounded in elk, deer, antelopes, bears, rabbits, porcupines, and many kinds of birds, large and small. There is evidence that these people domesticated the wild turkey and thus assured themselves of a meat supply in time of storm or siege. Their "livestock" also included dogs but no other animals. Horses, burros, cows, sheep, and goats were unknown in the American Southwest before the arrival of the Spaniards in the sixteenth century.

In such a situation these people might well have been self-sufficient, yet they chose to carry on an active commerce with other tribes, trading their surplus animal skins and foodstuffs for pipestone, salt, cotton, stone axes, pottery (black-on-white types), turquoise, and sea shells. The latter, valued for jewelry, were carried to the canyon clear from the Pacific Coast.

While the men of the cliff village busied themselves with farming and hunting, their women carried water and cooked the meals. They tanned animal skins for clothing, molded and decorated attractive pottery, made excellent baskets, fashioned sandals of yucca fiber, and possibly wove cotton cloth. Matting, cotton fabrics, and even spindle whorls used by the ancient weavers have been found in the ruins.

Nor were these canyon dwellers denied the luxury of music. The earliest scientific examination of the ruins revealed the presence of flageolets, small wind instruments from the throats of which strangely haunting melodies doubtless drifted along the canyon walls and through the silent groves of junipers and pines.

Thus life went on until that day when the last pottery jar of water was carried up the steep trail on the head of a Walnut Canyon housewife, and the last ear of corn was harvested or left for the wild creatures to glean. After some 500 years of occupancy, the inhabitants of Walnut Canyon, for some unknown reason, made their way to the rimrock for the last time.

There, as far as recorded history is concerned, they might have vanished from the face of the earth. Some believe that they traveled to the Hopi villages far to the northeast and were assimilated. Others hold that their descendants became the founders of Elden, Turkey Hill, and Old Caves Pueblos, all in the Flagstaff district. Either belief is, admittedly, only conjectural.

Thus ended Act II.

While the stone-walled cliff dwellings continued to lie vacant in a silence broken only by the whistling wind, Joan of Arc was burned at the stake; an explorer named Ponce de León started looking for a fabled Fountain of Youth; Cortez conquered Mexico; Coronado pushed northward in search of the Seven Cities of Cibola; on the Isle of Corsica, Napolean Bonaparte was born; a silversmith named Paul Revere made a notable ride; gold was discovered in California.

Thus nearly 600 years rolled by after the last lingering note of a flageolet had drifted from a canyonside door. In all that time, no Spanish or American explorer mentioned Walnut Canyon. Then, one day in 1883, an archaeologist from the Smithsonian Institution, James Stevenson, arrived on the scene.

It isn't particularly difficult to imagine the thrill that he felt as he penned his report.

"The city, or rather cluster of villages," he wrote, "occupied the sides of a canyon which has recently been christened Walnut Canyon. The sides have been gullied by storms and torrents, leaving shallow, cave-like places of great length at different heights, along the bottom of which, wherever the ledge furnishes a sufficient area, dwellings in groups or singly were built.

"The group of villages which was the most narrowly examined was about a half mile in length, and consisted of a single row of houses, the common rear wall being the lining rock, while the sides and front were made of large squared stones set in clay. A narrow street or pathway extended along the entire front. Other and similar villages could be seen along the canyon for some distance.

"Among the relics found was a wooden spindle whorl similar to those in use by the Pueblo of the present time . . . A shaft of reed resembling bamboo still remained in the whorl. It had been broken by the maker and neatly mended by winding about it a piece of fine twine. The ends of this twine being examined under a microscope disclosed the fact that its fiber was made of very fine human hair!

"Articles of wood, corn cobs, and even the perfect grains of corn; walnuts, bones of elk and antelope and wolf; portions of wearing apparel of a fabric resembling the mummy cloth of Egypt but made from material unfamiliar to the explorers, and other perishable articles, were found in abundance buried in the piles of debris which partially fill these deserted homes . . .

"The preservative qualities of the atmosphere in this region are remarkable, and it is the belief that centuries have elapsed since the last of the departed race occupied these old cities and villages. . . ."

Often publicity is not all to the good. Certainly Walnut Canyon unknown fared much better than it did in the 20 years following its discovery by white men. Its lively stream of water and bounteous shade made the canyon a popular picnic ground for gay young blades of the Flagstaff area. Soon, one of the favorite Sunday pastimes was to load a buggy with a hamper of lunch, some beer, and shovels and drive out to the canyon. The shovels, sad to say, were for digging in the ruins. Pot hunters, both amateur and commercial, were enjoying a Roman holiday at the expense of posterity.

Because the relatively small windows and doors of the old cliff dwellings did not admit enough light to work by, these Sunday-picnicking-pot-hunters resorted to an expedient that now seems incredible. By blasting, prying, and pushing, they managed to tear out most of the walls—walls that had been laid before William the Conqueror set forth from Normandy on his conquest of England!

Once the stones of the walls had thundered down the steep slope to the canyon's bottom, the vandals were no longer hampered by inadequate lighting. Thus digging for such loot as the ruins contained went merrily forward until 1915, when a slowly awakening government took cognizance of the situation and belatedly locked the farm door by making the canyon a National Monument. By that time, little remained that was worth the stealing.

Even in its ravaged state, Walnut Canyon possesses a vast amount of interest for any thinking person. Not every day can one view the remains of a 1000-year-old mode of life.

From the rear of the small exhibit room at the Monument Headquarters, rock steps lead to an easily traversed ledge. Encircling a jutting, chaparral-grown peninsula around which the canyon loops in a hairpin curve, this ledge trail leads to 30 of the best preserved—or, more accurately, "least destroyed"—ruins. In addition, the trail provides a distant view of approximately 100 more ruins on the opposite wall of the canyon.

In some of the houses, we found the masonry walls still remarkably sturdy. Partition walls, many of

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THE GREAT *Green Iguana*

How this modern reminder of the age of dinosaurs uses his magnificent livery in love and war

By JEFF PRICE*

All photographs by the author

▲ PORTRAIT OF THE MALE IGUANA: six feet of reptilian ginger. He can spread the dewlap or fold it back according to his humor, and his skin changes color from green to brownish hues and bronze-gold

THE Great Green Iguana lives in practically all of the humid lowlands of tropical America, including many of the islands of the West Indies. The present study was made in the western part of Mexico. This huge lizard reminds one of some prehistoric, scaly monster that has survived the vicissitudes of time since the disappearance of the giant dinosaurs. That has been a long, long time, too, because the dinosaurs are known to have become extinct about 60 million years ago.

Actually, the green iguana superficially resembles several species of the ancient dinosaurs, but, of course, it is only remotely related to them. Large specimens of this great green lizard, the largest in the Western Hemisphere, measures 6 feet from snout to tail tip, and every one of those 72 inches is alive with spark and ginger. The flashing jaws can snap off a man's finger or crush his wrist, while the lashing tail stings like a whip and can easily knock down a dog.

The animal's claws are large and needle-sharp and are used to excellent advantage when the iguana is cornered. But while this giant of the lizard tribe is quite capable of protecting itself with tooth, claw, and tail, it rarely has to use force to drive from its home territory an enemy of its own size or smaller. It uses other means. Like a bull that merely lowers its horns menacingly to repel another animal, the great green iguana bluffs a great deal; but the lizard's technique is far more involved than the bull's.

If another iguana approaches, the male turns slowly sidewise toward the intruder, flattening his body vertically so that while he stretches high upon his toes, the belly drags on the ground. This flattening is accomplished by drawing the ribs inward and downward. If one were to gaze down upon an iguana while the body is thus flattened, it would look like an arrow, the head being much wider than the body. But

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▲ READY TO CHARGE: the iguana bluffs with elaborate, menacing gestures, then makes a lightning attack. His jaws can snap off a man's finger, yet he prefers to nibble orchids

when the iguana relaxes, the ribs spring upward and outward, while the belly is drawn up from the ground. The body is then much wider than the head.

In addition, the iguana opens his mouth menacingly and erects the three-inch "spines" along his neck and back. Finally he raises his head high and displays the throat fan, or dewlap, which he flashes in the sunlight as he circles and sidles toward the adversary in a most forbidding manner.

The dewlap is such a remarkable structure and is used in such dramatic fashion that it deserves closer attention. It is eight to ten inches long and is usually golden bronze in color and iridescent—a thin, double-walled, oval-shaped flap of skin that hangs like a curtain from beneath the lizard's chin and throat. A series of long, slender bones lie within the folds of the dewlap but are hinged at the front angle of the lower jaw. When angered or otherwise excited, tiny muscles draw the bones forward. This spreads the structure. When the excitement passes, the bones move backward toward the animal's chest. This movement furls or pleats the dewlap close up against the neck.

While the throat fan is usually bronze in color, the head, body, and tail are most commonly green. I repeat, most commonly green, because the great iguana can, at will and within a few seconds, alter its coloring from green to yellow-green, mottled green-brown, brown-red, and finally to bronze-gold. During this process of color change, the dewlap may remain golden in hue or assume the altering kaleidoscope of coloring of the rest of the body. Generally, the changes in pigmentation begin at the head and progress slowly backward along the trunk to the tail tip.

There is often considerable significance in the color patterns. For example, when the animal is displaying to the fullest extent in an attempt to bluff away another male lizard, his general color pattern is green. If, however, the rival also struts and becomes unusually bold, the chances are that the color will slowly shift to a mottled green-brown.

Usually, however, the iguana that is defending his own tree or a section of deserted stone wall where he has been living for many months, is the one that remains predominantly green; he is the one that bluffs the hardest and follows up this display with the most vicious in-fighting with tooth and claw, if this is necessary to chase the interloper off the premises.

In any case, the lizard that finally turns away is the one that shifts in color from green to some shade of red or a mottled green and yellow. There is no doubt that when an iguana turns "yellow" he has lost his courage.

It is curious that when sleeping, this iguana is also green. Apparently the tiny color bodies that control the pigmentation of the skin, the green chromatophores, expand when the animal is completely relaxed as in sleep.

The green iguana leads a regular but monotonous life. Having spent the night on a bough high up in a tree, stretched out with claws deeply imbedded in the bark, he arises stiffly. Although dawn comes at about six o'clock, it is often eight or nine A.M. before this reptilian monarch sets about securing breakfast. This is because he waits until the sun is well up. He likes sunshine. In fact, without it, he is invariably lethargic. Being "cold-blooded," the sun's heat must seep into his bones to warm the muscles and sensory faculties.

What a breakfast! Believe it or not, the great green iguana dines on flowers and fruits. He prefers the blossoms of tropical fruit trees but deigns to nibble at wild orchids during those seasons when there are no fruit blooms. Nimble on his feet, he climbs out to the tips of the branches, where he bites off the flowers or even reaches out with his forefeet to pull them within reach of his mouth.

After breakfast, which might occupy as much as an hour, he concerns himself with patrolling his beat. Every male iguana dwells within a restricted area containing a number of blossoming trees and other flowering plants. If another male iguana appears, the resident immediately rises to full standing posture, erects his spines, and flashes his dewlap.

The intruder hesitates; if he is no larger than the resident and not particularly bold, he moves away. If larger or especially belligerent, however, he returns the challenge as dramatically and silently as it was delivered, and the two combatants move closer, circling slowly, strutting as they come.

They never take their eyes from each other, and it is interesting to observe the manner in which the contestants push out their feet with toes stretched wide, exploring, feeling for footholds. Their fans are stretched wide, then folded up, and again flashed out in full bronze iridescence.

The approach of these reptilian giants toward each other is circumspect—no mad, head-on charge, at least not yet. Instead, they move sidewise and circle to display their grandeur. The whole idea of all this strutting is to appear as large and menacing as possible to the other fellow. It's all a part of the bluff that each rival is pushing in the hope that the other will back down and retreat.

But with all this bluffing, it is significant that the animals are drawing closer and closer together. Finally one or the other, but usually the resident iguana, becomes so filled with rage that he abruptly stops bluffing and, with jaws wide and teeth gleaming, charges with lightning speed at the adversary. The latter usually turns and scurries away, leaving the field to the victor, who chases the intruder to the boundary of his territory. Then the victor climbs a stump or tree and struts again and again with flashing dewlap in much the same manner as a lion roaring defiance at a conquered foe or a dog barking at a defeated enemy.

When the mating season approaches, which is just before the spring rains begin, the green iguana uses his magnificent livery to the best advantage, not only in defending his territory but also in courtship. The male that possesses the most attractive and largest home area is the lucky one, for he will have the greatest number of available females.

However, just because a female has chosen a certain iguana's territory does not mean that the fortunate male can win her without an extensive, ardent, and highly picturesque love-making routine. While she rests on her favorite lookout post and assumes a completely indifferent attitude toward his stately parading, he shows off as only a green iguana can. Repeatedly he struts past her, much as he would if trying to bluff away a male; but he does so with a jerky movement so that his coloring appears more vivid and flashy.

As he extends his fan, the female is quite apt to nod her head perhaps as a sign of encouragement. But when he comes close to her, she moves slowly away and rests. He continues this slow and courtly dance while circling about her, until she finally decides to wait for him instead of studiously avoiding him when he comes alongside. Her final signal of assent is given by arching her neck and back.

After mating, the female digs a hole in the ground, which has been made soft by the rains, and deposits from 25 to 70 eggs, depending upon her size. She carefully buries them and leaves the surface of the soil without a telltale trace. After about ten weeks the eggs hatch, and the tiny baby green iguanas burrow slowly up through the earth until they emerge and begin searching for food.

Insects, snails, and other small animals augment vegetable food in the early diet of the juvenile iguanas, which are about six inches long from snout to tip of tail. Early in the second year of life they become accustomed to the diet of adult iguanahood, the gorgeous wild orchids that grow in profusion, as well as other jungle posies.

▼ SURPRISING though it may seem, the iguana is an excellent swimmer and is equipped with valvular nostrils that close when he is in the water

The Bowfin IS A HANG-OVER

A poor fish to look at and a poor fish to eat, the male bowfin nevertheless displays a parental devotion that is one of the most interesting spectacles to be seen in fresh water

By Ben East

IF you'd like to meet one of the queerest and most evil-tempered fish that swims in fresh water, let me refer you to the bowfin. In many sections of his range, which includes most of the north-central United States, he is better known to anglers as the dogfish, but he must not be confused with the various small sharks that have the same name.

Mr. Bowfin is what the books call a geological hang-over. His remote grandparents were nosing around, gobbling up smaller fish, in muck-bottomed lakes and ponds an incredibly long time ago. His family dates from a period before the first warm-blooded animals saw the light of day. Yet surprisingly enough, the present-day fresh-water dogfish looks almost exactly like those ancestors of the distant past.

During all the time it has taken mammals to pass through their evolutionary development, the bowfin has hardly changed the expression on his face, as one fish authority sums up the situation. This is another way of saying that he looks just as he did long before the first horses, little bigger than modern jack rabbits, roamed the plains of western America, and saber-toothed tigers preyed on mastodons trapped in the boggy swamps.

The bowfin is an ugly fish, with blunt snout, wide mouth, small, wicked eyes, and a sloping forehead. His thick, heavy body is mud colored and has a greenish sheen. He is covered with coarse scales, and his rounded tail and long, wavy dorsal fin are unlike those of any other fresh-water fish. As a trademark of his sex, the male is decorated with a green-and-black eyespot at the base of the tail, a characteristic lacking in the female.

The bowfin's favorite haunts are muddy, weed-grown lakes, rivers, and swamps. He's a warm-water

◂ Young bowfins by the thousands cluster like a storm cloud around their protective male parent: probably the first picture ever published showing the act of parental care by the bowfin

Photo by George Tamlyn

fish. Cold, clear streams or lakes are not for him. His coloring conceals him in the weed thickets where he prowls, and he feeds on anything that is not too large for him to swallow.

For all his unattractive habits and appearance, he has one redeeming characteristic. He is a good father. In late April, May, or early June, the male fish excavates a shallow nest in the mucky bottom of a swampy shoal. There the female spawns, and the male guards the nest until the eggs hatch. He then gathers his numerous brood about him and escorts them wherever he pleases, usually keeping to shallow water for protection. By some mysterious instinct, the young keep together in a dense cloud around the parent fish, which continues to guard them vigilantly until they reach a length of about four inches, late in the first summer of their lives. Such a closely-packed, guarded school of young bowfins, held together like a swarm of underwater bees, is one of the most interesting spectacles to be seen in fresh water. Not even the black bass, known for his traits of good fatherhood, carries out his parental duties more faithfully and zealously than the male bowfin.

AMNH photo

▲ BOWFINS nest in the mucky bottom of swamp shoals, where the female spawns and the male keeps guard until the eggs hatch

As a game fish he rates close to zero and on the dinner platter even lower. I grew up on the banks of a sluggish, muck-bottomed creek, with many bayous and channels winding through a wide, cattail marsh. Big bowfins abounded in every deep hole. We caught them occasionally on hook and line and speared them by the score in the warm, still evenings of early spring with the aid of a jacklight.

Time after time my fishing buddy and I lugged them home and prevailed on our mothers to try some new method of preparing and cooking them. We resorted to every device at our command to render the meat edible, but it was a lost cause. We soaked the fish overnight in salt water, in soda water, and in vinegar. We parboiled, fried, baked. The end result still tasted like a handful of soft, black muck from the creek bottom. We came finally to the conclusion that the bowfin is not for the table. I know no one who has tried it who disagrees.

As a fighter, however, this fish from the ancient past has his redeeming qualities. He is caught frequently by anglers using live bait for bass or pike, and now and then he's pulled in on a casting plug. Fish experts say he would bite more readily were it not for the fact that he spends the bulk of his time, except in breeding season and at night, in water too deep for the fisherman to reach him.

Once he takes the hook, he makes a good showing. With plenty of brute power and endurance, he fights a tough, stubborn, no-quarter battle, as might be expected. He has no love for the surface of the water. He makes his stand deep down among the weeds, taking advantage of any cover he can find. The few fishermen who have hooked and fought him on a flyrod say it's an experience not soon to be forgotten. I know one who admits that he'd rather fight a big bowfin on such tackle any day than a bass of like weight.

He's a hold-over from forgotten times, this Old Man Bowfin—an unlovely fish in the present-day world of trout and bass. He's the product of a line of unattractive ancestors, and he has not changed. He's skilled at converting better fish into bowfin, and that's all that matters to him.

Sportsmen rate him a foe of game and pan fish with good cause, but fish authorities have one kind word to say of him. His young, they point out, probably figure fairly often on the dinner table of bass, pike, and other game varieties. Fishery researchers believe that bowfins in a lake may not be altogether a detriment.

THE CLIFF CITY OF WALNUT CANYON *Continued from page 420*

them laid double and a few tying in with the front wall, divide the long lines of ledge dwellings into separate rooms. Inasmuch as there are no connecting doors in any of these partitions, it is probable that each family occupied but a single room.

The few doorways remaining intact are of the T-type, typical of Pueblo III architecture. In this style of entryway, a normal width prevails to within a foot or so of the ground, where additional stone blocks have been built into either side of the aperture, thus narrowing the lower portion to approximately one-half the width of the upper portion. The idea, presumably, was to make it possible to cover the upper opening with skins or matting, thereby providing privacy and protection from wind and snow. The narrowed portion, left uncovered, supplied an air draft for the fire, which was laid on a raised rock platform in one corner of the room. Lacking chimneys or other means of exit, the smoke followed the back wall to the rock ceiling. After crossing the ceiling, it made its escape via a small "smoke hole" built in the masonry over the door.

The imperishability of soot is eloquently attested by the thick coating of greasy black which overlays the interior of all these dwellings. Although we used utmost care in exploring the rooms, our headgear emerged from the experience carrying plenty of evidence of contact with prehistorically blackened low ceilings.

Walking along the same narrow, dizzy trails as these ancient people (even the skillfully engineered trail to water is still visible and usable after all these years!), one is appalled by the difficulties that must have attended the rearing of children in such surroundings. Surely the hazard of broken necks transcended any danger presented by enemy warriors!

One still finds broken pottery shards in the rubble outside the dwellings and trodden into the trail dust. Mostly they are finished in warm browns and soft grays, but occasionally fragments of the imported black-on-white types come to hand.

Fingering an ancient piece of broken pottery—once a water jar or a cooking vessel or perhaps a ceremonial bowl—is a short step to daydreaming. Sitting in the warm sunlight of a May afternoon with my back adjusted comfortably to the masonry of a wall ten centuries old, I found myself peopling the canyon with life. Once again, wood smoke was rising from the cook fires, its aroma blending with the spicy fragrance of juniper. Wild turkeys were gobbling, and Indian dogs were yapping in pursuit of a squirrel.

In my imagination, a lithe, young Indian girl passed along the ledge in front of me, so close I might have touched her. On her head she carried a large pottery jar, and I could imagine her being greeted by friendly voices from open doorways. Occasionally she would stop to exchange a bit of gossip with other women of the village.

This primitive girl may have had dreams and problems and happinesses and griefs little different from mine. She could step into my world, or, more conceivably, I could step into hers.

Suddenly I was aware of high-pitched, strident voices near by. From around the bend emerged two women and a fat, baldheaded man wearing shorts and carrying a motion picture camera.

"But Homer!" one of the women was wailing, "I can't see why we've got to waste a lot of time at this junky old place! If you hadn't insisted on coming here, we could have made it to Las Vegas tonight!"

My pleasant world of reverie was shattered into bits smaller than the pottery fragment I held in my hand. With reluctance I reminded myself that this was the twentieth century, the day of speed, hyperefficiency, discontent. Not for seven centuries had an Indian girl carried water over this trail. No longer was there a running stream on the canyon's floor. The cliff dwellers were gone.

Their customs, their traditions, their legends were irrevocably lost.

"Give me three thousand years," wrote D. S. King, of the Southwestern Monuments Association, "and I'll grow you some more giant sequoias; natural bridges are being formed constantly, perhaps ones bigger than Rainbow. Time could even produce another Grand Canyon . . . But Walnut's cliff dwellings were made only once. There will never be any more. . . ."*

As I rose from my sunny cliffside seat and started back up the trail, I was humbly thankful that at least a few of these fine old stone walls had escaped pillage at the hands of thoughtless persons whose greed has made Walnut Canyon an everlasting monument to vandalism.

*Arizona Highways, October, 1941

LITTLE DINOSAURS OF GHOST RANCH *Continued from page 399*

situdes of stream travel and thus come to rest where the power of the current was no longer sufficient to carry them farther. They were then covered by silt and thus protected against rapid decay, so that the slow process of fossilization could set in. The soft parts quickly disappeared, but the hard parts—the bones—were protected and re-

placed, molecule by molecule, by rock material deposited by the ground waters. So the form and structure of the bones were preserved, even though the substance was changed.

Ages passed. The land, which had been a low jungle for so many millions of years, was eventually uplifted by the mountain-making forces that built the Rockies. And as it rose thousands of feet into the air, the forces of erosion acted upon the landscape with new vigor. Streams and rivers, wind and frost cut into the many thousands of feet of sediments deposited during the Age of Dinosaurs to form canyons and cliffs. By these slow geological processes the New Mexico of today came into being, a high desert country of brilliant cliffs and forested mountains. The former jungle stream, in which the little dinosaurs met their fate, became part of a sloping cliff. And as erosion continued, bone fragments near the surface were washed down, to be seen on one bright day in June by the sharp eyes of a fossil collector.

Ghost Ranch was tranquil in the bright autumnal sunlight when we left. The summer had run its course. The alfalfa from the irrigated fields had been stored in the barns, and all was being put in readiness for the desert winter. High on the cliffs above the ranch a drama had been unfolded—a drama of life as it had been almost 200 million years ago, a drama of the tropics of long ago, when strange animals inhabited the earth, when the Age of Reptiles was still young, and when the dinosaurs were still fragile creatures, not in the least aware that at some date in the distant future their descendants would be giants on the earth.

AT HOME WITH THE GOLDEN EAGLE

Continued from page 417

take-off. Al was able to grab the legs of the eagle that had just flown from its nest. It was a strong bird and showed its resentment by beating its wings furiously until brought under control. Anger radiated from its eyes as it looked across Calaveras Lake toward freedom. We flipped it over onto its back to be banded. While Willy was applying the band, the bird's talons were taut, ready to grasp anything within their reach. The talons were now more than three inches long and still growing. It was easy to see how they might crush the back of a fawn. Having banded the bird, we stretched it out to measure its wingspread, which was not quite seven feet.

Only then did we begin to realize the wonders of growth in the Golden Eagle. In the short period of two and one-half months, this bird had developed a wingspread from a few inches to almost seven feet, weight from a few ounces to ten pounds, plumage from a fluffy white to shiny brown, talons from mere fingernails to bayonets over three inches long, and power from a listless, almost lifeless, foundling to a master of the sky.

We gave the eagle its freedom, and it soared forth from the hillside out over the lake. It turned its head a little for a last look at its would-be captors and then disappeared into a cloud. We were sorry and almost sad to see the last of our young eagles leave, for we had become well acquainted with each one and had learned that eagles, like human beings, have distinct personalities.

We wished there were some way we could again visit with our feathered royalty, some way we could learn what it means to have the freedom that only an eagle knows.

Our thoughts then turned to some of the disgraceful records of Golden Eagles killed in Texas during the last few years for a state bounty; of the braggart who claimed to have killed fifteen of these magnificent birds in this same vicinity the year before; of the ruthless egg collectors who rob the nests of far more eggs than the number allowed for scientific purposes.

We knew that if everyone could have the privilege we had had, they would no longer look upon the Golden Eagle with malice but would recognize it as a personality —as the King of the Air.

BOOKS

Continued from page 391

Harvard by a few years, in prospecting, sampling, and developing Canadian gold prospects. This quarter-century appears to have been the critical period in Canadian mining, a development continuing to the present, with Yellowknife expanding, and who knows what yet to come.

With abundant experience and a facile pen, Arnold Hoffman has produced a thoroughly readable account, including actual conversations and behind-the-scenes activities. Anyone who has an interest in Canadian mining—as a geologist, investor, or collector—will find the book filled with information. The book is geologically sound and economically practical, for the author's experiences have taught him that it is a long way from a rich assay to a producing mine. The account of the financing methods used in Toronto is eye-opening and should produce caution in investors. On the other hand, successes of the greatest mines have come only after vicissitudes and repeated failures. They show that mining is surely one of the great gambles.

The general reader may find the plethora of names and localities confusing. Some—like the Labines, Noah Timmins, and Harry Oakes—have appeared in the news, but most are known only to the mining fraternity. The language is often rich and salty, but no true picture of primitive mining camps in remote regions could be given with expurgated dialogues. Hoffman has given a realistic picture, an interesting history, and sound practical information, seasoned with reliable, readable anecdotes. Anyone who desires information on Canadian mining should certainly read this book.

F. H. Pough.

THE GREAT FOREST

- - - - - - by Richard G. Lillard

Alfred A. Knopf, $5.00
399 pp., 24 illust.

THIS is not, as the title might suggest, a book describing the great forests that once covered much of our country. It is not a "nature" book, nor one on forestry, though that subject receives considerable attention. It does, incidentally, tell much about those forests, but it deals mainly with the reasons and purposes for which, and the ways and means by which, they have been so prodigally liquidated, and still more particularly, with the people who accomplished it. It gives an exceptionally well-written, pageant-like, historical picture of the successive generations who carried it out—first as pioneers, then as permanent settlers and agriculturists, and lastly as industrialists. It vividly presents the characteristics, lives, habits, and ideas of those who dealt directly with the great forests in different ways as settlers, woodmen, lumberjacks, and millowners, not omitting some of the "lumber barons" who later took over the industry.

Several chapters tell about the almost unbelievably unscrupulous manner in which the forest lands, while still mainly in public (colonial, state, or federal) ownership, were treated as plunder for anybody clever enough to take possession of them. The more valuable tracts were practically all appropriated by private and corporate interests, the laws intended to protect them being flouted by the politicians, by Congress, and by the courts. The author also discusses the more recent, though none too successful, efforts to save a little of what remained.

Throughout the book's immense wealth of information there is evidence of the author's sincerity, industry, and unremitting effort to present a true and fair picture. Many good and pertinent illustrations, a list of the sources of quotations, and a useful, extensive bibliography are included.

It is a real contribution to American history which can be appreciated both by serious students and those who enjoy worth-while reading, presented in a vivid and entertaining form.

Willard G. Van Name.

A MULTITUDE OF LIVING THINGS

- - - - - - by Lorus J. Milne and Margery J. Milne

Dodd, Mead & Co., $4.00
278 pp., 23 illust.

THIS is a pleasant nature book, discussing, as the title indicates, a multitude of things, but principally small invertebrates. It consists of 20 unrelated chapters, each on some different aspect of natural history. The book appears to be designed to stimulate interest in natural history among those who are unacquainted with the pleasures of nature study. In this it should be successful, as it is interestingly written and discusses many things that can be seen on any walk in the woods or the countryside, on any trip to the desert or the seashore. So great is the multitude of living things that one sometimes feels he has read too little about too many and has been shifted about from one subject to another too much. This is scarcely avoidable, however, in a book covering such a wide field.

Chapters are included on such diverse subjects as beechwoods, deserts, caddis flies, land snails, soil animals, cave animals, and sea worms. Also, there is a chapter on Baltic amber and the fossils it contains. Information on the Canadian amber would have been an interesting addition on a subject close to home. The chapters on the eyes of animals and on their eggs are interesting and may help a beginning observer to interpret some of the things he sees.

The book is marred by the apparent inability of the publisher to place most of the photographic illustrations near the part of the text where they would be appropriate. A few minor errors have crept into the book; for example, there are no native beech trees in California, and the sexton beetles had been reared before the Milnes' studies in 1944. It is unfortunate that there are only sixteen plates, all in black and white, although the authors are excellent photographers.

C. D. Michener.

The flame birds

- - - - - by Robert Porter Allen

Dodd, Mead & Co., $3.50
233 pp., 21 illust.

In early times, the beautiful Roseate Spoonbills were plentiful along the Gulf Coast of Florida to Texas. Between 1860 and 1880, a serious decline took place which continued until the species was virtually extirpated within our borders. This was due not only to direct persecution but also to disturbance at nesting time by hunters interested in other prey. Fifty years later a return in some degree was evident, but while breeding colonies became established in Texas, the situation in Florida remained unsatisfactory.

In 1939, Mr. Allen was commissioned by the National Audubon Society to determine the causes underlying the situation. For some two years he remained in the field studying the birds under varying conditions. A formal report was issued by the Society in 1942, in which Mr. Allen ably discussed the details of the investigation. The present volume is not so much a treatment of the results of this study, although these are not forgotten. It is rather an account of the author's experiences in the southern swamps and keys, including his personal impressions of the spoonbills and their fellow inhabitants, human as well as feathered. There is much information here about the birds and the disadvantages with which they have to contend, and much, also, on the conditions under which they would seem mostly likely to prosper, although they would appear to have failed to take full advantage of their opportunities. The author's explanation is that the spoonbills are incapable of breeding until they are 33 to 36 months of age, while almost all of the birds that reach Florida in spring are younger individuals. Establishment of a greater breeding population must, therefore, await the spring arrival of adults, and there is no evident way to hasten the process.

J. T. Zimmer.

The birds of brewery creek

- - - - - by Malcolm MacDonald

Oxford University Press, $5.00
334 pp., 23 illust.

The Ottawa River flows past the capital of Canada and is joined a mile downstream by a small tributary, Brewery Creek. Although so near civilization, the two streams meet in a rather secluded expanse of bird-haunted marsh, mud flats, and low woodland. Malcolm MacDonald lived just across the river from this area in 1944 and 1945, when he was High Commissioner to Canada. An amateur bird lover, he canoed over to Brewery Creek several times each week to spend an hour or two in field observation. This volume is an account of the 160 bird species he saw there. One chapter is devoted to each month of the year. There is considerable mention of plants, insects, and other indicators of the rapidly changing Canadian seasons. This arrangement and emphasis agree with the present revival of interest in phenology, the science of the relations between climate and periodic biological phenomena.

This volume was avowedly written for the amateur or inexperienced bird lover. The style is informal and sometimes enlivened by verse or humor. The author has supplemented his own findings with information gleaned from such standard authorities as Audubon, Forbush, Taverner, and Bent. The more experienced student will find some observations of significance. For instance, MacDonald saw a parent Spotted Sandpiper gathering insects apparently for its young during their first week of life. Such precocial chicks are generally believed to find all their own food from the first.

The Birds of Brewery Creek is excellently printed and bound. It is illustrated with 23 full-page photographs by Arthur A. Allen and W. V. Critch, seven of them in color. This work may be recommended to anyone seeking a pleasant introduction to many of the commoner birds of the northeast.

D. Amadon.

Tomorrow's a holiday

- - - - - - by Arthur Loveridge

Harper and Brothers, $3.00
278 pp.

What a museum curator calls work may look to outsiders like play. Arthur Loveridge, Curator of Reptiles and Amphibians at the Museum of Harvard University, makes light of both field and laboratory occupations. His earlier book, *Many Happy Days I've Squandered,* displays the same spirit, yet I cannot imagine Loveridge wasting a single day. His trained African assistants felt they had plenty of work. A dove that called *"Kesho siku kuu"* was berated by Salimu for lying; and a translation of those words forms the title of this new book.

It describes two East African tours made by Loveridge for the Museum of Comparative Zoölogy, first to mountainous Uluguru and Usamba, later to many other highlands and Lakes Nyasa, Tanganyika, and Victoria. Travel entices the naturalist; there is the lure of the unexpected and the expectation of discoveries.

Loveridge is a leader in his field, and a great general collector. He tells of big game and a host of curious creatures. But his greatest enthusiasm is for the small cold-blooded vertebrates which most people ignore. Give him rare frogs and toads (particularly if they break all rules for breeding), camouflaged chameleons, snakes that mimic branches, burrowing skinks, amphisbaenians, or caecilians, and his eyes will glow.

Never have I known anyone more expert at finding them; and Loveridge has trained African adepts: Salimu, Ramazan, and Abedi. He enlists native children to lend their sharp eyes to the search. The result is a grand harvest of zoological treasures. Adventure he takes in his stride. Loveridge deals energetically with thieving Nyakusa people; Salimu fights off a buffalo with bird shot. With all his zest for zoology, Arthur Loveridge is serious about life. When he really takes time out, it may be to read the New Testament in Swahili to his helpers.

JAMES P. CHAPIN.

LETTERS

Continued from page 385

boat trip down the Colorado River to the Gulf and thence to Bahia de Los Angeles, I found jeep tracks crisscrossing this whole area; hence the fate of this herd is unknown. From San Luis Bay to Los Angeles Bay there were at least three other areas that supported antelope in the past, but the animals have not been observed for years by the Mexican prospectors who occasionally get into the region. One group of about 40 animals still exists between Los Angeles Bay and Santa Rosalia.

On the Pacific slope the disappearance is even more pronounced. In 1929, I saw a band of about 20 animals near San Vincente, less than 50 miles south of Ensenada. Lorretto Fernandez, a rancher at near-by Arroyo Calentura, told me that they had been discovered by American quail hunters a few years later and had completely disappeared by 1933. Some were rumored to exist on the flats south of Hamilton Ranch until about 1935; and inland from Socorro Point there were a few until 1939. North of the road between Rosario and El Marmol there was a band of over 50 antelope until at least 1940, but the searchers for the two Marine fliers who crashed in that area last year failed to see any trace of the animals.

At present, there is only one region, about 200 miles long by 20 wide, where antelope still exist in their former numbers. The fact that this area can be reached only by boat and a long overland hike has kept its antelope comparatively safe. The menace from the air, however, is about to open that territory, for there are many strips where even large planes can land safely. If this occurs, and it seems imminent, the antelope of Lower California will soon be a memory, just as they are now in our own Borrego Desert.

The history of Lower California's sheep is also discouraging, but as they frequent places unsuitable for roads, some isolated bands still exist on much of their former territory. In other years every water hole had its quota of sheep—herds of from ten to one hundred. Now, however, the big water holes near traversable trails are completely deserted, and only the small trickling springs, which become dry in arid years, retain a dwindling number.

Mexicans will hire out as guides for American hunters not because they enjoy seeing the sheep eliminated but simply because money is a scarce but necessary commodity. They are beginning to say, "If we don't, someone else will," despite the fact that they realize that a meat supply, from which they have drained the surplus for years, is now on the way out.

A few farsighted residents have made futile attempts to halt the slaughter. In one case a rancher living on the Gulf 30 miles from the nearest auto road requested ammunition from a friend of mine so that he could kill sheep and sell the meat. He was turned down with the stipulation that he could only have enough cartridges to procure meat for his own ranch. Soon afterwards a band of hunters found the water hole, and there are no longer any sheep. The rancher now travels fifteen or twenty miles to get meat, instead of one or two, and admits the wisdom of restriction.

At the present rate of extermination, there seems almost no hope of saving the animals of Lower California until the day when their worth will be appreciated. It will take more than laws or proclamations to do the job. Both sheep and antelope have had year-round protection on the peninsula for years—but only on paper. Almost every party of American fishermen carries a gun under the seat, and there is practically no search at the border, so evasion is relatively safe. To have an efficient patrol of game wardens on the peninsula would be an absolute impossibility; the distances are too great. An honor system among the sportsmen of the Southwest might work, but I have my doubts—especially after last year's Laguna Mountain massacre of hand-fed deer in the San Diego back country.

Actually Baja California is the poorest big game area that I have ever visited. In the past two years I have driven over 10,000 miles of its trails—trails that average one car a day. In all of this driving I have seen one deer, no sheep, and no antelope. Perhaps a few publicized corrections of the myth that Lower California has abundant big game will tend to keep hunters away. If not, there will be nothing left but memories within a very few years.

LEWIS W. WALKER.
San Diego, Calif.

Spiders' Long Lines

SIRS:

Today in my front yard I found a single strand of spider web 26 feet long. One end is anchored to an oak bough about seven feet from the ground and the other to a snowball bush about six feet from the ground. The intervening area is covered with grass except for a flagstone walk about four feet wide and approximately halfway between the two anchorages. Can you tell me how on earth the spider ever strung this line across such a distance without getting tangled in the grass?

J. H. HOWARD.
Greenville, S. C.

The following answer is offered by Dr. Willis J. Gertsch, Associate Curator in the American Museum's Department of Insects and Spiders:

Spiders often bridge tremendous gaps with their silken lines. This single line 26 feet long is undoubtedly one that was sent across the gap by means of air currents. Spiders fix the foundation lines of their snares either by actually carrying the lines (held at arm's length to avoid entanglement) across the space and then drawing them taut, or by letting them drift to the breeze and ballooning them across till they become attached to an object. Once the primary line is secured (and often this may be across a sizable stream), the spider moves across the line and strengthens it by adding other lines of silk and attachment discs at the extremities.

Incidentally, these primary lines, unlike the viscid silk used later, are not actually sticky but adhere only because they are extremely fine and easily become entangled in vegetation. The viscid silk is produced from very different glands in the spider's body and remains sticky almost indefinitely.

Even though the primary line is not sticky, it would not be easy for a spider to carry it by hand through thick grass, mixed brush, or over many types of obstacles. Ballooning is the answer to the problem, and a most satisfactory one.

Dolphin Coin from Iasus

Courtesy Chase National Bank

SIRS:

George G. Goodwin is right about the classical legends of dolphins saving people. The best-known story of all is that of Arion, the musician, who was condemned to death by pirates but was granted a request to sing one last song. At its conclusion, he hurled himself into the sea, but a dolphin, charmed by his music, came and rescued him.

But there are three other stories, much less well known. The most important one, which is not in Pliny, is now little remembered, though Milton alludes to it. Pausanias, the traveler, tells us that a dolphin bore ashore the body of a drowned boy, Palaemon, to Corinth. Palaemon was buried and then worshiped as a sea divinity under the name of Melicertes. The Isthmian games were founded in his honor. The reference is Pausanias, II, i, 3. The story is so little known nowadays that only two out of more than a dozen commentators on so famous a poem as Milton's *Lycidas* correctly interpreted his allusion to "Ye Dolphins, waft the hapless youth. . . ."

Besides this, Taras, the founder of Tarentum, is portrayed on ancient coins riding astride a dolphin. Most interesting of all, however, is the coin from Iasus, in Caria, which shows a youth (variously called Hermias or Dionysius) swimming with one arm over the back of a dolphin. This Hermias was befriended by Alexander the Great; he was not a pure myth.

THOMAS O. MABBOTT,
Department of English.
Hunter College,
New York, N. Y.

Flamingos Depleted

SIRS:

. . . Dr. Paul A. Zahl, my companion on the Andros Island trip described in the January, 1947, issue of NATURAL HISTORY, just returned from a check-up visit to that island. He reports that the flamingo rookery discovered by Dr. Frank Chapman in 1904 and also the one found by us a year ago are now completely deserted . . . It appears that the natives have practically exterminated the flamingo for food. . . .

DUANE FEATHERSTONAUGH.
Duanesburg, N. Y.

* * *

SIRS:

Enclosed find my check for $10.00 to pay for my Annual Membership. I consider it one of the best investments I have. The lectures give far more in return than the money expended by members for them.

WILLIAM SEAMAN.
New York, N. Y.

* * *

SIRS:

. . . Six years ago today my parents gave me, for my thirteenth birthday, the priceless gift of Membership in the American Museum. I recall with what eagerness I read every issue of NATURAL HISTORY. In the high school years, I noticed the respect my science teachers had for the work of the Museum and for NATURAL HISTORY. In those years it was always a valuable aid in my courses. Now I am a university student, a zoology major, and I find it even more useful. Yes, NATURAL HISTORY and I have grown up together. Some day, I hope to be able to make a more substantial contribution to the Museum that has given me so much; to assist it is to give education to other generations of American school children.

J. A. M.
Washington, D. C.

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L E T T E R S

SIRS:

The interesting photograph you published, in the October issue, showing the work of a pileated woodpecker prompts me to submit this one, which I took in Michigan this summer while collecting material for the American Museum's beaver group. It shows the work of a pileated woodpecker, and, although not nearly so extensive as the one shown in Mr. Dalton's picture, it is the same type of working and affords an interesting check on our identification. The excavation measured 19¾ inches in height, 6½ inches in width, and 9¾ inches in depth. The tree was a live balsam, which had obviously been the home of carpenter ants.

T. DONALD CARTER,
Department of Mammals,
American Museum of Natural History.

New York, N. Y.

° ° °

SIRS:

In your article "The Worm that Ruined a Nation" (NATURAL HISTORY, October, 1947), it was pointed out that if there proved to be snails in this country suitable for the development of blood flukes, the disease might secure a foothold on this continent. I therefore offer the following additional information from *Science*, March 23, 1946:

"We have already reported negative results following efforts to infect eleven species and subspecies of native snails with *Schistosoma mansoni*. Lest those results engender a false sense of security, it is deemed advisable to report promptly recent experimental evidence which indicates that the snail *Tropicorbis havanensis* is suitable for development of the intermediate stages of *S. mansoni* . . . (Eloise B. Cram, Myrna F. Jones, and Willard Wright, U. S. Public Health Service.)"

It is of incidental interest that swimmers in the inland lakes of Wisconsin have for some years suffered from an itchy eruption of the skin, which was blamed on weeds and other local irritants. The true cause was discovered accidentally when Dr. W. W. Cort, a biologist of Johns Hopkins University, was handling snails and got the itch. The irritating agent was found to be the cercaria of a trematode worm of the family Schistosomidae. The adult worm is a parasite in the veins of birds and mammals, but apparently the larva dies soon after attaching itself to the skin of man. Consequently, the disease is not serious, though it can cause considerable annoyance.

PAUL H. REED,
Publisher, *Mollusca.*

Tavares, Fla.

° ° °

SIRS:

Your article on the Louisiana Live Oak Society, in the February, 1946, issue, interested me particularly because San Diego County, California, has a number of unusually large live oaks, and I have recently had the opportunity to visit a group of some 50 to 100 trees. One of these, which we may call "El Monte" because of its location in El Monte Park, is shown in these photographs. Its girth, four feet above the ground, is twenty feet. This measurement is taken above the long limb that extends to the left, which measures 68 feet from the trunk to the tip. The total spread is 124 feet.

I did not measure the height of the tree, but it appears to be approximately one-half of the spread, or about 62 feet.

It is somewhat to be regretted that picknickers like to carve their names or initials in the tree and that the trampling and packing of the ground under it may threaten the continuation of its apparently flourishing condition.

The writer sincerely wishes that "El Monte," as well as some of the other venerable old oaks, might qualify for membership in the Live Oak Society.

ORSON W. PAYNE.

San Diego, Calif.

° ° °

SIRS:

A relative of mine saw fresh-water eels in a stream in Connecticut apparently building dams. She said they put their heads against a stone and worried at it until it was moved, and two sometimes seemed to work in unison on the same stone. Can you shed light on this?

(Miss) MERCY E. BAKER.

New Bedford, Mass.

The fish may well have been the brook lamprey rather than the eel. The brook lamprey builds nests in this manner.—ED.

° ° °

SIRS:

I would like to take this opportunity to tell you what I think of your magazine. Besides being intensely interesting, it is educational, often going beyond the beaten path. I like the thoroughness with which each subject is handled.

ALBERT O. H. GRIER.

Wilmington, Del.

NATURAL HISTORY

The Magazine of the American Museum of Natural History

FREDERICK TRUBEE DAVISON, President — ALBERT E. PARR, Director

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PUBLICATION OFFICE: American Museum of Natural History, Seventy-ninth St. at Central Park West, New York 24, N. Y.

EDITOR: Edward M. Weyer, Jr., Ph.D.
Elizabeth Downes, *Editorial Assistant.*
Atherlie E. Karp, *Editorial Assistant.*

ART AND PRODUCTION: Robert E. Williamson.
Jean Bruck, *Assistant in Art and Production.*

Magazine subscriptions, Membership applications, and Advertising inquiries should be sent to Charles J. O'Connor.

NATURAL HISTORY is published monthly (except July and August) at New York 24, N. Y. by the American Museum of Natural History, Seventy-ninth Street and Central Park West. Subscription price $4.00 a year, single copies fifty cents. Subscriptions to Canada, Newfoundland, and all foreign countries $4.50. Entered as second class matter March 9, 1936, at the Post Office at New York, under the Act of August 24, 1912. Manuscripts and illustrations submitted to the Editorial Office will be handled with care, but the publisher cannot assume responsibility for their safety.

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MARINER OF THE NORTH
The Life of Captain Bob Bartlett

- - - by George Palmer Putnam

Duell Sloan and Pearce, \$3.50
246 pp.

THE many friends and acquaintances of Captain Bartlett will welcome and enjoy this biography of a uniquely great man. Mr. Putnam, long an intimate friend of the Captain, is well qualified for his task. Moreover, he had the privilege of knowing Captain Bob's parents and the environment in which he grew up. This is important, for too often the factors in the molding of character are obscured by time and are difficult for the biographer to assess. In this instance these factors are well reported, and I believe that those who knew the Captain best will agree that the author has presented a well-rounded portrait of his subject.

The years of Captain Bob's active career saw the closing of gaps in geographical knowledge of the north and the shift to air-borne exploration. His part in this record is told, therefore, against a background of contemporaneous achievement. A detailed report of the many *Morrissey* voyages is not attempted, for such a task might well fill several volumes and would be hard to compile. The lack of such detail in no way detracts from Mr. Putnam's presentation of the life of a man we all miss so deeply.

JUNIUS B. BIRD.

MAYA EXPLORER
John Lloyd Stephens and the Lost Cities of Central America and Yucatan

- by Victor Wolfgang von Hagen

University of Oklahoma Press,
Norman, Okla., \$5.00
324 pp., 56 illusts.

AMONG the many who have devoted themselves to searching among the ruins of the ancient peoples of America, none has been more deserving of a biographical study than John Lloyd Stephens. A citizen of New York, already well known for his accounts of travel in Egypt, Arabia, and eastern Europe, Stephens made two extended trips into the then relatively unknown portions of Central America in the early 1840's. He went as United States ambassador to the Government of Central America, but his primary interest was in exploring the ruined cities that had first been reported a short time before. An inveterate traveler and talented observer, he returned and wrote two successful and charming books, *Incidents of Travel in Central America, Chiapas, and Yucatan* and *Incidents of Travel in Yucatan.* With these, Stephens had discovered the Maya. They were outstanding archaeological reports, beautifully illustrated with many superb and accurate drawings by his fellow traveler, Frederick Catherwood.

While all students of American archaeology are familiar with Stephens' books on the Maya, it is only in this excellent study of von Hagen's that his life and travels can be seen in the perspective of the people and life of his times. It is a fascinating story, for Stephens was not only an archaeologist, he was one of the prominent men of his times. Among other things he built the first railway across the Isthmus of Panama during the time of the rush to California in '49.

The most valuable portions of this book are those that treat of the years in Stephens' life not covered in his own books and for which Mr. von Hagen has had to do a great deal of research among surprisingly scanty sources. For the Central American travels, however, he has to a large extent merely paraphrased Stephens' account, retelling the story that Stephens told so well in his own words. But it is a good selection of the most exciting of the "incidents" and will undoubtedly make Stephens known again to many readers—as he was a century ago.

GORDON F. EKHOLM.

CANADIAN SPRING

- - - - by Florence Page Jaques
Illustrated by Francis Lee Jaques

Harper and Bros., \$3.50
216 pp., 74 illusts.

EACH new volume by these gifted collaborators reveals to what a remarkable degree they both contribute to their books. Lee Jaques' black-and-white drawings, among the most superb book illustrations appearing today, first catch the eye. But the text, which his wife contributes, is no fill-in matter to wrap around the pictures. It stands firmly on its own feet as exceptionally fine nature writing, and it has been getting better, it seems to me, with each new volume. There is less straining for laughs in recent books, more vivid and beautiful nature reporting.

The latest, *Canadian Spring*, tells of several months' junketing through the prairie provinces of Canada—Manitoba, Saskatchewan, and Alberta—and into the Canadian Rockies. There are meetings with big game, with mountain goats, elk, antelope, moose, and bears, as well as with the waterfowl that represented old friends to this pair who followed them south one fall, as told in *The Geese Fly High*. To anyone who has read the past Jaques' books, the new volume will have added interest—the interest of a continued story in which we meet old acquaintances again. Different readers will pick different chapters in this new book as their favorites. For myself, I think the one I shall remember longest is the affair with the ruddy duck. That is a section for the anthologies.

Perhaps a captious critic might mutter mildly about an increased proportion of bridges and highways and railroad tracks in the drawings in *Canadian Spring*; but there is also a bountiful supply of the kind of wildlife drawings for which Lee Jaques is justly famous. In 1946, these collaborators received the only John Burroughs Medal ever awarded jointly for a distinguished nature book. Their new volume, *Canadian Spring*, is a welcome addition to nature literature.

EDWIN WAY TEALE.

CAN SCIENCE SAVE US

- - - - - by George A. Lundberg

Longmans, Green and Co., $1.75
122 pp.

EVER since men began to investigate the world they live in with a consciously controlled method that could be called scientific, science has been exposed to the hostility of church, state, and other traditional seats of authority. In the past, attacks upon science arose principally from the fear that science would undermine the dogmas that had accumulated around and in part supported tradition. Now we see science being belabored for a different reason and principally by another group of men—writers and intellectuals. These men see the difficulties of our world as the consequence of scientific activity and for the most part see them in the glamorized light of a happier past. This view is summed up by President Hutchins of the University of Chicago who declared, "The world has reached at one and the same moment the zenith of its information, technology, and power over nature and the nadir of its moral and political life." This juxtaposition implies that the zenith of science has brought about the nadir of morals. But whether or not President Hutchins means that, there are many others who call for a moratorium of science for that reason.

There is no doubt that science has provided us with the greatest degree of control and understanding of natural phenomena that any age has ever possessed, but I suspect that Dr. Hutchins has been reading his 100 books with rosy spectacles if he thinks we are at the nadir of morality and politics. The problem that faces man and threatens him with extinction is the problem of social and human relationships. Man is not much worse in these respects than he has been in the past, but he cannot afford to continue that way with the vastly increased powers he now commands.

That is why Professor Lundberg asks *Can Science Save Us?* The answer is "yes" with an "if." If we apply science to our social problems, we can obtain answers that can inform us on the consequences and cost of the path we elect to follow. That is all science should do. It cannot or should not attempt to dictate the choice.

I know of nothing on this crucial subject that presents the promise of science with more vigor and sound sense. Anyone who fears the application of scientific reason to the field of human relationships as an invasion of violative hands should read this book.

HARRY L. SHAPIRO.

SCIENCE IN PROGRESS

- - edited by George A. Baitsell

Yale University Press, $5.00
353 pp., 151 illusts.

THIS is the fifth series of *Science in Progress*, edited by Professor Baitsell. As in the previous series, the articles are based upon material prepared originally for the Sigma Xi National Lectureships and have been presented to university audiences all over the country. Brief biographical sketches of the eleven contributors are given, indicating that they are eminently qualified to handle their respective subjects.

Each chapter is an up-to-date discussion of the status of a branch of science. The first chapter, entitled "The Future of Scientific Research in the Postwar World," is by Dr. Frank B. Jewett, President of the National Academy of Sciences, and really constitutes an introduction to the volume. The remaining ten chapters are on the following topics: "The Interior of the Earth," "Development of Betatron and Applications of High Energy Radiations," "Contact Catalysis between Two World Wars," "Fundamentals of Oxidation and Respiration," "Complement: Immunity Intensifier, Diagnostic Drudge, Chemical Curiosity," "Genes and the Chemistry of the Organism," "Concerning the Cancer Problem," "Plant Diseases Are Shifty Enemies," "Living Cells in Action," and "Recent Advances in Our Knowledge of the Anterior Pituitary Hormones."

Several pages at the end of the book are devoted to references—from eight or ten to forty or fifty for each chapter.

Each article or chapter is an engrossing story of the recent advances made in each respective field, set forth by a leader in that branch of science. The abundant, well-selected illustrations add much to the interest and attractiveness of the book.

CLYDE FISHER.

WINGS IN THE WILDERNESS

- - - - - by Allan D. Cruickshank

Oxford University Press, $6.00
260 pp., 125 illust.

MR. CRUICKSHANK enjoys the distinction of being this country's outstanding bird photographer. In *Wings in the Wilderness* we have what he regards as the *125 best pictures* among the many thousands he has taken, all beautifully reproduced in sepia in an 8 x 10 format. Faced with the problem of conveying in words something of the exquisite beauty of these photographs, one has the feeling that simple prose is hardly capable of doing them justice.

There have been a number of recent books on art forms in nature that have dealt with the patterns and designs to be found in plants and some of the lower animals. These, however, seem almost crude and mechanical when compared with the subtle grace and beauty of Mr. Cruickshank's birds. This is certainly a book that belongs in every art library, not only for its pictures but as a beautiful example of book making.

After seeing these pictures it is not hard to understand why the study of birds has attracted so many devotees. To them the brief but interesting paragraph that goes with each photograph will be especially valuable. The birder will find both the exotic and the familiar among the birds portrayed. The young mockingbirds begging for breakfast and the house wren at its nest could have been taken almost anywhere. Others, like the amazing view down the face of the gannet colony at Bonaventure, the wonderful brown pelican series, or the striking picture of a wild turkey gobbler in a sunlit glade, reveal how extensively Mr. Cruickshank has traveled in his pursuit of bird portraits.

Those who make a hobby of photography will enjoy seeing what an expert can do in what is generally recognized to be one of the most difficult branches of photography. For them full photographic data on each picture have been provided.

RICHARD H. POUGH.

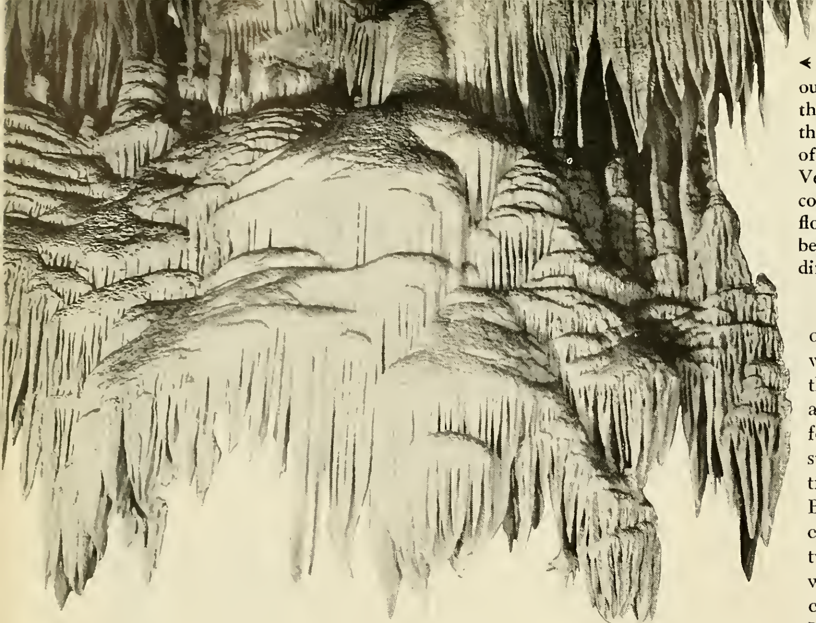
GOLDFISH VARIETIES AND WATER GARDENS

- - - - - - - by William T. Innes

Innes Publishing Company,
Philadelphia, Pa., $5.00
381 pp., 285 illusts.

BY a thoughtful handling of his material, the author has divided this handsome book into two approximately equal parts. The first covers goldfish, and the second aquatic plant life. This first section is replete with data on both indoor and outdoor goldfish culture. Everything seems to be covered, from how to feed them to how to photograph them. Did

Continued on page 474



◂ AFTER GROUND WATER has hollowed out a cave, moisture seeping through the roof often partially refills it through evaporation and precipitation of minerals in solution. "Titania's Veil" in Luray Caverns, formed by the coalescence of festooned stalactites and flowstone, represents an unusually beautiful glacier-like step in this direction

Wonders Underground

The crystal palaces that nature has created beneath the surface of the land tell a fascinating story of the geologic processes through which the earth is constantly being destroyed and rebuilt

By RAYMOND E. JANSSEN

Associate Professor of Geology, Marshall College

FROM time immemorial, caves and caverns have been utilized by man and beast as places of shelter, hide-out, burial, or even economic advantage. Long before the advent of man on earth, reptiles and mammals found suitable dens in these natural openings in the rocks; and when man, himself, finally appeared, his first home seems to have been in a cave. On the floors of subterranean passageways have been found some of the earliest skeletons of human beings, as well as ancient implements, tools, and pottery. On cavern walls are to be found early pictographs and artistic presentations made by primitive man.

In more recent times, accounts of pirates and outlaws are full of caves and caverns used for headquarters, hide-outs, or concealment of loot. The history of many regions, such as parts of Kentucky and the Ozarks of Missouri, would not be complete without mention of the frequent use of dark caverns for housing illegal liquor stills or counterfeiting equipment. Even fiction and fable contain their share of caverns, such as *Ali Baba and the Forty Thieves* and *Alice in Wonderland*.

Although the terms "cave" and "cavern" are generally used interchangeably, most geologists distinguish between the two on the basis of their origins. Strictly speaking, a cave is a natural cavity of somewhat limited extent formed at the surface of the ground by meandering streams as they strike against their valley sides or by pounding waves as they undercut cliffs along the shores. Caverns, on the other hand, are formed beneath the general ground level, often at depths of hundreds or thousands of feet, where subterranean waters seeping through the rock have dissolved it away. In other words, caves are formed by the abrasive action of surface water, caverns by dissolution of rock by subsurface waters. Because geologists have only recently attempted to distinguish between the uses of the two terms, we find that many caverns are called caves, such as Mammoth Cave in Kentucky or Wind Cave in South Dakota. Others, discovered and named more recently, such as Carlsbad Caverns in New Mexico, are more accurately designated.

Most true caverns are veritable fairylands with their vast network of subterranean passageways and vaulted chambers, draped with myriads of dripstone formations of fantastic shape and queer design. A visit through a cavern is an experience that everyone should have, for it takes him beyond the limits of everyday life and enables him to wander among the ages of the past.

Beneath the surface of the earth the familiar noises of the outside world are absent; except for the sounds of the visitor himself, there are only those of dripping waters. Everything is shrouded in the inky blackness of eternal night, except where artificial lights play upon the glistening stone and cast weird shadows here and there.

The cavern pathway leads downward through narrow, rock-walled passages or broadens through low-vaulted ceilings and highly-arched chambers. Massive draperies of gleaming onyx hang from walls and ceiling like carnival festoons, and beyond them other passageways lead in scattered directions into distant realms of blackness. Long, stone icicles hang everywhere from the cavern roof. Their sparkling surfaces, reflecting the lamplight back and forth, resemble jeweled chandeliers in some exotic, oriental palace. Rising from the floor, massive pillars and spires imitate the broken columns of ancient temple ruins. Others, like endless pillars, rise upward out of sight, seeming to support a roof that vanishes in utter darkness overhead.

Sometimes beautiful snow-white flowers appear to be growing from cracks in the cavern walls. Touch them, and they fall to pieces before your eyes, for these are crystal flowers, not made to endure the touch of human hands. Everywhere strange shapes and curious designs, half-human, half-grotesque, are sculptured in the massive stone, and fantastic elflike forms seem to peer out from amid the shadows. Something strangely familiar keeps tugging at the intruder's memory, until at last he realizes that he is following a pathway made famous long ago by that little girl who followed a rabbit down a hole—for certainly Alice's adventures in Wonderland must have taken place in an underground world very much like this.

It is possible to wander indefinitely through the dark passageways, but eventually the visitor must return again to the familiar world outside. At first the glaring sunlight blinds his eyes, but soon familiar landscapes greet him, and he wonders if he has just awakened, like Alice, from some strange dream. Such experiences, of course, are not dreams. Rather, they are opportunities of witnessing at first-hand some of the amazing natural wonders that exist in this unique world of ours.

An understanding of the manner in which these vast subsurface caverns have been formed is no less interesting than the thrill of visiting them. Countless studies of these underground wonderlands

▼ Myriads of glistening dripstone festoons make Luray Caverns of Virginia a wonderland unsurpassed in natural beauty

Photos courtesy Luray Caverns Corp.

▲ Largest of all known underground passages are the Carlsbad Caverns in New Mexico. The relative size of the tremendous dripstone formation shown in this photograph can be seen by comparison with the human figures

and the rock structures in which they occur have shown that there are two great geological processes involved in their creation. The first accounts for the hollowing-out of the extensive network of subterranean chambers and passageways in the once solid rock; the second produces the vast array of exquisite dripstone formations within the caverns.

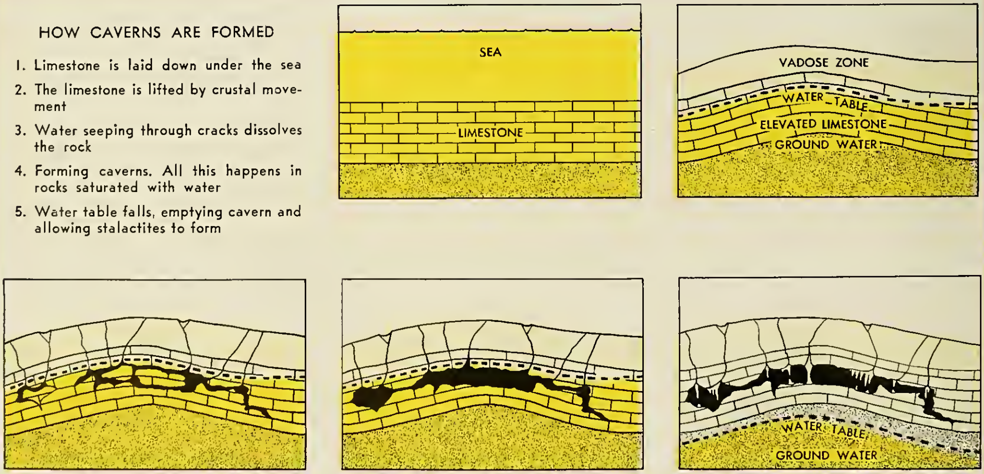
It is generally recognized that caverns are simply cracks that have been enormously enlarged by the solution of underground water passing through them. Hence, true caverns occur only in soluble rocks, the most common of which are limestone, dolomite, marble, gypsum, and salt. Because limestone is more widely distributed throughout the world than any of the others, most of the great caverns are found in it. Limestone is quite readily dissolved by water, particularly if the water carries carbonic acid. Nearly all subsurface waters contain varying amounts of this acid, because it is picked up from decaying vegetation when rain waters soak down through the porous soil into the rock layers beneath.

Most of the water that seeps downward from the surface tends to percolate deeper and deeper until it reaches a level where all pores, openings, and cracks in the earth are completely saturated with water. This is known as the *ground-water level* and is the depth to which wells must penetrate if they are to be permanently supplied with water during all seasons. All the area above this level to the surface of the ground is known as the *vadose-water zone*. Here the soil or rock is only partially saturated with water, which is in process of seeping downward to the ground-water zone. The actual line separating the two zones is called the *water table*. The water table normally fluctuates from season to season and may be at any depth, usually from a few feet to several hundred. In swamps and lakes the water table is actually at, or above, the surface of the land.

Since a vadose-water zone overlies the ground-water zone in most regions, it follows that the vadose water is constantly seeping downward to become a part of the ground water. In turn, the ground water itself is also percolating downwardly and laterally to the limit of its ability. Its limit of depth is reached several miles below the surface, where the pressure of gravity is so great that no cracks or pores can remain open in the rocks to receive any water; but its

HOW CAVERNS ARE FORMED

1. Limestone is laid down under the sea
2. The limestone is lifted by crustal movement
3. Water seeping through cracks dissolves the rock
4. Forming caverns. All this happens in rocks saturated with water
5. Water table falls, emptying cavern and allowing stalactites to form



lateral limit is reached only at the sea, where the sides of the continents drop off toward the ocean depths. Hence ground waters, like those of surface rivers and streams, tend to move by gravity or pressure toward the sea. Subsurface water moving toward the sea excavates the caverns as it passes through cracks in soluble rocks. It was long believed that this took place in the vadose zone, where the water is able to move most freely toward lower levels. However, most geologists today agree that caverns are excavated principally in the groundwater zone, where water is held constantly in contact with all the rock surfaces of the openings through which it moves.

The hollowing-out process must take immeasurably long, for all caverns, regardless of size, started merely as cracks in the rocks. Rock layers, when first formed, are massive and solid, essentially free from openings other than pores. Movements in the crust of the earth elevate them and produce cracks and joints. These cracks then provide the most ready route for groundwater circulation, although the openings are ordinarily so small that the movement can only be very slow at first. Nevertheless, because the cracks are always completely filled with water, they are gradually enlarged by the dissolving action of the water during the countless years of continuous seepage. Cracks that crisscross each other through the strata thus develop into a labyrinth of channels, extending indefinitely through the rock layers.

As these channels enlarge, the ground water moves more freely in its seepage toward the sea. Because it can now disperse a little faster, the water table of the region tends to subside. The caverns then have their upper parts drained of water, while the lower levels still remain saturated. If crustal movements happen to elevate the rocks further, the caverns are more completely drained. In any event, either by uplift of the land or by gradual lowering of the water table, the caverns eventually cease to be saturated with water. At this point they automatically become a part of the vadose zone. The water that hereafter passes through the caverns is merely the drip water of overhead seepage or stream water that has found its way into the caverns and flows along the floors in the same way that it does on the surface of the land. In some regions the water table may rise and fall more than once over a long period of time, so that the cavern may go through several cycles of the usual sort.

Underground streams are common in some caverns, and in many instances they can be traced to their point of inlet or exit. Those that start as surface streams and then enter underground channels through cracks or other openings in the ground are often referred to as *lost rivers.* Many streams, on the other hand, actually start in caverns, because these openings provide good collecting areas for seepage water. These streams later emerge at points along hillsides where a cavern floor intersects the side of a valley. The exits of such streams are, in effect, large springs.

⮝ RIVERS flowing through caves cut channels in the same way as do rivers on the surface. Echo River, in Mammoth Cave, is actively widening its bed, as shown by its tendency to undercut the walls

➤ BLIND, WHITE FISH inhabiting the waters of Mammoth Cave demonstrate the effect of total darkness on creatures that pass their entire lives underground. Blind salamanders, beetles, and other insects may also be found in large caverns

Photos courtesy National Park Service

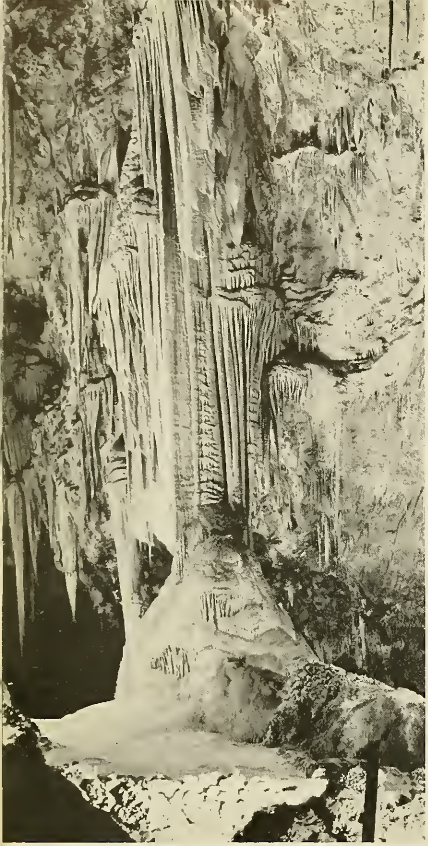


Photo courtesy National Park Service

▲ Onyx draperies in the Hall of Giants, Carlsbad Caverns

The movement of vadose water through caverns in the form of a stream may continue to enlarge or deepen the passageways by means of ordinary erosion in the same way that a regular stream deepens its valley by flowing through it. This is shown by undercut sides and swirl marks along cavern walls near the floor. However, this is relatively insignificant compared with the vast amount of rock that has previously been dissolved by the ground water. To all intents and purposes, a cavern has "gotten its growth" when the passages are no longer in the ground-water zone. At lower levels, however, where the rocks are still saturated, caverns continue to develop. This accounts for the existence of various floor levels in most caverns.

With the transfer of a fully developed cavern from the ground-water zone to the vadose zone, the second great geological process begins—the gradual refilling of the passageways and chambers with stone and sediment. It is this process that builds the beautiful formations seen in most caverns.

These formations, collectively referred to as *dripstone* and *flowstone*, are varied in shape, size, and coloring. Most interesting, perhaps, are the stalactites—those long, icicle-like dripstones that hang suspended from the cavern ceilings. They grow by accumulation of mineral matter, usually lime, from droplets of water that drip or evaporate from the cavern roof. Water seeping downward through the rock and soil above a cavern eventually reaches it through pores and cracks in the ceiling. There it hangs like water from a dripping faucet until the drop becomes heavy enough to fall to the floor. While hanging, however, the droplet of water is partly evaporated by the air currents moving through the cavern, causing it to deposit an infinitesimal amount of the lime accumulated during its seepage through the ground. Countless drops of water, following each other in slow succession through years and ages, thus build the long, tapering stalactites.

In their early stages, stalactites are usually slim and hollow, small ones looking much like soda straws. The water seeps downward through the hollow interior, depositing concentric layers of mineral matter on the inside and lengthening the structure at the lower end. Eventually the interior may become filled with mineral, or at least sealed off in the lower portion, so that the flow of water down through it is stopped. Thereafter, water may trickle down the outside of the stalactite, continuing to increase its diameter and length and also adding to the irregularity of its surface.

Where a number of stalactites

▼ **Stalactites and stalagmites of unusual purity and whiteness characterize Ohio Caverns. Note the resemblance of young stalactites to soda straws**

Photo courtesy Ohio Caverns

are growing close together, their gradual increase may eventually cause them to join, resulting in a festooned appearance. Sometimes, when water is dripping through a long, continuous crack in a cavern roof, a great sheet, or curtain-like formation, is produced. If such a curtain extends across the entire width of a cavern passageway, it may eventually close off the passage completely. Frequently, when exploring newly discovered caverns, it is necessary to break through such wall-like formations that separate chambers and passageways from each other.

These curtain-like dripstones are banded in structure and commonly translucent, so that if a light is placed behind them, they may remind one of huge slabs of bacon. This banding results from the precipitation of alternate layers of relatively pure and impure mineral matter. The water that seeps down through the ground may, at various times, take into solution coloring matter from the earth through which it passes. Depending upon whether such coloring agents are carried continuously, intermittently, or not at all, individual stalactites and dripstones may be solidly colored, banded, or pure white. Stone thus formed is known as travertine; and banded varieties, called onyx, are often cut and polished for decorative and ornamental purposes.

The process that causes stalactites, sheets, and curtains to grow downward from cavern ceilings also produces other types of dripstones which grow upward from the floor.

Photo courtesy Skyline Caverns

▲ "MINERAL FLOWERS," called anthodites (from Greek *anthodes* meaning flower-like) add a garden-like touch to some caverns. They grow by capillary deposition of calcium or gypsum on walls and ceilings

Raymond E. Janssen photo

▲ STALACTITES are usually hollow when young, as shown by these cross sections. Water flows through them, depositing mineral matter at the lower end and in time filling them up

Such growth, called stalagmites, usually have the appearance of posts, tree stumps, or domed beehives. They are generally seen directly under the suspended stalactites. They grow by the gradual accumulation or piling up of mineral matter that precipitates out of water droplets. Stalagmites are never hollow like stalactites but from the start are always solid and massive. The same drops of water that cause the growth of stalactites are evaporated further when they fall to the floor, thus initially building a little mound of lime or other mineral matter directly below. With the continued drip, drip, drip of the waters, both stalactite and stalagmite grow in length, one downward and the other upward. Finally the two may meet, forming a continuous column or pillar. Subsequent flow of water down the sides of such pillars adds concentric or irregular layers of mineral, so that the columns sometimes become so massive as to resemble gnarled tree trunks.

The water that produces flowstone usually follows a sheetlike movement as it flows down the walls of caverns or upon piles of fallen rock or other irregular surfaces, as well as over previously built stalactites and stalagmites. The texture of the resulting deposits closely resembles the ice or sleet that collects on objects during a winter storm. Many of the flowstone formations look like frozen waterfalls, and nearly every cavern has its so-called "Frozen Niagara" or similarly named attraction.

Dripstone and flowstone formations having unusually beautiful coloring or fantastic shape have made many caverns world-famous. Some, as in Carlsbad Caverns in New Mexico, are noted for their immense sizes, many of them approximating the proportions of small buildings. Others, like those in the Ohio Caverns, are noted for their great variety of coloring. But for sheer beauty, abundance, and variation in shape and color, probably no known caverns exceed the dazzling display of Luray Caverns, in Virginia.

The rate at which dripstones and flowstones accumulate has been the subject of much speculation. Large formations such as those in Carlsbad Caverns or Mammoth Cave undoubtedly have taken thousands, if not millions, of years to grow to their present size. In most caverns observed during the past century, growth is going on so slowly as to be essentially unmeasurable. However, flowstone that is now forming from seepage water along an open road-cut near Huntington, West Virginia, has reached a thickness of about half an inch in less than ten years. The amount of water, its rate of seepage, and the proportion of dissolved mineral matter in it are all factors. The rate of growth is undoubtedly quite variable, and a stalactite that has grown to a specified length and diameter in a century may not be duplicated elsewhere in a thousand years.

Under controlled laboratory conditions, it is possible to grow artificial stalactites of small size within periods of weeks or months, but it cannot be presumed that natural growth takes place so steadily or quickly. On the other hand, natural growth may not be so slow as is popularly believed. Many cavern proprietors who cater to the tourist trade like to astound their visitors by saying that a certain formation within their cavern is estimated to be a thousand, a million, or a hundred million years old. Anyone, amateur or professional, is free to guess, but his estimate is only a guess, for no way is yet known to determine accurately the age of a particular dripstone formation. The most that can be said is that any such formation must necessarily be younger than the age of the rock layers in which it is found. Most of America's famous caverns are in limestones of Mississippian Age, which were laid down in the sea some 300 million years ago. Carlsbad Caverns, formed in rocks of Permian Age, about 200 million years ago, is a notable exception. From these dates must be subtracted the time involved in the elevation of the rocks from the sea bottom, the vast extent of time required to dissolve out the enormous caverns themselves, and the eventual draining of the ground water from the caverns. Finally, and only then, could dripstone formation begin, because there would be no dripping water in a cavern so long as it was completely saturated.

It can be easily seen that the huge dripstone and flowstone formations are slowly tending to refill the caverns. But this is not the only way in which caverns tend to become refilled. Where streams of water now flow along cavern floors, one can observe that they behave in essentially the same way as surface streams do. If the flow of water is rapid, particularly in places where its drops from one level to another, active erosion is in process, tending to deepen or widen the cavern floor. But where the flow is sluggish, the streams deposit silt, sand, mud, and pebbles, thus building up the floor just as surface rivers deposit sediments on their flood plains. In most caverns there are passageways that have been filled nearly to the ceiling by such sediments. In order to explore, and later to provide access for visitors, some of these passages have to be excavated. It is in such deposits that bones of prehistoric animals and early man have been found. Most of these sediments, as well as some of the fossils they enclose, have been carried into the caverns by the streams and deposited there.

To a great extent, also, caverns tend to become refilled by collapse, or caving-in. There are very few instances known where persons have witnessed the falling of rock from cavern roofs, and injury from such cause is relatively rare; hence, in this respect, caverns are among the safest places known. Yet all caverns show evidence of considerable downfall of ceiling rock, which can be seen as huge slabs and piles of jumbled stone. Sometimes this is piled upon the floor to such height as to block off a passageway completely and make removal of some of the stone necessary in order even to crawl through. Such falls of rock, for the most part, have taken place long ago, probably during or shortly after the time when the cavern was changing from the ground-water zone to the vadose zone. This is evident because most of the fallen rocks have either been buried or partly buried by the later stream sediments or covered with flowstone and dripstone formation. The growth of huge stalagmites upon them and the hanging of long stalactites from the ceiling above are indications that the rocks could not have fallen within recent decades or centuries.

Where great falls of ceiling rock have taken place, particularly in places where the caverns are not far beneath the surface, corresponding depressions are usually found on the surface of the land above. These basin-like depressions, called sinks, may vary in size from only a few feet in diameter to a mile or more. In cavernous regions, such as that of the Mammoth Cave in Kentucky, the land surface for miles about is dotted with thousands of sinks. The existence of underground caverns can thus be inferred from the nature of the surface. Land that is characterized by vast numbers of sinks is called Karst topography, after the famous region of that name east of the Adriatic Sea in Yugoslavia. But the same effect is sometimes produced when abandoned coal mines cave in.

The sinks themselves may or may

not hold ponds or lakes, depending upon the relative permeability of the rock beneath them. Many of the lakes of central Florida are sink basins capable of retaining permanent bodies of water, as are also some of those in Kentucky. Small ones are often utilized as hog wallows, duck ponds, and watering places for stock by the farmers who own the land. Some sinks hold water only for a few hours or days after a heavy rainfall; in others the water seeps down into the cavern below as fast as it accumulates on the surface. In the greatest extreme, some sinks remain open like great funnels. If one stands in the cavern below, he can, of course, look upward and see daylight or sky above. In populated areas it is necessary to enclose such openings with fences or attempt to fill or cover them.

The caverns under these open sinks not only receive the material that has caved in but tend to become refilled by the sediment funneled into them from the drainage area around the sink. An additional characteristic of Karst regions is the absence of any notable surface streams. Because most of the rainfall soon finds its way underground, surface rivers have little chance to form; and those that do form usually enter a sinkhole and become "lost" streams. It is for this reason that very few large or long rivers are found in Kentucky, which is largely honeycombed with extensive caverns.

▼ THIS NATURAL BRIDGE was formed in Crystal Cave, Pennsylvania, when a huge section of ceiling rock fell. Caverns are actually among the safest places in the world. Cave formation is a slow process, and most debris shows evidence of having fallen long ago

Photo courtesy Crystal Cave Co.

A number of small sinks, more or less closely spaced, may in time coalesce by continued caving-in to form much larger basins. Because the joints in the rocks beneath usually follow a somewhat regular pattern, such enlarged sinks tend to be elongated basins aligned with the fissure system. They are then called valley sinks, or valleys of solution. These are quite numerous in the cavern regions of Kentucky. Along such a valley some of the surface rock occasionally fails to cave in, leaving natural bridges spanning the valley in one or more places. The famous Great Natural Bridge of Virginia is believed to have been formed in this way. There appears first to have been a long tunnel-like cavern beneath the surface of the land, upon the floor of which was flowing an underground stream. With the subsequent caving-in of the roof all along its course except in one place, the natural bridge was formed, and the underground stream became a surface stream flowing through a canyon.

The ways of Nature are fascinating and sometimes almost unbelievable. Strange it is that countless ages should be spent in excavating underground passages in the rocks only to have them filled in again. Yet the counterpart of this strange phenomenon is taking place upon the surface of the land in almost every stream valley. First the valley is excavated by the erosive action of the running water; later, when the stream has reached its grade, it starts to fill the valley again with flood-plain sediments of silt, sand, and gravel. But even these refillings are only temporary, for in the final analysis, the ultimate goal of all moving water is the tearing down of the lands and their removal, piece by piece, into the sea. Meanwhile, the ephemeral beauty of the valley and the subterranean cavern are but fleeting stages in the ever-changing drama of an evolving world—a world in which vast lands and lofty mountains are built and rebuilt, only to be worn away repeatedly by mighty processes which man today has only begun to understand.

Courtesy Yale Laboratories of Comparative Psychobiology

▲ SPENDING HARD-EARNED MONEY. If the Chimp-O-Mat failed to work, the chimpanzees treated it as angrily as any human who had lost his coin in a defective chewing-gum machine

Payday FOR PRIMATES

When scientists taught monkeys the value of money and gave them a Chimp-O-Mat in which to spend it, significant changes took place in their behavior toward one another, and new light was shed on the capacity of lower animals for symbolic thought

By FRANK A. BEACH

Professor of Psychology, Yale University

HAVE you ever heard of an animal that would work for wages—not for food but for actual wages that could be used to *pay* for food, water, or even a ride home? Most animals that work for man do so because they have very little choice in the matter, but there have been a few who learned to work hard and willingly for payment in poker chips. Of course, the chips had to be worth something, or the animals wouldn't have worked to earn them; but that's getting ahead of the story.

"Trader," the Bartering Monkey

Buried in the pages of the exceedingly technical *Journal of Genetic Psychology* is an erudite scientific article bearing the imposing title, "Notes on Symbolic Behavior in a Cebus Monkey." Although it pretends to be a scholarly treatise, it is in actuality the charming story of Trader, the bartering monkey.

Trader lived at the Zoological Garden in San Diego. Soon after his arrival, he became a star attraction because of his ingenious method of obtaining treats from indulgent visitors. When a visitor strolled by his cage carrying a bag of peanuts or a bar of candy, Trader would scurry around until he found a bit of wood, a stone, or a wisp of straw. Then, stretching his skinny arm through the bars, he would chatter and gesticulate to indicate his willingness to trade. If his first offer was accepted, the monkey would hunt for something else to use as barter and then do his best to promote a second exchange.

The visiting public delighted in Trader's antics, and it seems likely that he would eventually have died from overeating if fate had not intervened. One day, a psychologist saw Trader in action and was so impressed that he purchased the animal and took him home in order to learn more about his abilities.

Trader seemed perfectly happy to exercise his huckstering habits under experimental conditions. The experimenter sat on a chair in the center of the room and extended his hand, saying, "Give me something, Trader." Thereupon Trader proceeded to collect a handful of sawdust, a scrap of paper, a bit of trash —in fact, anything available—and placed it in the psychologist's hand. If the first offering was refused, the animal continued his hunt and turned up with something else, which he seemed to hope the experimenter would regard as acceptable. Sometimes when an item of barter had been deposited in the scientist's palm, the monkey would extend his own paw, palm upward, politely but firmly requesting the peanut which was his usual reward.

Ordinarily Trader was not averse to making one or two advance payments before he received any return, but he made it quite plain that he could not be exploited by any psychologist! When the experimenter accepted one offering after another without delivering any peanuts, the monkey became highly indignant. Screaming at the top of his lungs, he threw himself on the floor, beat the rug with his heels, and behaved in general like a child in a temper tantrum.

Poker Chips for Money

Boxes were placed in the corners of the experimental room, and each one was filled with poker chips of a certain color. Each time that Trader paid in a red chip he was given a piece of orange. A blue chip was worth one shelled peanut. A white one purchased a slice of banana, and a green one bought a slice of bread. It didn't take the monkey long to master this coinage system, and he indicated plainly that the most valuable item in stock was the banana. White chips were turned in more frequently than any other color. Second came the blue chips for peanuts. Least popular of all were the green. Trader was not at all fond of bread.

One thing about the monkey's behavior puzzled the psychologist. Although Trader did not like bread and would not eat it, he nevertheless continued to bring in green chips occasionally. Furthermore, he sometimes proffered yellow chips, which were worth nothing at all. This usually happened just after he had eaten a lot of his favorite food, and he seemed to deliberately choose the "valueless" chips.

It seems to me that only one explanation fits the facts. In Trader's veins there must have coursed a bit of Yankee blood. Even when he made no profit on the transaction, he tried to promote a trade just for the sake of making a deal.

High Finance at Yale

The psychologist who studied Trader had taken his inspiration from experiments conducted at the Yale Laboratories of Primate Biology. A young experimenter, Dr. John Wolfe, trained six young chimpanzees to operate a specially built slot-machine, which automatically delivered one ripe grape every time a poker chip was inserted in the slot.

To begin with, the apes had to learn how to make the Chimp-O-Mat pay off, and some of them caught on very quickly. Moos, a six-year-old male, watched the experimenter insert just one chip in the slot and then saw a grape roll into the food cup. With no hesitation, Moos picked another chip from the floor, pushed it into the machine with only a little fumbling, then put his hand in the food cup and waited for the grape to drop. Imitative behavior of this sort is extremely rare in animals, as pointed out in a previous article in Natural History; but there's no denying that occasionally it really does occur.

At the beginning of the experiment, the animals held white poker chips in low esteem. After all, they weren't nearly so interesting as toys or other playthings. However, as soon as the apes had learned to buy grapes at the vending machine, the little plastic discs were transformed into extremely desirable objects—prizes worth striving for.

The first time a handful of white chips and brass slugs was thrown on the floor, the little animals seized both with equal avidity. The slugs would fit the slot in the Chimp-O-Mat but would not cause it to disgorge grapes. Within just a few days, even the dumbest chimpanzee could differentiate between real money and "counterfeit" coinage. When a mixture of white chips and slugs was tossed onto the floor of the cage where Alpha, Bula, and Bimba lived, the three little females scrambled madly for white chips, stealing them from one another whenever possible. They never touched the brass slugs.

Human parents know only too well that when a child receives a regular allowance, he encounters no difficulty in spending it. People can recognize the value of money even if they don't have to work for it. However, one measure of the importance of money to an individual is the amount of effort required for its acquisition. This line of reasoning applies equally well to the Yale chimpanzees. They had, in effect, been given an allowance, and their behavior clearly showed that money, in the form of white poker chips, had a real value in their scheme of things. The next question was: Would they work to earn it?

In order to discover the answer, Dr. Wolfe introduced his "subjects" to the mysteries of a Work Machine. Each time the handle was lifted,

↗ In experiments on the behavior and intelligence of monkeys, food has been used as one of the chief incentives for performance, but not the only one

Attilio Gatti-Pix

the animal could reach in and pick up one grape. Then the handle returned automatically to the starting position, and when it was raised again another grape was disgorged. When the chimpanzees had mastered the operation of the Work Machine, white poker chips were offered instead of grapes, and the worker was later allowed to buy one grape with each chip. They worked for chips as readily as for grapes and would lift very heavy weights in order to secure their "money." When the machine was loaded with brass slugs, they performed no labor. As far as the apes were concerned, the entire affair was strictly a business proposition.

Every chimpanzee has a unique personality, and they differ as much as people in their temperamental make-up. Velt proved to be a very common type of laborer. His money burned holes in his pockets. He would work energetically as long as he was permitted to run to the Chimp-O-Mat to spend each chip as soon as it was earned; but he went on strike when forced to wait an hour with wages in hand. Moos and Bimba were the thrifty type. They were quite willing to operate the Work Machine and collect their pay in poker chips, even though it couldn't be spent until the next day. However, when the next day arrived and opportunity for spending was offered, the animals demanded prompt and efficient service.

Once, the machine was set so that the apes, after inserting a chip, had to wait several minutes before a grape would appear. Moos had participated in the "forced savings plan" without complaint, but he had no patience with this sort of foolishness. He dropped a poker chip in the slot and extended one hand into the food cup. When no grape appeared, Moos grasped the Chimp-O-Mat and shook it vigorously. He looked like a frustrated subway customer who has just wasted a penny in a defective gum machine.

The Idle Rich

By this time Moos and Bimba were definitely money-mad. When permitted to operate the Work Machine as often as they wished, these two apes amassed great piles of poker-chip wealth. In a single ten-minute period, Moos continued to lift the eighteen-pound handle until he had collected one hundred eighty-five counters. Unwilling to waste time, he didn't even grasp a chip in his fingers but feverishly brushed it to the floor and pumped the handle again.

A minute-to-minute record showed that Moos and Bimba worked fastest during the first part of their tests and then slowed down considerably in each succeeding minute. Fatigue didn't seem to be the answer, and so the psychologist cast about for some other explanation. Finally he thought he had found it. He reasoned that as the pile of earned chips increased, the apes became less and less inclined to work for more.

Once again Moos was permitted to operate the Work Machine as often as he wished for ten minutes. But this time he was *given* 30 white chips before starting to work. He lifted the handle exactly thirteen times. The tests were repeated several times and always turned out the same. When Moos was absolutely broke, he almost always pumped the handle at least 100 times; but if he was grubstaked before starting, his performance was very inferior. Like many human beings, the chimpanzee's willingness to exert himself for pay depends in large measure on the current state of his financial reserves.

An Expanded Economy

Little children learn to prize money long before they know the relative values of different coins. Many a four-year-old clamoring for a nickel has been entirely satisfied when given a penny instead. Dr. Wolfe's chimpanzees had readily learned to choose white poker chips in preference to worthless brass slugs, but was their mentality equal to the task of dealing with "coins" of different values?

To find the answer the psychologist introduced new forms of specie and broadened the market. Brass slugs still bought nothing, and white poker chips were still worth one grape; but when a blue chip was dropped in the Chimp-O-Mat *two* grapes rolled out. A red chip bought a drink of water. And if a chimpanzee inserted a yellow chip in a slot beside the door of the experimental room, he was allowed to ride "piggy-back" on the scientist's shoulders for prompt delivery to his home cage in the living quarters.

The young apes seemed to comprehend this new system after they had gained some practical experience with it. When given a choice, they came to spurn the white chips as long as they could get blue ones with twice the buying power. Thirsty animals passed by both white and blue chips to select the red tokens, with which water could be obtained.

The response to the yellow chips was in some ways the most interesting. A few chimpanzees never used them. These were individuals who seemed perfectly content to remain in the experimental room all day long. Other apes were continually bribing the experimenter to carry them home. Bula was standing by the Chimp-O-Mat buying grapes with blue chips when the psychologist suddenly opened a box that contained a white rat. He placed the animal on the floor beside the chimpanzee. For a moment she stared at the rat with obvious trepidation. Then, sidling carefully around the strange beast, she seized a yellow chip from the floor, dashed to the door, inserted the chip in the slot, and leaped onto the experimenter's back, chattering loudly to be removed from the presence of so menacing a creature.

Bula's closest friend was one of the smaller chimpanzees, who relied heavily upon her for companionship and protection. During the first part of the experiment, Bula was working in the experimental room when her friend began to cry loudly in the living quarters. Bula dropped the task she had been assigned and refused to resume work. She stood by the door, straining at the handle and pleading to be let out. Weeks later, after she had learned the value of the yellow poker chips, Bula again heard her little friend calling from the home cage. This time she made no attempt to open the door but quickly found a yellow chip, put it in the slot by the door, and ran to the experimenter with her arms outstretched, waiting to be picked up and delivered to her lonely companion.

The Root of All Evil

It might have been anticipated that the introduction of money into chimpanzee society was bound to make trouble sooner or later. Perhaps it is too much to say that the profit motive could wreck ape economy. And as far as the scientific report goes, there is no absolute proof that the Yale Colony succumbed to an irreversible process of moral decay as a result of these experiments. Nevertheless, it is just as well that they came to an end when they did, for certain ominous trends were rapidly becoming apparent.

Despotism and cruelty are not unknown among man's nearest living relatives, but usually they take simple and straightforward forms such as wife-beating or commandeering of the food supply. New and subtle kinds of treachery are possible when wealth is involved.

When Bula and Bimba were living in the same cage, a large supply of white poker chips was offered to the two females. Bula promptly assumed ownership of nearly every one, and Bimba was left with a very small hoard. She protested vocally and with gestures, whining and holding out an empty hand. Like a rich man tossing a coin to a beggar, Bula impatiently selected one chip from her huge pile and dropped it negligently in Bimba's palm. When the vending machine was wheeled up to their cage, both animals rushed to spend their windfalls. Bula roughly shouldered Bimba away and took complete possession of the machine. The menu that day was slices of unpeeled oranges. Bula calmly bought and devoured one slice after another, and when Bimba started to complain, Bula handed her the peels!

Poor Bimba! Later, when she set up housekeeping with Velt, she found that she had jumped from the frying pan into the fire. Her new lord and master wouldn't permit her to pick up a single poker chip until he had carefully selected the ones *he* wanted. Then she was free to take the leavings; but they did her no good. As soon as the Chimp-O-Mat was available, Velt would use up his entire supply of chips and then turn to stare at Bimba. His glance was one that some human husbands would envy, for when he turned it on Bimba, she invariably dropped the few chips that she had been allowed to collect. Needless to say, Velt picked them up and, of course, spent them on himself!

Though he was a lion at home, Velt behaved more like a lamb when he was out with the boys. At first, when he and Moos were together, Velt picked up a few poker chips, but each time he did so, Moos came over and gently but firmly appropriated the prize. After a few such experiences, Velt just gave up. Making no protest, he simply stopped gathering chips while Moos was around. As far as he was concerned, they could stay right there on the floor until Moos was ready to collect them.

So What?

The stories of Trader, Moos, Bimba, Bula, and the others are amusing and appealing, but some readers may say, "So What? What is the value of such experimentation? What does it all mean, if anything?"

Actually, of course, scientists who study animal behavior are not in the least interested in the entertainment value of their experiments. To the psychologist these particular studies are worthy of thought because they show that monkeys and apes are capable of dealing with symbols. The psychological chasm between man and the rest of the animal world yawns widest at just this point. A great deal of human behavior is based upon—in fact, utterly dependent upon—symbolism.

The outstanding example is language. Words are written or spoken symbols representing things or events. They are also something more important. Words are the ground stuff, the indispensable raw material, of thought. Nearly all of our thought consists of language—implicit language that never reaches the tongue. When we "sit and think" we are actually talking to ourselves. Try to do it sometime without using words, and you will discover that even silent thought depends heavily upon language.

Now, as far as we have been able to determine, no other animal has a true language. To be sure, many species are capable of rudimentary communication, but not all communication necessitates symbolic language. For instance, the shrill trumpeting of one frightened elephant may send a whole herd stampeding in panic through the jungle. But this represents the contagious spread of a vague though powerful emotional state rather than the transfer of a specific thought or idea. No symbolism is involved.

Are all animals except man inherently incapable of symbolic behavior? Is this the reason for their lack of language, their relatively limited mental powers? Psychologists believe that man far excels any other animal in his capacity for dealing with symbols, but they are equally certain that at least the higher mammals can learn to use symbols in a limited way.

The classic "poker-chip experiments" with young chimpanzees are partially responsible for this conviction. Moos and his fellows did learn to respond to chips as symbols or temporary substitutes for food and other biologically useful rewards. To be sure, this is a rather elementary form of symbolic behavior, but the fact that it could be established at all is significant.

It is generally conceded that the human body is a product of long, slow evolutionary change. Experiments in symbolic behavior support the gradually growing conviction that the human mind is also an evolutionary product. Such studies in the field of animal psychology reveal to us the rudimentary and primitive beginnings from which our own mentality has sprung.

Consider

By Clyde Fisher

Honorary Curator, Department of Astronomy and the Hayden Planetarium, American Museum of Natural History

as told to

Henry Morton Robinson

LOOK up at the star-studded vault of the heavens on a clear, moonless night. The shimmering grandeur of the spectacle quickens one's sense of awe and dwarfs by comparison the designs —even the significance—of man. Few gazers will escape the overwhelming questions of plan and purpose that the stars suggest; still fewer will be unmoved by their celestial beauty.

How many stars are visible to the naked eye? Seemingly a million —but actually, since we can observe only half the sky at one time (the other half being on the farther side of the earth), and since there is always a haze near the horizon, 3500 is a liberal estimate of the number of *individual* stars that can be seen without optical aid.

The average stargazer will never have the opportunity to peer into the eyepiece of a giant telescope. But it isn't necessary; a good pair of field glasses can increase to 120,000 the number of stars any person of normal vision can see.

No astronomer has even been able to count the total number of stars. The 100-inch telescope at Mt. Wilson shows about 1500 million, but this is a mere handful of bright pebbles compared to the numberless sands of the sea. Even a "perfect" telescope could not disclose *all* the stars; first, because many of them are so remote that no instrument could detect them; second, because the interstellar space itself shines with a faint glow, through which no star of *lesser* brilliance can penetrate.

Because stars have been the guides and familiars of man the mariner, shepherd, and camel-driver for hundreds of centuries, the more conspicuous ones have names, beautiful names, given them by Greeks, Romans, and Arabs. Polaris, the North Star; Altair in the Flying Eagle; Arcturus in the Bear-Driver glow with poetic associations as well as stellar light. With a little practice and the aid of a star chart, these and hundreds of other stars can easily be located with the naked eye.

Among the star features that a keen eye can pick up are the magnitude and color of the better-known stars.

◂The Mt. Wilson Observatory has a 100-inch telescope. Palomar's will be 200 inches

Magnitude means "degree of brightness." Ptolemy, the Egyptian astronomer, divided the stars into six magnitudes. The faintest stars visible to the unaided eye are of the sixth magnitude, stars two and a half times brighter are of the fifth magnitude, and so on until we are dazzled by the brightness of the stars of the first magnitude, such as Sirius, Vega, Arcturus, Rigel, and Procyon.

The colors of stars, easily discernible to the naked eye, range through the whole chromatic scale. The sullen red of Betelgeuse, the flushed yellow of Mira, the sapphire hue of Vega, help us to identify these stars when we look for them in their various constellations.

Stars vary in color because they vary in temperature. Anyone who has watched a blacksmith heat a bar of iron knows that the iron first becomes a dull red, then yellow, then almost white as its temperature rises. Likewise, a dull red star like Aldebaran will be least hot—about 6000° Fahrenheit at the surface. Yellowish stars—Capella, for example—are twice as hot. The hottest stars in the sky are blue-white; Spica, a blue-white star in the constellation Virgo, has a surface temperature of 36,000° F.

To measure a star's temperature, the astronomer uses a bolometer—an electrical instrument which exposes a blackened platinum strip to the radiations of the stars, thereby recording with minute accuracy the heat of their exteriors. The thermocouple, another type of "astral

he Heavens

Since the days when the first astronomers tried to measure the sky, the universe has been expanding. Read of the breath-taking discoveries that modern telescopes have made possible, and then form your own philosophy about the mysteries of "outer space"

thermometer" used by the astronomer, is a tiny instrument placed at the main focus of a telescope.

As we gaze at the stars they all seem to be approximately the same size, and not even the most powerful telescope can make a star appear as anything larger than a pin point of light. But astronomers have discovered that stars vary greatly in size. Some can be measured by the interferometer, one of the most remarkable tools in the astronomer's kit. In 1920, Professor A. A. Michelson noted (as had many before him) that when he focused his telescope on a star, certain rings of alternating light and darkness, called "diffraction patterns," were seen around it. Michelson arranged two sets of mirrors in such an ingenious way on the diffraction pattern of the star Betelgeuse that he was able to observe the difference between the two sets of reflections. Using these differences as the basis of some rather complex mathematics, he worked out the diameter of the star as 270 million miles—a monster with a diameter 30,000 times greater than our earth. Yet Betelgeuse is a pygmy alongside the gigantic Alpha Herculis—a star so fantastically huge that if it were in the position of our sun, it would engulf the earth and extend out beyond the orbit of Mars.

Since many stars of comparable size probably scintillate in the heavens, one might think that the sky would be overcrowded and that a celestial traffic problem would arise. Not at all, for as one astronomer has remarked: "Set three wasps flying over Europe, and its skies would be more crowded with wasps than space is with stars!"

Yes, the theater of space in which the stars play their glittering parts is unthinkably vast. To obtain some idea of this vastness, suppose we map the distances between our earth and the nearer stars. The sun (which is a star at the center of our solar system) is a mere 93 million miles away. At the outermost ring of our solar system lies the planet Pluto, at a distance of four billion miles from the sun. Now comes a great gap—an abyss of space that practically isolates our solar system from the rest of the universe.

The first star that swims into our ken at the other side of this abyss is Alpha Centauri, at a distance of 25 million *million* miles. But Sirius is about twice as distant. Stellar distances are so great that astronomers do not use the earth-unit "mile" but measure the heavens in terms of the "light-year." Since light travels about eleven million miles a minute, a light-year is approximately six trillion miles. Light from the sun reaches us in eight minutes, but it takes over eight years to reach us from Sirius.

But these gleaming pin points of light form merely the foreground of the cosmic picture; astronomically speaking, they are very close to the earth. Behind them are millions of stars which we cannot see because they are too dim; only the celestial camera shows us they are there. Then, much farther away, we behold a great belt of faint, pearly light spanning the sky like a powdery arch. This is the Milky Way, formed by the combined light of millions of stars. Nearly all of these are too remote to be seen separately. With his primitive telescope Galileo discovered that it was composed of myriads of stars, but he had little notion of its size or relation to the universe. Today we know that the Milky Way is a vast "galaxy," or stellar system, consisting of some 100 billion stars plus enormous quantities of star dust, the embryonic material, so to speak, of stars yet unborn.

Sir James Jeans describes the Milky Way as the rim of a great cartwheel

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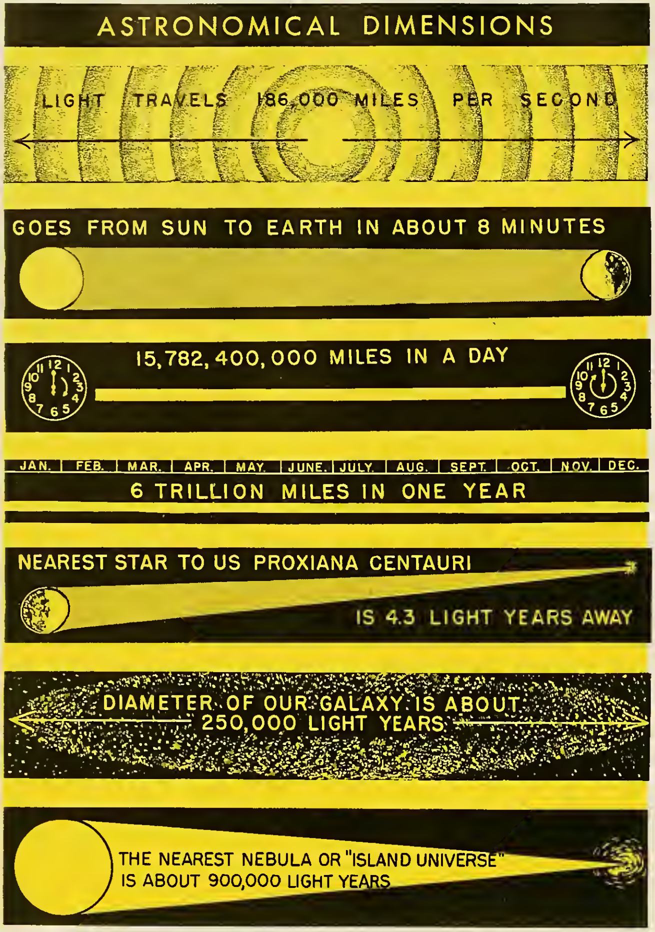
➤ GALILEO demonstrating his telescope. He discovered the moons of Jupiter



revolving around a central hub 50,000 light-years away from the earth. Our sun is one of the lesser stars of this system, located on a "spoke" of the great wheel about three-fifths away from the hub. In this galaxy (and there are at least 100 million others similar to it in the universe) our proudful earth is comparable to a speck of pollen floating over the Pacific Ocean.

But measurable distance still stretches out beyond the Milky Way! Aided by the telescope at Mt. Wilson, astronomers pick up the light of "globular clusters," bee-like swarms of stars so distant that their rays take 18,000 to 184,000 years to reach the earth. The star-beam that strikes the eye of the astronomer tonight from globular cluster M 13 in Hercules, for example, left its source about the time Neanderthal man appeared on our planet. Says Sir James Jeans: "Through the childhood, youth and age of countless generations of men, through long prehistoric ages, through the slow dawn of civilization and the whole span of time which history records, this light has traveled steadily on its course, covering 186,000 miles every second, and is only reaching us now."

If the remoteness of these globular clusters challenges the imagination, the still greater distances of the so-called "island universes" paralyze it. Far out in remote depths of space these "star clouds" rush at terrifying velocities toward the very rim of the universe. Professor Harlow Shapley of Harvard has demonstrated that light from Nebula M 87 takes 8 million years to reach us! At which point, the power of the human imagination (as well as the astronomer's telescope) halts for the present. Yet when the new 200-inch telescope atop Mt. Palomar in California is trained on the skies, the observable volume of space will be multiplied eight times!

A great deal of nonsense has been written about the nature of the new discoveries to be made with the 200-inch telescope. The misconceptions are based on a faulty understanding of the highly specialized purposes for which the Glass Giant was constructed. The 200-inch glass would be criminally wasted, for example, in gazing at the moon; instruments of moderate size (6 to 20 inches) are the most effective for such studies. To focus the Palomar telescope on a near-by planet would be like using the "Queen Mary" as a ferryboat across the Hudson River. The primary function of the new telescope is to gather light from unbelievably distant parts of the universe.

Astronomers expect that this powerful instrument will add vastly to our knowledge of outer space by penetrating celestial mysteries a billion light-years away. Among the problems it may solve is the enigma of "empty" space. Is the cosmos closed, finite in size, with definable boundaries? This belief is based on Einstein's theory that *space bends back upon itself*—somewhat like the curvature of the earth's surface. Or is it, as Eddington believes, an "Expanding Universe" filled with billions of galaxies like our own, continually racing from each other at incredible speeds into boundless savannahs of space?

Our present stars are still in a furious state of cosmic conflagration, an atomic chain reaction transforming their original material into heat, light, and electro-magnetic waves. For example, our sun (a tiny star) converts 4,200,000 tons of matter into energy every second. And it is this potential convertibility of "mass" into "energy"—daringly expressed by Einstein as a theoretical formula in 1905—that gave our physicists their first positive clue to the awful and unlimited power locked in the terrestial atom.

For a star is nothing more or less than a tremendous atomic pile perpetually in explosion. Under the bombardment of terrific heat at the center of the star, its atoms of gas are completely shattered. The debris of electrons and nuclei dashes about in chaotic disorder. Yet so terrific is the internal pressure at the core of the star that the shattered atoms are crushed together into masses of unparalleled density—a density so great that a cubic inch of their substance may weigh several tons. (Compared with these heavy atoms, our seemingly solid earth is composed of dandelion fluff.) In splitting the uranium atom, our nuclear physicists merely tapped on a tiny scale the energy-creating processes occurring constantly in the stars.

The astronomer can name many of the gases of which the stars are composed. This feat of cosmic interpretation is made possible by the spectroscope, an instrument that breaks up into a "rainbow" the light emanating from stellar bodies. Incandescent gases of these luminous worlds produce "visibility bands"—up-and-down streaks of color—which appear in various arrangements. Every element displays its own peculiar arrangement of these bands. Astronomers deduce the composition of the stars by comparing the rainbow markings of their spectra with the spectra of known metals and gases. About two-thirds of the 96 elements known in the earth have been discovered in the sun, and as many as 40 elements have been identified in some of the stars.

Until recently the astronomer was always pictured with his telescope, but today practically all astronomical observation is done by photography: the telescope has been turned into an astral camera. Stars too dim to be seen even with the aid of the largest lens can be recorded on sensitized photographic plates exposed for hours or for days. Again, changes in a crowded star field that might not be detected by the keenest human observer are spotted by the telescopic camera. An instance? Pluto, on the outermost ring of our solar system. By laborious mathematics Professor Percival Lowell calculated, around 1914, that Pluto *must* exist—but it took fifteen years and thousands of photographic plates to locate this wanderer of the skies.

Lick Observatory photo

▲ ONE of the nearest and brightest of the many thousands of extra-galactic nebulae: the spiral nebula in Andromeda

What, it will be asked, is the ultimate significance of the vast processes being worked out by the stars? Is there an intelligence operating behind the colossal panorama of which we can see only an infinitesimal part? Sir James Jeans, among others, inclines to believe there is. He suggests, in brief, that the universe is a magnificent and orderly system. The heat in the stars is being "stepped down" by radiation from higher to lower levels of energy, and he argues that the process must eventually end when all energy is reduced to its final low-tensioned form.

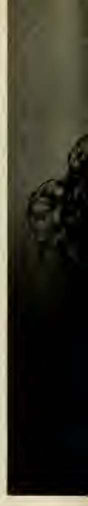
No one can conclusively deny his proposition that the stars came into existence only to burn themselves out. Indeed, the laws of thermodynamics bear him out. He states, in essence, that "God is a mathematician; the universe was not created for human beings at all."

Some may find deeper appeal in the philosophy of another astronomer, the beloved "Uncle" John Brashear, who asked that these words from a poem he had read in his youth be placed above the spot where he and his wife will rest for eternity:

"We loved the stars too fondly to be fearful of the night."

Under any interpretation, the fiery consummation of which Sir James Jeans speaks will take millions of centuries before it is completed. We have been given ample time, if we will but take it, to lift our eyes to study and marvel at the magnificent stellar bonfires blazing in the heavens.

◂ A WOMAN'S red silk hat from Tibet, the product of a people generally regarded as backward in terms of modern civilization but possessing an elaborate religion and a rich esthetic culture



How man, primitive and civilized, exercises his fancy in decorating his body, particularly

FROM THE NECK UP

By HARRY L. SHAPIRO

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All photographs by AMNH

THERE are living in the world today thousands of groups, tribes, populations, and nations. And among all this assemblage, it would be difficult to enumerate a dozen different groups completely content to leave their bodies as nature made them, unadorned, undecorated, and unmarked.

This passion for embellishment ignores climate, comfort, pain, or inconvenience. The dwellers in the tropics who have reduced clothing to a minimum or have discarded it altogether, scarify their flesh to produce keloid or scar tissue in patterns of bas-relief, pierce their noses to carry ornaments or other objects of virtu, elongate their necks with coils of brass, stretch their lips around huge discs, and in various other ways find means of decorating or mutilating their bodies. Inhabitants of cooler climates who find clothing a necessity also make an adornment of it, often obscuring its basic function under a mass of decorative and tortured detail.

While much of this artificial enhancement of the person is relatively of little or no inconvenience and in the case of clothing often of distinct value to the organism, men and women will endure for the sake of it incredible agony, torture, and discomfort. The comparatively mild distress of corset wearing pales before the pain of Chinese foot-binding, head deformation among the Aymara of South America, the tooth evulsion of some African tribes, and the subincisional surgery of Australian aborigines.

In fact, so universal is this urge to improve on nature that one is almost tempted to regard it as an instinct. Aside from such fundamental drives as those for food, love, security, and the expression of maternal solicitude, I can think of few forms of human behavior that are more common to mankind as a whole. Perhaps it is precisely because part of its motivation is involved with sexual attraction that this impulse to draw attention to

A preview of a special, temporary exhibit at the American Museum prepared by

KATHARINE BENEKER

Supervisor of Special Exhibition Department of Education

the body finds an outlet among the civilized sophisticate equally with the untutored savage.

But whatever the final cause that induces mankind to adorn itself, the immediate reasons are often removed from sex and in some cases seem to have little or nothing to do with it. The caste mark on the

▲ An extreme in modern American sophistication is expressed by this black felt hat with blue feathers, designed by John Frederics and set off with jewels by Cartier

▲ Contrasts in facial decoration. (*Top left*) A Tsimshian Indian with green face paint and copper appliqué ornaments representing the raven. (*Top right*) Charoti Indian, South America. (*Center*) Modern theatrical make-up, by Del Russo of Prince Matchabelli. (*Bottom left*) Arunta man of Australia, with face covered with feathers and blood as part of ceremonial ritual. (*Bottom right*) Mask-like effect of face paint in New Guinea employed on ceremonial occasions

▲ Type of headdress worn three centuries ago by the Indians of New York State and New England: Iroquois roached headdress of dyed deer hair, with face paint, crescent earrings, and bear-claw necklace forehead of the Indian may indicate eligibility for marriage or the reverse, but it seems more likely that it simply represents a form of labeling quite common in various parts of the world and comparable to tribal markings and status costumes quite general in distribution. The headdresses and regalia of the New Guinea native, elaborate and spectacular as they are, are sometimes displayed only before members of the same sex or form part of a ritual involving tribal or group welfare.

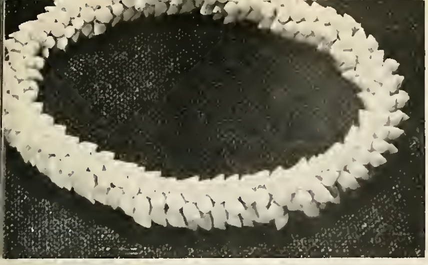
Other markings, amulets, or ornaments are talismans for good luck. The tattooing of some tribes is associated with tribal life or may represent stages in the individual's progress through various age or ceremonial groups. A large number of examples may be cited of decorations that have become so traditional that a member of a group possessing one would feel awkward and outcast without it. Thus the human body becomes a medium for the display of symbol, for the support of ritual, for the expression of traditionalism. It is decorated or mutilated for sexual enhancement, it may be modified for hygienic reasons, and no doubt the psychoanalyst could find even the *id* lurking in some manifestations of this preoccupation with the body. Perhaps modern man's refusal to accept his beard is indicative of a deep-seated longing for his childhood and a reluctance to enter upon the maturity of which it is symbolic.

▲ BRIGHT FEATHERS and iridescent wings of beetles comprise this ear ornament from the Jivaro Indians of Ecuador

▲ EAR AND LIP ORNAMENTS as worn in the Faradje District of the Congo, Africa, illustrating the extensive piercing of lips and ears. The decorations along the edge of the ear are animal teeth

➤ A SILVER EARRING worn by the Yakuts of northeastern Siberia

◀ A TLINGIT INDIAN earring, probably a simulated shark's tooth, from southeastern Alaska



▲ A NECKLACE of shells from Samoa

▲ A LEATHER NECK AMULET, or grigri, from the Mossi District, French West Africa

▲ DISCS of abalone shell decorate this red flannel dance hat of the Tlingit Indians, worn for any ceremonial occasion. The ear pendant was attached to the ear lobe or to a ring for festival occasions. The nose pendant is also mother-of-pearl

◄ A BONE NECKLACE from the Fiji Islands, which exemplifies the elegance of simplicity

▲ A MARQUESAS CROWN. The shell and tortoise shell are true to the aboriginal style; the commercial buttons, introduced by early voyagers and whalers, replaced native decorative elements

▲ A QUILTED RED taffeta sun hat inspired by a Tibetan woman's sunshade in the American Museum's collection. By Sally Victor

◄ A MUSICIAN'S CAP, from Tibet

Courtesy of Abercrombie and Fitch

▲ POLAROID SUNGLASSES protect the eyes of the ultra-modern vacationer

▲ A SWAN'S-DOWN HEADDRESS decorated with eagle and magpie feathers, with a mask representing an eagle, worn by the Tlingit Indian medicine man in a dance to bring good fortune

➤ FOX-SKIN CAP with eyeshade of embroidered sealskin, from the Angmagssalik Eskimos of East Greenland

▲ PRIMITIVE BUT EFFECTIVE SNOW GOGGLES with a narrow open slit protect the Eskimo hunter from snow blindness

There are two principal methods of altering the body to improve upon nature. One is permanent, the other temporary. Each has its advantages and disadvantages. In the former are included tattooing, scarification, head deformation, piercing and enlargement of lips, nose and ears, foot-binding, tooth evulsion or filing, the amputation of fingers, and various deformations and mutilations of the sex organs. Designs or modifications of this kind need no refurbishing to retain their artificial form. The elegant designs that covered the Marquesans from head to foot in highly complex and delicate patterns and entranced the early voyagers would have been too laborious to apply for anything but rare and special occasions if they were impermanent. By tattooing them, however, a lengthy and painful series of operations furnished an individual with a superb and ineradicable decoration requiring no further attention but also admitting no change. The flattened head of a Northwest Coast Indian might delight him as a mark of prestige, but it would permit no afterthought.

The temporary forms of bodily decoration embrace an enormous range and have the advantage of allowing for change. Body and face painting, ornaments, headdress, the vast array of jewelry, flowers, hats, clothing, and shoes can be put on or taken off according to the desire of their possessors. They require attention, and if valuable they represent wealth liable to loss or theft. They entail, as in the coiffure of Japanese or in the make-up of European and American women, tedious hours of grooming, but they allow for change and variety.

▲ Double spiral hairdress of a Bangba man on the Aruwimi River, in the Belgian Congo

▲ Many of the fanciest decorative effects in primitive groups are evolved by the men. An unusual beard esteemed by a tribe in the Congo

▲ Hair-do extroadinaire: an Abarambo woman of Mangalu Poko, in the Congo

▲ Intricate decorative elements fashioned of metal and kingfisher feathers adorn this bride's hat from China

▲ HAIRDRESS worn by the unmarried girls among the Hopi Indians of Arizona

▲ A HEADBAND that on first glance might be either primitive or civilized. By John Fredericks

▲ INSPIRED by a South American Indian feather headband in the American Museum's collections: a modern red felt skull cap with a brim of brown and white feathers. By Sally Victor

▲ MODERN VERSION of the Plains Indian war bonnet. Originally worn only by warriors who had achieved distinction in battle, it has now been adopted by many tribes beyond the plains

To list the materials and objects that men and women have found decorative or useful in creating personal adornments would require a great deal of space. They include such classifications as stones, bones, ivory, teeth, feathers, furs, hair, grasses, flowers, plants, fibers, insects, animals, birds, fishes, metals, plastics, ceramics, wood, beans, seeds, and shells. And they range from simple objects used as they are to the results of the most complicated technologies. They represent the crudest forms of adaptation as well as the most elaborate esthetic developments, in some instances approaching the status of fine art.

All these adjuncts to and modifications of the human body are not necessarily meant to be esthetic. Many are, as I have already mentioned, either utilitarian or symbolic and ritualistic. But the creative spirit of man tends to endow even these with some aspect of decoration, or by their very nature they take on a decorative quality. This brings me to the necessity of stressing that the standards of what is beautiful are shifting and ephemeral. Those of us who find the adornments of uncivilized men barbaric, bizarre, or unlovely should remember that nothing appears more ludicrous, exaggerated, or exotic than our own styles of "only yesterday," when time has not yet rescued them from abandonment and refurbished them in the cycle of taste and fashion.

The photographs shown on these pages are drawn from a temporary exhibit in the American Museum, designed to illustrate the human fancy expressing itself on a part of the body—from the neck up. Even within this limited region the variety and ingenuity displayed is astonishing, but it represents only a fraction of the ways with which man has dealt with his body for purposes of adornment, symbol, distinction, prestige, utility, and sex. Apparently all men are brothers on the skin.

◄ A BLUE TURBAN with red tapestry trim, inspired by a Chinese turban from northern Yunnan. By Sally Victor

▼ HEADGEAR WORN by the principal wife of a Mayogo chief, in the northern Ituri District in equatorial Africa: a bristling circlet of dog's teeth, surmounted by a basketry cap adorned with feathers and bone hairpins

▲ BASKETRY HAT decorated with boar's tusks, worn by the Bontok Igorot warrior, Northern Luzon, Philippine Islands

▲ HEADGEAR worn by the Azandi, Niangara, Congo, Africa. Basketry base decorated with feathers

◀ FUR AND SILK HAT from Mongolia

▶ RATTAN HAT from the Ilokano tribe, Northern Luzon, Philippine Islands

Tomato Worm INVADED

By Clark Champie

Photos by the author

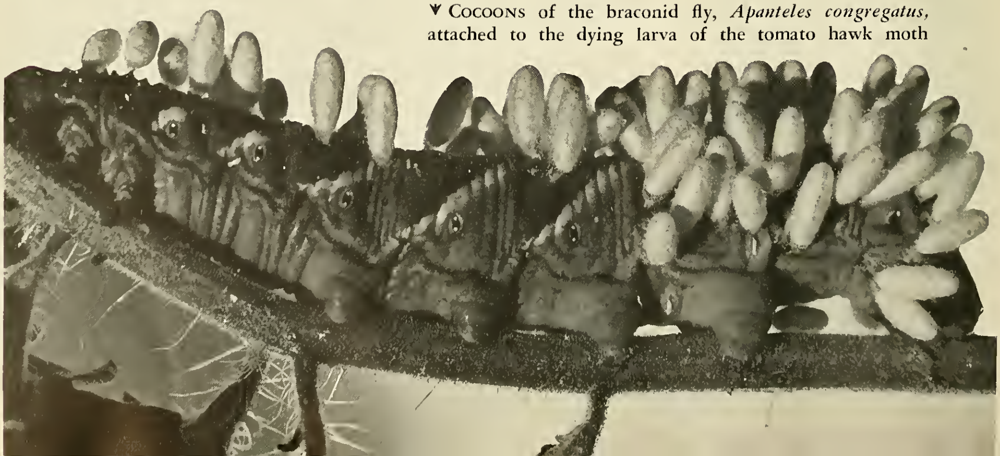
▲ Healthy tomato worm, showing mouth parts and adjacent legs

ALTHOUGH many persons may never have seen a tomato worm covered with cocoons like the one shown below, I am told that this is a relatively common sight and that sometimes most of the tomato worms in a garden are destroyed in this way. The tomato or tobacco worm is the larva of the sphinx moth, so-called because when disturbed, it habitually assumes the rigid position of a sphinx. Close examination of the head in the upper photograph will show the mouth parts and also the legs used to hold the food.

The cocoons are those of a Braconid fly, a parasitic insect belonging to the same order as the ants, wasps, and bees. This wasp is equipped with a long, specialized organ for depositing eggs under the skin of caterpillars. After having perhaps flown around for days hunting for a suitable host, the wasp attacked this tomato worm and with its sharp ovipositor punctured the worm's skin in successive places and deposited its eggs. The eggs hatched in a day or so, and the grubs lived off the fat cells and blood of the caterpillar for about two weeks. Just before the end of this time, they developed cutting jaws and a silk gland on their lower lips. Then, all at approximately the same time, the larvae cut their way through the skin of the caterpillar and emerged halfway. At this point, they started to spin their cocoons. When the cocoons were well outlined and secured to the back of the host, the larvae emerged the rest of the way to complete them.

By this time, the caterpillar is very sluggish. It has stopped feeding, but it usually remains alive until about the time when the adult braconids emerge from the cocoons. Thus a generation of braconids is raised at the expense of the more or less harmful tomato worm.

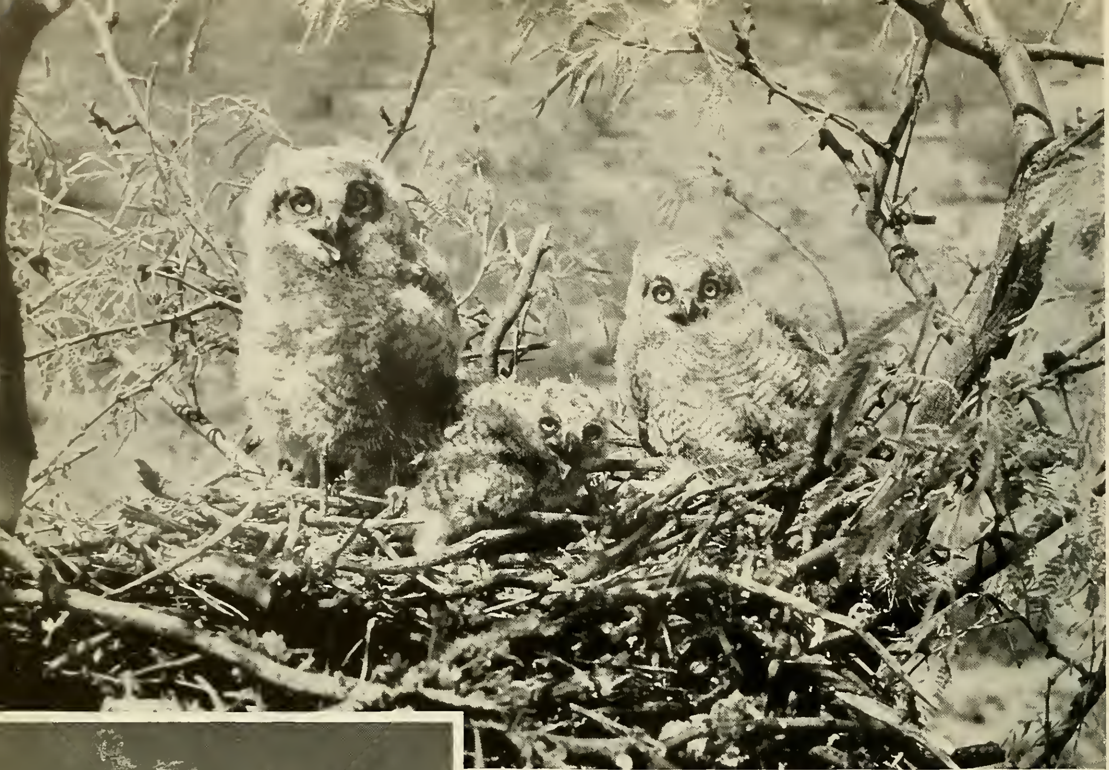
▼ Cocoons of the braconid fly, *Apanteles congregatus*, attached to the dying larva of the tomato hawk moth



The TARSIER'S Place IN THE Family Tree

N. Y. Zoological Society photo

▲ THIS PHOTOGRAPH by Lilo Hess portrays an unusual and interesting animal which occupies a significant place near the foot of the primate family tree. Surviving from a time before there were any monkeys in the world, it leads a nocturnal life in the forests of the Philippines and adjacent islands, sleeping during the day and feeding at night on insects and lizards, which it apparently captures by making tremendous leaps. Its eyes are enormously large for night vision, and its fingers have disc-like adhesive surfaces. Special muscles in its ears enable it to reef them like a sail



▲ THE TRIPLETS in the mesquite nest were always belligerent. "Shorty," in the center, was an emaciated victim of brute strength; at mealtimes, his brothers appropriated the lion's share. But he almost caught up with them

▲ PHOTOGRAPHING the owls in their nest nearly cost one of the observers a broken neck. Neither the owls nor the tree supporting them invited undue familiarity

Trailing DESERT OWLS

IF the pursuit of owls has ever taken hold of you, you may not be surprised that we traveled more than 600 miles over the heat-bitten Arizona desert or that one of us came close to breaking his neck just to watch two families of owls grow up. Marvin Frost and I are old hands at that sort of thing, whether it involves owls, rattlesnakes, bears, or anything else that walks, flies, or swims. Frost is a good outdoor photographer and is addicted to wilderness exploration, and I, too, acquired long ago the habit of spending my time in the open, looking for wildlife adventure. We are always happier outdoors than in, regardless of cricks in the back, time, distance, or the weather.

We located our first owl's nest of the year early on an April day, while journeying along a sandy excuse for a road down near the Mexican border. A good many miles had rolled beneath us before we found anything deserving our undivided attention. Then, far off across the open country, we saw an isolated mesquite tree standing high above the plain. In the upper branches was a dark mass that suggested a nest of some sort. We headed the car straight toward it, avoiding round-tailed ground squir-

▲ THE YUCCA TWINS at home. Like the other Great Horned Owls, these youngsters were uncompromising in defending their sheltered platform and threatened a battle whenever disturbed

Adventures in pursuit of the Great Horned Owl in remote sections of Arizona—a pugnacious bird that means business when he plays hard to get

By WILLIAM H. CARR, *Photographs by* MARVIN H. FROST

▲ THE GIANT YUCCA PLANT that housed the birds above. In this open country, the wide desert swept toward mountains in one direction and toward infinity in the other

rel mounds and the larger cactus plants with their ever-ready spines.

Some 20 feet overhead, was a good-sized nest composed of several bushels of sticks and twigs. While we were doing an Alphonse and Gaston act over who should climb the rough-barked tree, a large, brownish form suddenly hurtled from the platform above and shot straight at us. A few feet away, it turned and sped off over the desert to perch in a stunted shrub about 100 yards distant. The enraged Great Horned Owl had changed its intention to dive-bomb us at the last instant of attack. Frost and I looked at each other somewhat shaken.

There is something about owls that has always lured us. It is a combination of their unfailing courage, their marvelous adaptation to environment, and the fact that these birds of the night have ways that baffle us.

I was the first up the tree, and in a moment I was gazing into the faces of three comical, fuzzy, white infants that glared unwaveringly at me. They focused those yellow eyes on my face and swiveled their necks this way and that to follow every move. The merciless sun beat full upon them, and their mouths

➤ WHEN FIRST OBSERVED, the owls in the mesquite tree were little more than a handful, but thereafter they were never too small to protest vigorously when handled

were open, but they seemed ready for action if I was. The nest itself had doubtless been constructed by some other large birds, possibly a pair of Red-tailed Hawks. Our Great Horned Owls are adept at appropriating the home sites of others.

From the precarious spot, I could view sharp-peaked mountains at least 40 miles away. Owls can see very well in the daytime, too, and there is no doubt that the old bird sighted our approaching car long before it reached the home tree. Nevertheless, she had continued to shield her offspring from the sun until we were right beneath her.

We had located several nests in previous years, but this was our first experience with one that contained as many as three young.

Frost climbed up to see the birds and to lower two of them in his shirt so we could snap their pictures. During this operation, the young ones did their best to sink their small talons into his fingers, but they were unable to do any damage just then. Meanwhile, the mother left her perch and sailed out of sight down an arroyo. We photographed the protesting infants as quickly as possible, returned them to the nest, and left the area. Even though the nest was more than 50 miles from home, we were determined to return every week until the birds flew away.

Before we were half a mile away, the large bird, nearly two feet in length, reappeared and alighted in the lower branches of the mesquite before venturing into the nest. She certainly wasted no time after our departure.

◄ WITH NEEDLE-POINTED TALONS set for action, Charlie defies the camera man. His sharp weapons were capable of inflicting deep wounds

A few miles farther on, Frost sighted one of the most massive yucca plants either of us had ever seen. Like the mesquite, this tall growth stood out as a landmark, visible from all sides. Binoculars revealed a suspicious bundle of sticks in the crotch of the plant where three large arms forked skyward. Once again we turned our car and headed across the desert.

This time, before the car stopped, a big owl set sail from the depths of the yucca and perched in full view upon a much lower plant near by. We got out immediately, and Frost, with camera ready, stalked the bird as carefully as he could. As he drew near, the owl coaxed him farther and farther from the nest.

To make things a bit more difficult for the disturbed bird, a pair of diminutive sparrow hawks arrived and proceeded to heckle her as she stared at Frost. I watched the attack with glasses as the irate hawks dived and dived again, actually striking the owl several times though she ducked to avoid them. When they flew off, several smaller birds arrived to pester the owl further, flying at its head and scolding with vigor and complete lack of fear. The Great Horned Owl obviously lacked friends and allies in the desert. No doubt its nighttime maraudings had something to do with this. Scattered on the ground beneath the nest were the remains of smaller birds, indicating that the diet of the growing young had included a number of unfortunate feathered neighbors. There were also traces of defunct rabbits. But, as Frost put it, the owls have to eat. In this world someone is always taking advantage of someone else in one way or another. We aren't all vegetarians!

The stout yucca repels all human invaders, sheathed as it is with bundles of long, sharp-edged leaves that surround the trunk from the base upward. We could not climb it without being cut to ribbons, so we placed the car where we could stand on the roof and peer into the dark center of the nest. Here we found two young owls that were farther advanced than their cousins in the mesquite. They were twice the size and unhesitatingly aggressive. Their every action and attitude seemed to suggest, "Lay one finger on me, brother, and I'll make you wish you hadn't!" They snapped their beaks like miniature castanets and occasionally uttered a sharp hiss just to demonstrate their fierceness. When we approached closely, the embattled nestlings threw themselves backward and shot their feet forward, preparing to sink those sharp-pointed talons into an incautious hand.

We wanted to photograph these growing owls, too, and I succeeded in lowering one without getting pierced. But later I was not so fortunate. When the picture had been taken, I gathered up the struggling youngster, and he instantly took advantage of a slight opening. His stiletto-tipped claws caught my thumb in an iron grasp, went through the flesh, and held on. Frost had to use care in prying the talons apart, and it took about three minutes to free me. We decided to obtain a pair of heavy gloves for the next visit. The sturdy little owl was finally returned to the nest without further casualties, and we departed.

Both nest sites were faithfully revisited as the weeks went by. Each time one or more of the young were temporarily removed to secure pictures of their growth. Their

➤ **Charlie did his best to intimidate his observers by spreading his wings and fluffing his feathers, which added several inches to his stature. And his anger was no bluff** deportment did not improve as April passed into May. They never failed to greet us in the same uncompromising manner, and the larger they became the more difficult it was to handle them without getting stabbed. Once the parent owl stood her ground above the nest even when we were practically on top of her. It was a windy day, with the sand blowing across the open desert, biting our faces and hands. Long feather tufts on either side of the adult owl's head streamed outward in the gale.

The buffeted bird anchored herself to a horizontal stick that had somehow become wedged between two upright yucca arms above the nest. The wind shook her body, but she kept her place and looked straight at us. Frost secured a photograph before the bird decided to vacate. She took a dive at us when we least expected it and missed us by only a foot. Then she flew to a near-by perch, where she swayed back and forth and scolded us with a series of strange, low-pitched hoots. The blast of air was so powerful that we decided not to disturb the young birds that day. The shelter of the car was welcome, for a steady, pounding, desert wind does not soothe the nerves.

We visited a ranch house that afternoon and toward evening started for home. The gale had now abated. When we drew near the owl's nest in the mesquite tree, we heard a full-throated coyote chorus drifting over the desert and stopped to listen as the shrill, weird voices rose and fell and trembled. The sky rapidly grew darker, and I aimed my 27-power telescope at the distant owl's nest to see what owls did at that time of day. Silhouetted against a golden sunset, a parent owl fluffed her feathers and peered about in the gathering gloom. Then, as I looked more closely, I detected additional movement and was surprised to see another large owl on the edge of the nest, dwarfing the three infants beneath. Both parents were at home and were surveying the landscape before starting out on their nightly search for food.

After an extended contemplation of the surroundings, the mother bird soared away, moving along with a comparatively slow, flapping motion. She circled the desert and then set her pinions and glided for quite a distance. All at once she dived earthward and vanished behind a big clump of prickly pear. Presently the other bird joined her, and together they flew off into the night; and the coyotes, having concluded their concert, went off on hunting expeditions of their own.

Several days later we returned to the mesquite tree to learn that the young ones were exceedingly well fed and had lost their downy, natal covering. Now they were dressed in the soft, blending browns, yellows, and grays of the adults. They had increased in size and were crowding the nest. We were anxious to secure a picture of the triplets at home, and it proved to be anything but a simple task. It was absolutely impossible to obtain photographs by standing in a crotch beneath the nest, because our eyes were barely on a level with the stick platform. To include the whole scene in a picture, we would have to move farther back, where there were no other limbs to support us.

Lacking a helicopter, the only practical procedure was to set up a ladder above and away from the nest. On our next trip we brought three short sections of ladder that we could lash together to form a camera base and a perch for the operator. We raised our makeshift affair, but to get it anywhere near the nest, the wiry, thorny branches had to be trimmed considerably. Scratched and bleeding, I finally climbed the shaky, ill-fastened contraption to tie the uprights to some branches, for when Frost took his pictures, he would have to stand on the very top rungs. I looped the rope above me and gave a powerful tug. In an instant the line slipped through my hands. I lost my footing and flew through the

▼ THIS OWL ARGUMENT was a draw. Whether in the nest or on the ground, the mesquite owls never hesitated to debate with expressive gestures

air—but not like an owl! On the way down, I encountered one of the guy ropes below, and this helped to break my fall. Then I struck the hard desert floor, flat on my back. For a few moments I had a splendid view of the deep blue sky through the green branches of the mesquite. Frost, who was perched in another part of the tree at the time, said it took me so long to come down that he had almost completed plans for getting me to the hospital before I landed!

I recovered very quickly, but my neck had a remarkable twist for days thereafter. We went back to work and soon had the desired pictures. Meanwhile, the smallest owl, "Shorty," stood upon the nest edge and watched everything, no doubt hoping for the worst to happen, if owls are capable of hoping. But we fooled him. Shorty was the least developed of the three young owls, and we had named him on our very first visit. He was so small that we wondered at the time whether he would survive. We even considered taking him home to feed and care for him. Most of the food brought to the nest seemed to be grabbed by the much larger birds. But he managed somehow, and toward the end he almost caught up with his brothers or sisters. He was now the most active of the group and was usually the first to give us the equivalent of a "Bronx cheer" whenever we arrived.

▲ CHARLIE faces the full desert sun—and the camera—with unblinking eyes. We rarely saw him with his beak closed. Charlie always had the last word

Of this particular family, "Charlie" was the largest. He was a decidedly self-sufficient young owl. As he grew up, he ruled the roost when the older birds were away by shoving the others about and, from a human point of view, exhibiting very bad behavior generally. He waged an increasingly strenuous battle whenever we reached for him and once flopped out of the nest altogether. He landed, very much startled, on a lower branch, where he quickly collected himself and resumed his usual glaring and offensive operations. We had real difficulty returning him to the other owls, for he seemed determined to leave the county altogether. We compromised by encouraging him to sit upon a limb that projected from the home platform, and there we left him, to the familiar accompaniment of beak snappings and hisses.

Charlie was on deck the next week, but we concluded it would be simpler to photograph one of the other owls rather than endure the usual struggle. However, when we climbed the mesquite and peered over the nest edge, Charlie gave a leap into space and took off for a near-by tree. He lacked the masterly flight of his elders, overshot his mark, and came to grief upon the ground. We quickly followed and caught him before he could regain his wits after the abrupt landing. For a time, he lay upon his back with talons wide open and thrust upward, ready for any eventuality. Finally, he got to his feet and resorted to different tactics. This time he spread his wings in a successful attempt to appear at least twice the size nature intended for him. He lowered his head and, with eyes wide open, faced us in the unmistakable pose of a fierce, unconquered foe, warning that if we approached, it would be at our own peril. Charlie had plenty of courage, but, after all, he was only a little owl. We picked him up and moved him to another location, where the background was better for photography. Then we took his picture and somehow returned him to the nest.

That was the last we ever saw of Charlie, for the next time we came an empty nest faced a burning sky. The owl family in the yucca had vanished several weeks earlier. Five newly-released young birds had joined the hunting fraternity, cruising on silent wings through the long black shadows of desert nights.

Do You Know Group Names?

By Mabel Irene Huggins

No one would say a *"flock of cattle"* or a *"litter of larks."* Are you just as familiar with the proper use of other group names as you are with these?

Write the correct word in each of the blanks in the five groups below. Then turn to page 476 to find your score.

A

1.	a........................of	goats	*(bevy)*
2.	twenty..............of	yearlings	*(gam)*
3.	a........................of	quail	*(flock)*
4.	a........................of	whales	*(head)*

B

5.	a........................of	partridges	*(litter)*
6.	a........................of	buffaloes	*(brood)*
7.	a........................of	martins	*(herd)*
8.	a........................of	woodchucks	*(covey)*

C

9.	a........................of	gnats	*(team)*
10.	a........................of	horses	*(swarm)*
11.	a........................of	seals	*(hatch)*
12.	a........................of	chicks	*(pod)*

D

13.	a........................of	geese (flying)	*(colony)*
14.	a........................of	swine	*(span)*
15.	a........................of	ants	*(drove)*
16.	a........................of	mules	*(skein)*

E

17.	a........................of	dogs	*(yoke)*
18.	a........................of	robin eggs	*(brace)*
19.	a........................of	shrimps	*(clutch)*
20.	five....................of	oxen	*(school)*

Turn to page 476 for the correct answers

BOOKS *Continued from page 439*

you know, for instance, that goldfish are but highly inbred albino strains of the ordinary carp, *Carassius auratus*? Or that among the larger enemies of pond goldfish the leading ones are the cat, rat, snake, and small boy?

However, it is in the second half of the book that is found an almost perfect fusion of beauty and knowledge. Here readers of Natural History Magazine should feel right at home as they enjoy page upon page of striking photographic reproductions of water lilies and outdoor pools, many in full color. A pool will improve almost any garden, and for the flower lover with a backyard too small for a garden, or where precipitation is inadequate, the lily pool offers a very satisfying substitute.

Mr. Innes mentions that Oriental goldfish may first have been introduced into Europe in the eighteenth century, as a gift to Mme. de Pompadour, but the great German ichthyologist Bloch (a contemporary of de Pompadour) fixed the time as approximately A.D. 1400 and England as the place. Bloch's date is generally accepted.

In these days when well-constructed and inexpensive commercial tanks can be bought in abundance, the author might well delete from future editions all instructions on homemade aquaria. They are hazardous at best.

W. Otis Fitchett.

Apache land

- - - - - - - - - by Ross Santee

Charles Scribner's Sons, \$3.50
216 pp., 98 illusts.

In this rambling, leisurely, and altogether pleasant book, Mr. Santee has done a first-rate job of depicting the Apache Indian country as it was at the close of the frontier era. The action centers around Globe, Arizona, and the San Carlos Reservation during the rough-and-ready days of the late nineteenth century.

Through a series of deft characterizations of actual individuals, supplemented by the author's free and vigorous ink drawings, the people and events of that turbulent period are expertly portrayed. Some of the characters figured importantly in southwestern history—Geronimo, the cruelest of the renegades, Cochise, the honorable chieftain, and Apache Kid, who raided from Arizona to old Mexico and terrorized Indian and white man alike. Other colorful figures—of no historical consequence but of considerable human interest—are Al Sieber, the Yankee scout, Ole Indian Jim, the friendly Apache cow hand, and Burro Frenchy, the prospector who escaped the marauding Indians by convincing them that he was insane.

Although no attempt is made to describe the customs and beliefs of the Apaches in any systematic way, the various anecdotes contain interesting material on the nature of Indian-white contacts during the early days of the Reservation Period. While some of these relationships were amiable, and a few even friendly, most were bitterly hostile. The ill-treatment of the Indian by the white man is an old story. It is a wonder, however, that any Apaches were able to survive the incredible vindictiveness of the soldiers and cattle men and the bungling of the early Indian agents.

Today, the soldiers, prospectors, scouts, and stage drivers are all gone, but not the Apaches. The Indians are on the increase, and many have now become successful ranchers. This section of the West is still Apache territory.

Harry Tschopik, Jr.

Adventures in man's FIRST PLASTIC: The Romance of Natural Waxes

- - - - - - by Nelson S. Knaggs

Reinhold Publishing Corporation, \$6.75
329 pp., 91 illusts.

Undoubtedly, many persons will be surprised, as I was, to find that an entire book has been written about waxes. We seldom give these substances a thought, although, as is amply shown in this book, wax and other natural plastic materials have played an important role in the history of civilization. And today, more than ever before, they are essential raw materials which enter in one way or another into nearly all of our industrial processes and products.

Mr. Knaggs is a chemist who is apparently normally occupied in the technical study of waxes, but *Adventures in Man's First Plastic* is in a purely popular vein—part travel and part history, with a flavoring of more technical information. He gives several accounts of trips he made to Brazil and to Mexico during World War II in search of new wax-bearing plants and for the study of the methods of production of other waxes. There is a long chapter on "Wax Through the Ages," in which he discusses such things as the lost wax process of casting metals, the use of wax by the Egyptians, and its use in candles, in painting, in sculpture, and in many other processes. He describes the various sources of wax—trees, insects, whale oil, and petroleum. He also tells about a wax known as ozocerite, which is mined in the earth much as coal or metallic ores are mined.

In a book of this kind the author has necessarily had to stray into the fields of general anthropology and biology, and in so doing he has occasionally made some misstatements and errors. These do not detract seriously, however, from an interestingly written, profusely illustrated, and highly informative book in a field that has not previously been explored.

Gordon F. Ekholm.

Trinidad Village

- - - - - - - - - by Melville J. and Frances S. Herskovits

Alfred A. Knopf, $4.75
351 pp., 5 illusts.

THE Negro in the Western Hemisphere constitutes a significant fraction of the population and bears a culture distinctively his own, if no longer purely African. Either of these facts would be ample reason for lending importance to the study of the Negro in the New World. Both of them make it imperative. No one, perhaps, has recognized this more acutely than Melville and Frances Herskovitz, who together have devoted much of their field work and professional writing to an understanding of the cultural patterns of the Negro, both in Africa and America. With *Trinidad Village* they have added still another meritorious and sympathetic study to an already distinguished list.

The Herskovits' in this book are concerned with two aspects of Negro culture in America. They have sought and have succeeded in presenting a warm and intuitive picture of a specific Negro group—Toco, a protestant and English speaking village on the island of Trinidad in the Caribbean. The major facets—and many of the minor ones—of life as the natives of Toco live it are described with sufficient detail to endow this description of a remote community with immediacy.

But beyond this aim stands another: to explain why Toco life has the character it does. Many institutions that flourished among the ancestors of these New World Negroes have not withstood the Middle Passage. Certain aspects of African life, however, have survived in this group in almost pristine vigor; others merely reflect African origins. Again, only some features of Western culture have been adopted by the villagers of Toco, while others have been rejected or modified almost beyond recognition. These are the underlying processes of acculturation and offer, in the case of Toco, material for an attempt to arrive at the general laws that govern them. The authors have much of value to offer in attempting such a theoretical explanation of the life of Toco.

HARRY L. SHAPIRO.

Answers to Quiz on Page 474

SCORE: *20: Perfect*

18-19: Excellent *15-17: Good*
12-14: Fair *Below 12: Poor*

A

1. a ***flock*** of goats
2. twenty ***head*** of yearlings
3. a ***bevy*** of quail
4. a ***gam*** of whales

B

5. a ***covey*** of partridges
6. a ***herd*** of buffaloes
7. a ***brood*** of martins
8. a ***litter*** of woodchucks

C

9. a ***swarm*** of gnats
10. a ***team*** of horses
11. a ***pod*** of seals
12. a ***hatch*** of chicks

D

13. a ***skein*** of geese (flying)
14. a ***drove*** of swine
15. a ***colony*** of ants
16. a ***span*** of mules

E

17. a ***brace*** of dogs
18. a ***clutch*** of robin eggs
19. a ***school*** of shrimps
20. five ***yoke*** of oxen

Insects in the House

SPRINGTAILS and SNOWFLEAS

By C. H. CURRAN

Curator, Department of Insects and Spiders, American Museum of Natural History

IT is seldom that insects indicate that something is wrong in a building, but Springtails do just this. Their presence is a sign that the building should be examined and excess moisture eliminated.

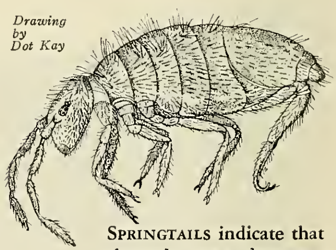
Springtails and snowfleas are small, wingless insects, and most of them inhabit damp places, feeding upon lichens, decaying vegetation, and tiny plants or animals. They derive their name from the fact that the end of their abdomen is in most cases modified into a tapering organ that enables them to leap into the air. When the insect is disturbed or wishes to leap for other reasons, the tail is curved forward under the body and snapped sharply against the surface upon which it rests. The insect is hurtled into the air and, having no control over the position of the body during its "flight," may hit the ground in any conceivable position. But it quickly regains its footing and, unless again disturbed, may crawl leisurely away. The snowfleas receive their name because they often occur in extraordinarily large numbers on melting snow.

Since the normal habitat of springtails is in damp places, their presence shows that some portion of the building is abnormally damp, and steps should be taken to discover and eliminate this problem. The springtails occurring in houses feed on fungi and algae that develop in the moist areas. While they usually remain close to the source of their food supply, they may spread to all parts of the house when they become extremely numerous.

Most people who complain about the presence of springtails find them in the cellar. This does not indicate that the whole cellar is unduly damp. The insects may be breeding in a drain, along a wall through which water seeps, or on the surface of floor or paneling that is too damp for the good of the building. Or they may occur in water and heating system risers, escaping from these into bathrooms and other portions of the house. At times the insulation in steam and water pipes may be "alive" with them. Their presence in rooms above the cellar is evidence that there is probably a leak in the piping system and that there should be an immediate examination to determine the source of the insects and the necessary repairs.

Control of springtails consists primarily in the elimination of excess water, regardless of its source. But since their presence is annoying, their immediate control may be desired. This can be achieved by spraying a two to three per cent emulsion of DDT on the infested areas until the surface glistens. Since this form of DDT is applied in water, the spray must never be heavy, or it may result in staining. If a heavy residual spray is desired, it may be applied lightly on two or three successive days to the areas in which the springtails are seen. Spraying into the air is of no value. Kerosene fly sprays containing DDT will kill the bugs, but oil sprays will run off damp surfaces and will probably not control the insects satisfactorily.

Drawing by Dot Kay



SPRINGTAILS indicate that there is more dampness than is good for the house

CHARLES FRANCIS PRESS
NEW YORK