NATURAL HISTORY

THE MAGAZINE OF THE
AMERICAN MUSEUM OF NATURAL HISTORY

VOLUME XLII

June-December

1938

TEN ISSUES A YEAR

Published by

THE AMERICAN MUSEUM OF NATURAL HISTORY

NEW YORK, N. Y.

CONTENTS OF VOLUME XLII

INDEX TO VOLUME XLII

TEXT AND ILLUSTRATIONS

Names of Articles Are Set in Capitals and Small Capitals

INDEX TO VOLUME XLII

SCHOOLS and CAMPS

CRANBROOK SCHOOL

Distinctive endowed preparatory school for boys. Also junior department. Exceptionally beautiful, complete, modern. Unusual opportunities in music, arts, crafts, sciences. Hobbies encouraged. All sports. Single rooms. Strong faculty. Individual attention. Graduates in over 50 colleges. Near Detroit. Address Registrar, 2600 Lone Pine Road, Bloomfield Hills, Mich.

SUSQUEHANNA

Boys 5-18. Mountain Camp on Private Lake

New Milford, Pa.

20th Year 700 Acres

DAILY RIDING

COMPLETE COURSE IN HORSEMANSHIP

Fine lake swimming. All other sports. Our own dairy farm and gardens. 3 age groups. Skilled leader for each 4 boys. Personal development our aim. Telephone TRafalgar 7-1317. For illustrated booklet write:

ROBERT T. SMITH

318 West 81st Street New York City

FOR JUNIORS!

• • •

JUNIOR NATURAL HISTORY

a monthly magazine for all children

12 issues for $1.00 write:

JUNIOR NATURAL HISTORY

American Museum of Natural History

79th and C. P. W., New York

Zenon Schreiber

LANDSCAPE DESIGNER

Specialist in Distinctive Gardens for home grounds, large or small. Alpine and rock gardens; wall, formal and water gardens designed and executed along correct lines.

Write for circular to

25 Home Place

BERGENFIELD, N. J.

Unusual Services

Children look forward to the summer as it means **VACATION.** Possibly at no other time in their lives will vacations mean so much. Adventurous days packed full of action, hiking trips, boating, games played with their friends—every day something new. Camp Susquehanna will send you a booklet on request. And as fall approaches the problem of a good school faces parents. The Cranbrook School stimulates industry and initiative in boys. It instils responsibility both as to the boy's own concerns and as to those of the community in which he lives.

•

When you read **DUDE RANCH** advertising, a picture comes into your mind of ease and happiness, of loafing in the sun or shade, and healthy exercise. For those to whom vacation means fishing in lakes and streams or overnight pack trips in wilderness areas, a dude ranch is the answer! This summer plan to visit a dude ranch and see what the West has to offer. Relax and get healthy and then return to your daily tasks refreshed and with memories of the happy days that **DUDE RANCH** life affords.

•

At Grand Central Palace in New York this year thousands of people gathered to see the International Flower Show. Around one exhibit in particular were crowds of people. It was the Gold Medal winning rock **GARDEN** of Zenon Schreiber, indeed a flawless garden of elfin size and beauty, seeming not to have been created by man but by nature. Mr. Schreiber has won many awards, the State Diploma of Switzerland for garden architecture and horticulture, first prize at the International Flower Show in 1936, Gold Medal of the Horticultural Society of New York in 1937, the Gold Medal of the American Rock Garden Society in 1938 and many others. Write to him for advice and estimates, send for a circular, for here is the man to design and execute your garden—small or large. His address, 25 Home Place, Bergenfield, N. J.

•

The coming summer will find many readers out in the open equipped with their **CAMERAS.** Objects in motion, in the semi-dark, home portrait work and shots where time counts have been made easier, in the past few years, by the rapid strides made in better equipment that costs less. Candid cameras and accompanying equipment are within the reach of all enthusiasts at such reputable stores as Willoughbys, 110 West 32nd Street, N. Y. What until recently was considered too difficult to photograph for the amateur is now comparatively easy. Be prepared for the summer by checking your old cameras at Willoughbys. Add to your equipment at low cost.

WYOMING

PATON RANCH. A home, on a mountain stream in the foothills of the Big Horn Mountains, where you may relax and rest. Everything that life on a ranch affords. Gentle horses, wholesome food, attractive cabins. Guest capacity limited, rates reasonable. Address William Paton, Shell, Wyoming.

CL BAR, Cora, Wyoming, in the Upper Green River Valley. A large, old stock ranch offers you Cabins—with baths, fireplace, electricity. Lake or Stream Fishing. Best food.—Excellent mounts.—Comfort. Accommodations limited. References required. Winter address: Dr. E. S. Lauzer, Rock Springs, Wyoming.

ATTENTION MUSEUMS and PRIVATE COLLECTORS!

Experienced collector leaving within two months for Tropical Rain Forest Belt, Nigeria and the Cameroons.

Familiar with these from previous expedition of 11 months. Will contract to collect zoological and ethnological material. Also willing collect any pertinent data. Reference furnished—correspondence invited.

GERALD MORGAN RUSSELL

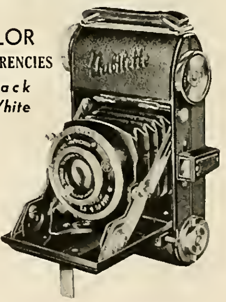
10 East 83rd Street New York City

Announcing the

JUBILETTE

A POPULAR PRICED 35MM MINIATURE CAMERA WITH CONVENIENT EXTERNAL SHUTTER RELEASE

For COLOR TRANSPARENCIES *or Black and White*



The Jubilette is a new light and compact miniature camera making 36 exposures on 35MM film.

It has the features and the power of a high priced camera and is being put on the market as a result of constant demands for a miniature camera fitted with some of the candid camera essentials at a popular price.

It is equipped with an F2.9 highly corrected anastigmat lens in a compur shutter with speeds up to 1/300th part of a second, enabling you to enjoy the most entrancing advancement of modern photography—Kodachrome in full color—as well as perfect black and white shots of every type, even under poor light conditions.

TRADE IN YOUR OLD CAMERA

$35.00

Leather Eveready Case $8.00

Leather Zipper Case No. 64. $2.00

Mail Orders Filled. Write Dept. JUB.

WILLOUGHBYS

World's Largest Exclusive Camera Supply House

110 West 32nd Street, New York

"At the Sign of the Camera"

A.M.N.H. Photo by Julius Kirschner

Elkhorn Ranch—a recently completed group in the New York State Theodore Roosevelt Memorial

This is the second of a chronological series of four groups designed to represent four distinct influences on the illustrious life of Theodore Roosevelt. A pair of prong-horned antelopes gaze down on the grazing fields where Roosevelt as a delicate young man gained not only the renowned vigor that characterized his public career, but his life-long interest in Natural Science. Set against its background of arid North Dakota badlands, this ranch group was reproduced under the direction of Dr. James L. Clark with absolute fidelity to every detail. Exact floor measurements of the ranch building *(middle distance at right)* were provided by the North Dakota State Historical Society; flora and animals were secured by an American Museum expedition

Reproduction by permission New York State Roosevelt Memorial Committee. Animals and flora by the Museum's Preparation Department. Background painted by Hanson Putoff

LETTERS

Sirs:

Your attention, and that of author Natalie Harlan Davis, should be called to an altogether different story concerning the crest of the Mikado of Japan.

I transcribe from "Exploring for Plants," by David Fairchild (The Macmillan Co., 1931): Chapter: Among the Herbaria & Gardens of France, pp. 39-40:

"To one like myself who had been introducing plants into America for many years there were two historic trees of great interest. There is the first *Paulownia Imperialis* tree to be introduced into Europe, still alive, though now a battered old specimen. It is a curious coincidence that this famous 'Kiri' tree of Japan, whose conventionalized flower panicle and leaves have for centuries formed the Japanese Emperor's crest, should have been named by two European botanists after the daughter of a Russian Emperor who became Empress of the Netherlands, Anna Pavlovna, daughter of Paul I. That this tree, which was introduced in 1834, actually within the lifetime of people now living, should cast its shadow over the Japanese botanist Nikai as we walked together from the museum, seemed to me a striking example of the changes which the years have wrought in our knowledge of and our attitude toward Japan. In 1834 Japan was so unknown a country to Europe that the tree whose flower decorated the crest of its emperor was an undiscovered species, to be honored by naming it after the daughter of a Russian Emperor."

Truly, a fair lot of our children yet know little about Japan. It is not amusing to see such errors in Natural History.

Creston Collins.

Hollywood by The Sea, Florida.

* * *

Neither Natural History nor David Fairchild was wrong about the crest of the Japanese Emperor. Both the conventional design of sixteen-petaled chrysanthemum *(kiku)* and the design of Paulownia *(kiri)* leaves and flowers are crests of the Imperial Family of Japan. Both have been in use for centuries.—Ed.

Sirs:

In a recent issue of Natural History, there was printed a short request for suggestions regarding the format and contents of the magazine.

My suggestion is this: the articles start at a leisurely pace and proceed at that pace for several pages. Then, about two paragraphs from the end of the article, there appears a sudden need to condense the remaining quarter of the story into those last two paragraphs. The result reminds me of the classic example of too great condensation. This is the example: "The Duke took a Scotch high-ball, his hat, his departure, no notice of his pursuers, a revolver out of his hip pocket, and, finally, his life."

I am sure that my criticism is obvious. Before I close, however; please do not think that all articles in Natural History are open to this cross-fire from a reader.

Roy S. Farmer.

Los Angeles, Calif.

* * *

Sirs:

The lovely magazine which comes each month to my husband, Lt. Michael Phillip Barr, U. S. N. (Retired) gives much pleasure. It is a fine magazine in every way and always contains something of interest to read aloud in our home. Lt. Barr and myself are old people who do not get about so far or so often as in former years. At present we cannot enjoy the interesting things in Manhattan as in former years, but we hope to again later and we appreciate having such a fine Museum where out-of-town guests are always taken or sent. . . . We appreciate *good* literature and people and interesting and instructive subjects.

Mrs. Michael P. Barr.

Brooklyn, N. Y.

* * *

Sirs:

On page No. 289 of the April issue of your magazine, there is a picture of wild fox* with a statement that this is the only picture which was ever taken of wild fox at such close range.

It may be interesting to you to know that I have an amateur Kodacrome color movie picture which was taken up in the Adirondacks about a year or two ago and which includes quite a few shots of wild fox at distances of between three and 50 feet. These pictures were taken in the Ausable Reserve, which is more or less protected. In any event, this particular fox was coaxed by the local guides to come close to the camp. The guides called to this fox every day and threw some scraps of food to him. He has never been trapped or cut in any manner. No one in that locality has ever seen anything like it.

I believe that there was another fox from the same litter who came with him for a while, but seemed too shy to continue doing so.

I thought this story might be interesting to you.

Robt. P. Kehoe.

New York City.

*An Arctic fox.

Sirs:

Permit me to offer my hearty congratulations on the article in your April number of Natural History, entitled, "A Ticket to the Arctic," by Richard Finnie.

Mr. Finnie has a very fine picture with the caption, "Arctic fox and seal dinner: taken only three feet from this ordinarily timid fur animal, the close-up is perhaps the only one of a wild, untrapped fox in existence."

Perhaps your readers would be interested in the enclosed picture taken in the Attacama Desert of northern Chile. It is contact size from a six-inch lens focused at $2\frac{1}{2}$ ft., but the actual distance to the face of the fox was not over 2 ft., as can be seen by the sharpness of the focus at his shoulders. I also have a series of expressive "portraits" of this entirely wild and untrapped red fox, snapped in the open. The animal was gradually enticed closer by offering bits of food, and water. After various trials extending over several months I was able to get 400 ft. of 16 mm. film in addition to the stills. One shot even shows the fox on speaking terms with the cats, and their relations were very surprising indeed.

Wilson R. Maltby.

Carnegie Institute of Washington,
Washington, D. C.

"I WANT A TELEPHONE IN THIS HOUSE!"

"Suppose I get sick? After all, I'm only human. And if I do get a touch of colic . . . or have a nervous breakdown . . . do you know what'll bring it on? Worry! Yes, sir, worrying about how long it would take us to get the doctor if anything should happen.

"Or suppose a pipe bursts in the bathroom? Or a burglar comes along? When something like that happens you don't write a letter, or go after help on horseback. No, sir. You hop to a telephone!

"And what about my mother? She's got marketing to do. Sometimes she needs to get in touch with Dad during the day. And there are errands to be run. Well, she can't do all those things without a telephone . . . and at the same time give me the attention I expect.

"All Dad needs to do to have a telephone is get in touch with the Business Office. I'd do it myself if I could just get out. But I can't. So is it any wonder that worry is keeping me awake half the day?"

BELL TELEPHONE SYSTEM

NATURAL HISTORY

The Magazine of the American Museum of Natural History

FREDERICK TRUBEE DAVISON, President — ROY CHAPMAN ANDREWS, Sc.D., Director

VOLUME XLII—No. 1 ★ ★ ★ ★ ★ JUNE, 1938

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

EDITOR: Edward M. Weyer, Jr., Ph.D.

ASSOCIATE: D. R. Barton.

PRODUCTION: Frederick L. Hahn.

ART: Charles Curtis Hulling.

Manuscripts should be sent to the Editor, The American Museum of Natural History, N. Y.

SUBSCRIPTIONS. NATURAL HISTORY is sent to all members of the American Museum as one of the privileges of membership. Membership Secretary, Charles J. O'Connor.

ADVERTISING DEPARTMENT: Sherman P. Voorhees, Manager. W. Ware Lynch.

REPRESENTATIVES:
Frank S. Whitman, Chicago, Ill.
Warwick S. Carpenter, Santa Barbara, Calif.

NATURAL HISTORY is published monthly (except July and August) at New York, N. Y., by The American Museum of Natural History, Seventy-ninth Street and Central Park West. Subscription price $3 a year, single copies fifty cents. These rates also apply to Canada, Newfoundland, and all foreign countries. Entered as second class matter March 9, 1936, at the Post Office at New York, New York, under the Act of August 24, 1912.

A. M. N. H. Photo by Charles H. Coles

JADE NECKPIECE

This finely carved plaque, enlarged here to about twice actual size, was probably worn as a breast pendant or the central figure of a collar by a member of the mysterious Olmec race who lived in Mexico around the 10th century. Since no formal excavation has been undertaken in the Olmec area in southeastern Mexico, nothing is known of their beginnings or of their relations to other cultures. Traditions in the region often describe a highly civilized people by this name, but the Olmecs moved across the pages of history like mere shadows. That they may have differed in facial type from other tribes is suggested by the characteristic features which this piece, in common with the handful of other known sculptures ascribed to them, exhibits (Loaned from a private collection)

EVE AND HER JEWEL CASKET—*Showing that milady of today yields to an essentially barbaric impulse when she dons her gems. For jewelry is older than dressmaking, and its radiant variety has expressed the individuality of women since the dawn of time*

By HERBERT P. WHITLOCK
Curator of Minerals and Gems
American Museum of Natural History

THERE always has been and there always will be an element of mystery in the appeal of the bits of bright and colored stones that we call gems. I am loth to believe that this appeal is solely to the sense of beauty although beauty has very much to do with it. Nor is it entirely a question of value although again the sentiment of value is very closely linked to the lure of gems. In many things, but especially in the buying and wearing of gems, we desire most that which is rare, that which other people cannot afford to have, that which proclaims our opulence. This is, of course, a more or less barbaric heritage, like boasting and shaking our fists in peoples' faces and generally making a spectacle of ourselves.

Real gems vs. synthetic

It is undoubtedly this element of our barbaric heritage that impels the man or woman of today to pay many times the value of a synthetic sapphire or ruby for a natural stone of the same kind. And this in spite of the fact that in all essential characteristics the two gems are identical, and no eye but that of a trained gemmologist can discern the difference between Nature's product and that which is made of the same substance by man.

But back of all these considerations I am convinced that there lies a subconscious appeal, something psychic and primitive that moves us ofttimes to lie, murder and steal for the sake of some sparkling shred of mother earth.

And we have every reason to believe that this appeal swayed men and especially women before the beginning of history. The subtle charm that renders a modern woman spellbound before a jeweler's showcase is the same that urged her earliest forebears to hang bright colored stones about their persons before it occurred to them to adopt any other means of adornment. Jewelry is probably older than dressmaking.

Appeal of color

When we attempt to analyze the appeal of gem stones to our conscious rather than to our subconscious selves we find that much of our feelings toward them is linked with reactions to color. And color is by no means simple in its psychological responses. I once heard the story of a child that had been born blind, and who, upon reaching early manhood, was by some miracle of modern surgery, restored to the world of shape and color. So unusual was the situation involving someone who had lived hitherto in a darkened world and who was suddenly restored to sight, that people were interested in his first reactions to various colors. He was shown a piece of red stained glass, upon which he exclaimed directly, "That is like the sound of a blast upon a trumpet."

Red gems, such as rubies and garnets, belong with fiery, passionate people. Among the medieval astrologists ruby was associated with Aldebaran, the red star, in the constellation Taurus, and garnet with the heart of the star group Leo. Many old legends make use of rubies and garnets indiscriminately as luminous stones, as instanced in the Tal-

---

IMPORTANT NOTICE TO MEMBERS

NATURAL HISTORY is not published during July and August. Therefore it will not be necessary for members to send a change of address notice if they are to reside at a summer residence during these two months.

A. M. N. H. Photo by Julius Kirschner

ANCIENT AMBER NECKLACE. Such rough shaped beads as these, made from Baltic amber, were largely circulated throughout Europe in pre-Christian times. This necklace is from a grave in Hallstadt, Austria, and dates from about 300 B. C. *(Morgan Gem Collection)*

A. M. N. H. Photo by Julius Kirschner

A STRING OF PRIMITIVE BEADS fashioned from carnelian in Merovingian, France. The Gallo-Roman people loved fine apparel and jewels. This necklace was found in a grave near Soissons in northeastern France

(Morgan Gem Collection)

A. M. N. H. Photo by Julius Kirschner

A PERSIAN CHALCEDONY SEAL. The intricate and beautiful lettering engraved on this Mohammedan amulet form Arabic words taken from the Koran. It was worn suspended from the neck and protected the owner from ills, real or imaginary *(Morgan Gem Collection)*

A. M. N. H. Photo by Julius Kirschner

Chinese Glass Beads and Pendant. These are made from glass that has assumed an iridescent patina from having been buried for a long time. They were made in the Tang Dynasty (620-906 A. D.) and were found in a grave in Honan *(Morgan Gem Collection)*

(*Below*) A Moslem Dagger. The Persian blade of Damascus steel is set in a jade hilt embellished with rubies by Hindu craftsmen, and is inscribed in Arabic rimed prose: "Thanks be to Allah. Praise be to Allah. Patience is of Allah" *(Drummond Collection)*

A. M. N. H. Photo by Julius Kirschner

A. M. N. H. Photo by Julius Kirschner

A Jade Ring Tray. The ladies of the Hindu harems, being themselves strictly confined, had no need to safeguard their jewel caskets with locks. Finger rings and toe rings were kept in dainty trays, such as this one, which was carved in China *(Morgan Gem Collection)* mudic story of the huge garnet which furnished light to the ark of Noah.

According to a Hindu folk-tale that recounts the birth legend of the ruby, this fiery stone was once a diamond whose color was changed to red by the life blood of a Maharanee slain in anger, disappointment and envy. The stone was subsequently placed as the red glowing eye in the image of Siva, the destroyer. The garnet was the favorite gem of Mary Stuart, that tragic queen whose life was swayed by passion, and whose blood in the end stained the headsman's ax.

Most primitive piece of jewelry

I once held in my hand the most primitive, if not the oldest, piece of jewelry that it has been possible to trace. It was a small group of garnet pebbles from the grave of a Bohemian woman of the Bronze Age, pebbles pierced so that they could be strung together, but each stone blazing with the rich fire that prompts the Bohemian peasant woman of today to desire these same red stones.

Blue stones call to mind truth and constancy. There is something of divinity, something of heaven, in the deep blue of the sapphire or the opaque ultra marine of lapis lazuli. In the Veddic tale of the churning of the ocean, the sapphire was born from the last concentrated drop of *Amrita,* the drink of the Gods "whose shadow is immortality." And because this legend originated in India where Kashmirian or Singhalese sapphires must have been known in very early times, we have every reason to assume that the writer of the Rig Vedda referred to the blue stone that we know by that name. The sapphire mentioned many times in the older books of the Bible, on the other hand, was in reality lapis lazuli. This latter is the blue stone referred to in the Talmud legend as being the material upon which the ten commandments were engraved.

Many and various are the legends involving blue stones, but always their symbolism points to immortality, to divinity, to heaven. It is significant that the human-headed falcon that in Old Egypt represented the soul had its feathers beautifully inlaid with little slabs of turquois and lapis lazuli.

The green color embodied in the emerald invariably calls to mind the verdure of spring; the budding of life; victory over the cold of winter; faith in the fruition of plenteousness which comes with summer. There is something kingly, something of power over mundane things, something steadfast in the symbolism of this gem. It dominates. By the early Christian writers, the emerald together with the green jasper was the one among the Apostle stones ascribed to Saint Peter. To quote from Andreas of Caeserea, "The jasper which like the emerald is of greenish hue, probably signifies Saint Peter, chief of the apostles, as one who so bore Christ's death in his inmost nature that his love for Him was always vigorous and fresh." This apostolic symbolism has persisted in the Greek Church from the fifth century to our own time. Recently I saw a beautifully executed cameo head of St. Peter carved in a splendid Russian emerald which was probably the work of an eighteenth or nineteenth century lapidary. As to legend, there is the wonderful story of the mighty emerald which dropped from Satan's crown when he fell from Heaven. Up to the beginning of our era the mystical history of this gem is shrouded in obscurity. It may have been the emerald which was one of the four stones possessed by King Solomon, and which gave him power over all demons. It became the San Graal, the cup from which Christ drank at the Last Supper and in which later his blood was caught. From this legend emanated that remarkable cycle of myths which dominated romance of the Middle Ages; a veritable storehouse of symbolism.

Cleopatra's favorite

Emeralds were the favorite gems of Cleopatra, the embodiment of royalty and probably the most gem-bedecked queen of all time. Many of the green stones such as chrysoprase were often called, "victory stones" by the old writers. Such a one was reputed by Albertus Magnus as having been worn by Alexander the Great in his girdle.

The well known purple gem, the amethyst, as its Greek derivation indicates, was regarded as an amulet which would prevent intoxication. Dr. L. J. Spencer in his recent book, "A Key to Precious Stones," comments in a somewhat satiric vein on the use of this gem in episcopal rings. He says, "For this reason bishops, whose duties take them to public function of all sorts, wear an amethyst in the episcopal ring." Without doubt the medieval connection of the amethyst with Bacchus, god of the wine cup, comes from the story of the nymph named Amethyst one of those who followed in the train of Diana. Bacchus in order to fulfill a drunken vow was about to offer her to be devoured by the tigers that drew his car. The goddess in order to save her protégé from this horrid death, turned her into a white stone. And Bacchus, repentant of his cruelty, poured the juice of the grape over the stone figure, thereby dying it a rich purple.

The keynote of this birth myth is sorrow, repentance mingled with tragedy. And that is the feeling our minds associate with the color purple.

More obvious is this color association when we consider the myth of Hyacinthus, the youth accidentally killed by Apollo, who caused a purple flower to spring from the ground where his life blood had been spilt. The purple gem which commemorated this sad event among the ancients was variously assumed to be either an amethyst or a purple sapphire.

Diamond lacks romantic mythology

When we think of a white stone we instinctively visualize a diamond, because this gem among the galaxy of brilliantly colored stones is notably without color. However, we should not attempt to analyze the appeal of the diamond in terms of its white color because it is the brilliance of its reflection that constitutes this appeal and not the color of purity and innocence which white suggests. The appeal of the diamond is one of ostentation, of blazonry, of display. In the Occidental world at least the wearing of diamonds belongs to a culture already well advanced. There are no European myths that link the diamond with romances of early centuries. It is by far too sophisticated, too hardly brilliant in its glitters to measure emotions in primitive terms.

For the true color imagery of the diamond, we must turn to the Hindu folk tale in which the first diamonds fell from the lips of Krishna, when in the form of a swan, he chose this means of rewarding an act of self sacrifice, charity and mercy. But the diamonds that constituted "Krishna's Gift" were not the scintillant gems of the Rue de la Paix, but Indian cut stones with little fire and sparkle.

In marked contrast to the cold glitter of the diamond is the warm serene glow of a pearl of fine luster. There is something of life, something vitally individualistic about pearls. It is as if the one who wore them wore part of herself suspended from her neck. The fabulous and much discussed draft of Cleopatra was not a meaningless gesture. She seemed to drink something that pulsated with her own vivid vitality.

And what of the opal? How can one analyze the appeal of color in something which has all colors and yet whose colors forever shift and mingle? My answer would be that this rainbow stone should be dedicated to such of us who, like great actresses, great musicians and great poets, have the gift of stimulating human emotions by our art.

Turning once more to the folk tales of India, there is one that tells of the wandering flute player, who, when he was summoned to the heaven of Indra, played his Golden Song before the congregation of the gods, and received as his reward for rendering them dumb with ecstasy, the Opal.

As to the tradition of ill luck that has become associated with the opal, it is enough to say that this hoodoo, together with those assigned to all the other so-called unlucky stones, is founded upon such a commonplace principle as the law of averages. Some of us remember a time when the proverbial "red-haired girl" was a rather rare sight, whereas horse-drawn vehicles were very common, and among them, one in every ten was sure to be connected with a white beast of burden. And thus originated the saying, "If you see a red-haired girl, you will immediately see a white horse," simply because the former was uncommon and the latter common. So it is with ill luck, that commonest of all human experiences, we are reasonably certain to find some uncommon possession with which to connect it. And if we do not happen to have an opal or a blue diamond, then our misfortune becomes just that.

When the woman of the twentieth century of our era dons her string of raw emeralds or aquamarines or lapis lazuli, she no doubt considers that her taste is ultra modern. Yet the women of the twentieth century B. C. wore much the same kind of necklace. Stroll through the Egyptian gold room in the Metropolitan Museum if you are curious to see what can really be done with roughly fashioned emeralds. Or notice the magnificent string of primitive necklace beads fashioned from old Persian lapis lazuli in the Morgan Hall of the American Museum. These things far transcend in barbaric appeal anything that has thus far been produced to meet the demand of ultra modern taste.

Forgotten stones

And there are many semi-precious stones used in the crude but very beautiful jewelry forms of long past eras about which we seem to have forgotten.

There are soft neutral colors in the agate beads of Merovingian France, and charm in the roughly rounded aquamarine beads that are still to be found in the bazaars of North Africa, and no one knows how old these are. Even such a prosaic thing as glass can be made a material of supreme though barbaric beauty, as anyone can testify who has seen Chinese glass ornaments of the early Han Dynasty.

If we must return to simplicity in our jewelry, by all means let us mould that simplicity along lines freed from the shackles of sophistication. If you must be barbaric, madam, why not select a classic model of barbarism?

ANIMALS OF THE SARGASSO MERRY-GO-ROUND—

Ever since Columbus plucked a crab from its mass of seaweed, the Sargasso has stimulated fantastic legends in the minds of men. Now modern collectors discover creatures far stranger than the romancers' fiction

By MYRON GORDON

AWAY from the main trade routes of America, owing to the dangerous coral reefs, many of which can be seen from a boat only at low tide, and far away from the centers of human population, the coral reefs and islands of the Dry Tortugas—a series of islands about 90 miles west of Key West, Florida—have remained a virgin biological territory, practically untouched by advancing civilization. The Florida Keys have been reputed as places where the treasures of the Caribbean buccaneers have been cached. Great wealth was supposedly hidden near our headquarters on Loggerhead Key—the last coral outpost of the Dry Tortugas, but the only visible treasure was the wealth of tropical marine life that everywhere surrounded us, and we, as biologists, were grateful.

Every summer scientists from all parts of the country come from universities, biological laboratories and medical institutions and settle on Loggerhead Key. There, under the paternal supervision of the Carnegie Institution of Washington, they work in its camp-like Marine Biological Laboratory in a South Sea setting, except that there are quarters for bachelors only. The wives, if any, are left at home.

On one brilliant June day, Doctor W. H. Longley, leader of the colony, invited me to join him in an excursion to the Sargassum weed drifts in the Gulf Stream. As we walked down to the dock to board the Institute's yacht, the *Anton Dohrn*, the tropical waters were so calm that our view of the ship did not stop at the water's edge. Its image was repeated in reverse in the mirrored surface of the sea and it ended in the fleecy clouds that moved across the watery sky.

Once started, we headed directly for the Gulf Stream, only a short run from our laboratory base, but so small and low were the coral islands of the Dry Tortugas that we soon lost complete sight of land. From the view about us we might have been in mid-ocean, and from the sight of the floating Sargassum seaweeds, we might have been in the heart of the Sargasso Sea.

Over the side of the *Anton Dohrn* I saw a Portuguese man-of-war drifting in the sweep of the Gulf Stream, accompanied by its constant piscine retinue, the broad-banded, blue-black man-of-war fish *(Nomeus)* and the fine-striped, yellow-jack *(Caranx)*. About fifteen fishes milled slowly within the protective veil of the long, curly tentacles that hung down several feet from the transparent, pearly-white, floating balloon of the jellyfish. Not all fishes know their way around the jellyfishes' stinging tentacles. The Sargassum pipefish (*Siphostoma pelagicum*) a cousin of the famous sea-horses has repeatedly been seen hopelessly entwined in their treacherous clutches.

The notion is still wide-spread that the Sargasso Sea is a forbidding region of the tropical Atlantic and is cluttered with wrecked and rotting ships that are held in one enormous mass by the entangling jungle of seaweeds. Honest sea-captains, intent solely upon legitimate trade, supposedly shun "the port of missing ships, the graveyard of the sea," as they would a plague-ridden country. Novelists and motion-picture directors have gone on mental treasure-hunting expeditions into the Sargasso. Their imaginative, blood-curdling romances are but mild

---

MYRON GORDON, whose articles on fish are well known to NATURAL HISTORY readers, secured much of the material for his present contribution as a frequent summer guest-investigator in the Marine Biological Laboratory at Dry Tortugas, Florida. For 12 years head of Cornell University's fish breeding laboratory, his previous expeditionary work was done chiefly in Mexico. On his first trip thither he collected and preserved many specimens on which a forthcoming book *The Fish of Northeastern Mexico* is based. By bringing back live specimens from his second visit he was able to introduce several new species to the aquarist's collections.

Doctor Gordon has just been appointed to a Guggenheim fellowship which will take him back to Mexico in December. He is at present doing research at the Department of Anatomy in Yale's Medical School.

—THE EDITOR.

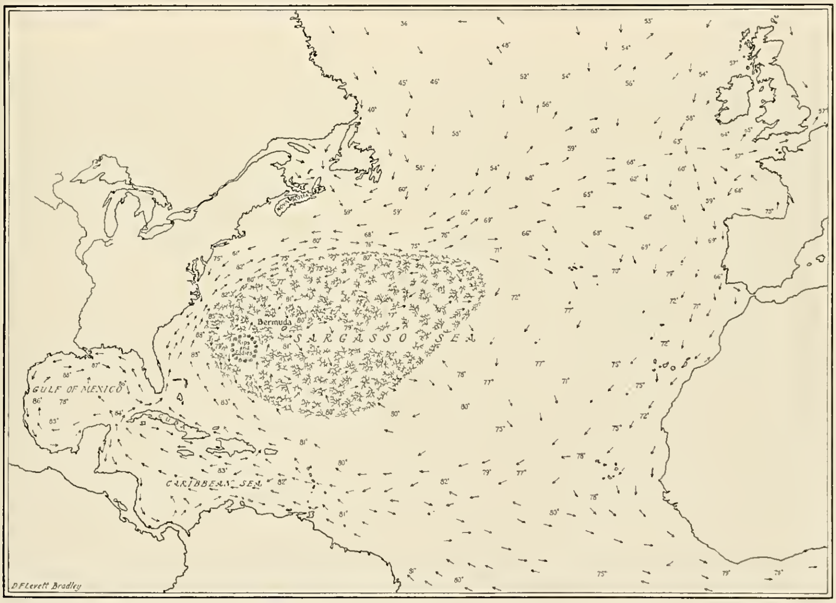
modernizations of age-old legends told by sailors of Columbus' day.

In reality, the Sargasso is a region in the southern Atlantic characterized by the presence of great quantities of seaweed that slowly, almost imperceptibly, rotate; they support a floating world of strange sea-organisms. The Sargasso Sea is mysterious in origin, prehistoric in age, and unique in the perfect fraternity of its bizarre plants and animals. So close is this organic fraternity that it is often difficult to tell its animals, judging by their shapes alone, from its plants. There are many things about the Sargasso and its Sargassum weed that are still as unfathomable today as they were in 1492 when Christopher Columbus discovered them 30 days before he discovered America.

Dr. Longley promised us a grand show when we were within hauling distance of the Sargassum weed rafts, and in preparation for it, we set up a stage in the shape of a large basin of water. The magic show began with our grasping portions of the bladder-tasseled seaweeds and shaking them vigorously over the basin.

We found not only weed-like fishes in the Sargassum, but weed-like crabs, weed-like slugs, and a host of tiny creatures that cling to the fronds so closely that at first glance they seem to be an intimate part of their algal surroundings. Small shrimps, in tones of rust and browns, row their curved shells cleverly through the tunnels formed by the interlacing weeds. Bryozoans, that look more like mosses than the animals they really are, have a perfect background for their colonial homes. Hydroides, the stay-puts of the jellyfish order, are so numerous, yet so small, that the Sargassum fronds appear fringed. Only by use of a lens can one definitely satisfy oneself that the fringes on the weed are not of vegetable but of animal origin.

Even the lowly worms build their spiral igloos of lime upon the wandering weeds. The annelids keep their bottom parts safely tucked away in their houses while the front-ends look out upon their



SARGASSO SEA IN AUGUST

This strange seaweed-strewn section of the Atlantic Ocean, which in August embraces an oval area approximately 2000 miles by 1000 miles, varies in distribution and density with the seasons and under the influence of local weather disturbances. It rotates slowly, almost imperceptibly; it is mysterious in origin, prehistoric in age

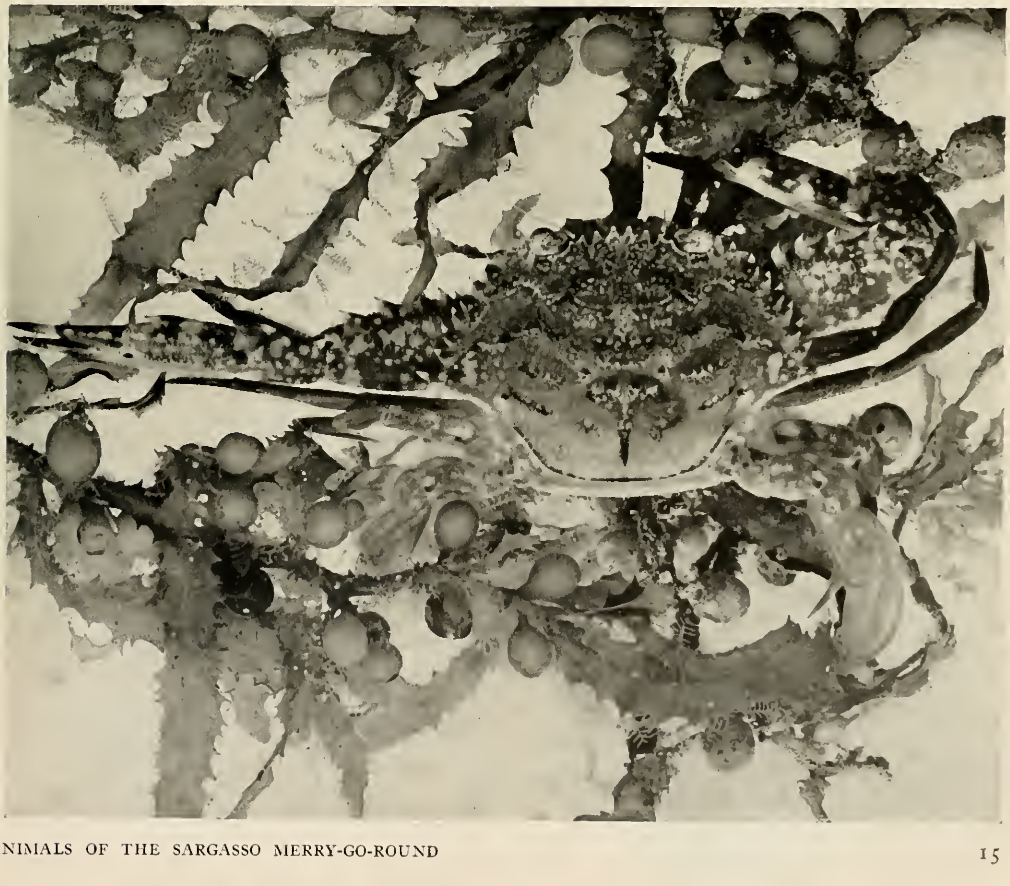
All photos by
Myron Gordon

(Left) One of the Strangest Creatures inhabiting the enormous seaweed-strewn Sargasso Sea, a region in the Atlantic Ocean long reputed by mariners to be a trap for ships and used as the setting for innumerable lurid tales of adventure. This fish, Pterophryne (ter-o-fry-nee), is camouflaged against its enemies of the weird seaweed world and can change its color to suit its background. While the photograph is clear, it is necessary to look twice to make out all the details of Pterophryne's peculiar anatomy. Can you find the mouth? It is not where it may first appear, but higher up. Where is its eye? Its fins?

If you think this photograph is perplexing, look at the one below, taken only a minute later. The instant the weed was placed in the aquarium with it, Pterophryne climbed aboard its weedy wagon. Note how its golden brown sides and markings blend with the branching fronds and gas-filled bladders of the weed. The fan-shaped object with radiating spines is one of Pterophryne's hand-like fins

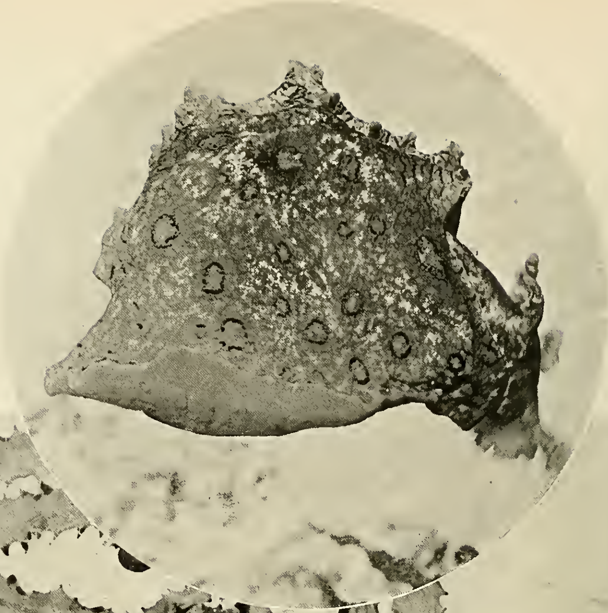
Christopher Columbus, the discoverer of the Sargasso Sea and its first naturalist, recorded in his journal the finding of a crab swimming in the thickly entangled Sargassum weed. It may have been this type. To him, the crab and the surrounding weeds meant nearness to land and to outflowing rivers. Little did Columbus know that the Sargassum weed and the crab were perfectly at home on the high seas. The tiny crab is hardly distinguishable from the weeds upon which it clings and Columbus must have had a keen eye to spot so small a creature. Small as it is, the crab is a veritable shark among crustaceans, for it is swift, certain and deadly when in the pursuit of its prey.

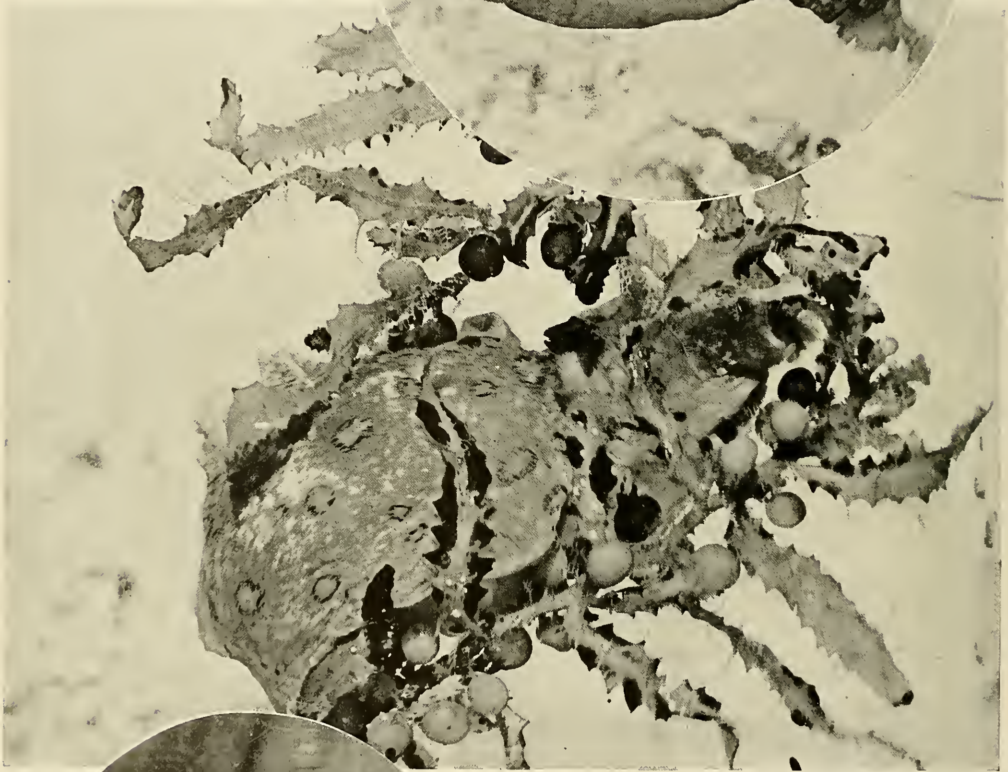
The floating weeds on which these creatures dwell slowly rotate, like a gigantic merry-go-round, under the influence of the great oceanic winds and currents. The density of the masses varies according to periods of occasional storms, and sometimes the rafts of weeds are blown thickly together and retard smaller vessels. Thus the notion persists that the Sargasso is a forbidding, an entangling jungle of floating vegetation



(Right) The Sargassum Sea-Slug, a seemingly innocuous animal and a member of the slow and meek fraternity of snail-like creatures, has taken on belligerent habits of life. It may appear soft on the surface, but in its little insides it hides a wicked, rasping gizzard, bristling with spines. Every spine points backward, directing the victims down a dark, one-way path. The Sargassum sea-slug, apparently, is no sluggard. Indeed it is a terrible carnivore

All photos by Myron Gordon





The Sea-Slug bears a remarkable resemblance to the color and the shape of the weeds it frequents. Its brown-colored body is covered with large, round, dark-edged circles that look like the air bladders of the Sargassum. Folds and flaps of skin extend from an otherwise chunky body, producing the effect of a clump of thickly tangled weeds

(Left) Yellow-Jack *(Caranx)*, a frequent traveler in the Sargasso merry-go-round. They hide during their infancy among the tangle of weeds and when older sometimes associate themselves with the Portuguese man-of-war. They have learned to avoid the jellyfish's many long, stinging tentacles and find a haven there from their enemies

floating marine world with flaming head colors. When disturbed in their monotonous routine of waving their food-gathering tentacles, they pull in their groping head feathers like a signal man retiring his flags after the end of his message.

From a clump of Sargassum I picked up a strange, blubbery mass about an inch in diameter. It was a tiny octopus. As it spread its tentacles and clung to my hand, I felt its strong, clammy, sucking power. It gave me an unpleasant inkling of what a man-sized octopus could do. But in this instance, I am sure that the less than pint-size octopus was more frightened than I. It first turned exceedingly pale; then it started to flash its signs of distress in many colored signals. From its variously hued pigmented cells, tiny discs of red, yellow, green and black enlarged and diminished in a series of pulsations. The flashing on and off of the many colored chromatophores seemed like the blinking of a multicolored Broadway electric sign. I wanted to let the little cuttlefish go but it clung tenaciously to me for a while before making off like an animated umbrella.

The floating seaweeds make up a marine nursery, probably the very first cradle of the deep. Many species of fishes lay their eggs within the protective folds of the Sargassum; there the young hatch and spend their infancy. In the 1870's Louis Agassiz, one of the world's most famous naturalists, startled the world of ichthyology by announcing the discovery of the nest of the Sargassumfish in a clump of Sargassum weed, that was held together by elastic, beaded threads. The beads, Agassiz thought, were the eggs of the Sargassumfish, but when William Beebe in 1932 watched the hatching of such eggs, out came embryo flying fish *(Exonautes)* instead. And Charles M. Breder the director of the New York Aquarium repeated the hatching of flying fish eggs when he explored the Sargasso Sea in 1934, and provided the final explanation of a 70-year-old Sargasso Sea biological mystery. Were it not for the eggs' anchorage on the floating Sargassum, Breder said, they would sink into the abyssmal depths of the Sargasso, in several miles of cold dark waters. From these depths flying fish embryos would never arise.

Where the eels breed

Yet from the depths of the Sargasso some fish do arise. Eels arise. Every fresh water eel that is seen in a creek, river or inland lake was born somewhere at a great depth between the oceanic floor and the surface of the Sargasso Sea. Doctor Johannes Schmidt, the great Danish ichthyologist and oceanographer, sailed and combed the Atlantic Ocean for eighteen years before he found the breeding grounds of eels. In the international waters near the Bermuda Islands, a thousand feet down, the American and European eels, in two separate camps meet and breed. When the eggs hatch, the young eels look no more like their parents than a crawling caterpillar looks like a fine-scaled, winged butterfly. The larval eels are thin, flat, ribbon-like; they look like open cigar-bands made of cellophane. The European and American eels cross one another's paths on the way back and forth, to and from their native continents; they never lose their way. The waters of the Sargasso may be the meeting grounds of eels, but they are no melting pot of nationalities; the American and European eels never interbreed.

But the first naturalist in the Sargasso Sea was its discoverer, Christopher Columbus. His journal records the finding of a crab, swimming in and out of the thickly entangled Sargassum weeds. The crab was regarded as having great significance and Columbus caught and preserved it. To him, the crab and the surrounding weed meant nearness to land and to outflowing rivers, for both the crab and the weeds were thought to have been of fresh water origin. Little did Columbus know that the Sargassum weeds and the crab were perfectly at home on the high seas.

Carcinologists and oceanographers think that Columbus' Sargassum crab was either the little wanderer *(Planes minutus)* or the drifting crab of the sea-god *(Neptunus pelagicus)*, for both are found abundantly in the floating vegetation of the Sargasso. Columbus must have had a keen eye to spot the tiny crab, for it is hardly distinguishable from the weed upon which it clings.

A voracious crab

A modern Columbus of 1867, Cuthburt Collingwood, traveled through the Sargasso and told the readers of the *Intelligent Observer* (a Review of Natural History, Microscopic Research and Recreative Science) his story of the animal life he found there. He says that Neptunus is a splendid swimmer. It can rest leisurely, motionless, near the surface of the sea or upon the drifting weeds. But its chief occupation is the pursuit of game. It is a veritable shark among the crustaceans, for it is swift, certain, and deadly; it is graceful and tiger-like in its movements: it never tires in preying upon the Sargassum community of animals.

The seemingly innocuous sea-slug *(Scyllaea pelagica)*, a member of the slow and meek fraternity of snail-like animals, has taken on belligerent habits of life. The sea-slug may appear soft on the surface, but in its little insides it hides a wicked, rasping gizzard, equipped with bands of hard, horny, sharp-edged plates, bristling with spines. And its tongue is covered with thirteen tooth-like cutting edges. Every spine points backward, directing the victims down a dark, one-way path.

The Sargassum sea-slug, apparently, is no sluggard. It is a terrible carnivore that has fully earned its scientific name, *Scyllaea,* for Scylla was a mythical she-monster with six heads, twelve feet and the voice of a yelping dog. She dwelt in a cave by the sea and snatched sailors from passing ships.

The sea-slug bears a remarkable resemblance to the color and shape of the weeds it frequents. Its brown colored body is covered with large round, dark edged circles that look like the air bladders of the Sargassum. Folds and flaps of skin extend from an otherwise chunky body, producing the effect of a clump of thickly tangled weeds. It clings to Sargassum so tightly that an early naturalist believed it was permanently attached to the weed. When it swims, Collingwood says, Scyllaea's club-shaped tentacles are thrown back. In this attitude, it bears a most grotesque resemblance to a small four-legged animal with large ears—a Scotch Terrier perhaps.

In the Sargasso, where everything seems to be unusual, you may expect the water-fleas to be peculiar, too. They differ strikingly from the cute, elephant-faced Daphnids that aquarists catch from inland fresh water pools to feed to their tropical fishes. Some Sargasso water-fleas have huge eyes, so large that they dwarf the rest of the body, while other members of the cladoceran clan are completely blind.

A mid-ocean hitch-hiker

The Sargasso supports one creature that seems to be totally out of place in mid-ocean; it is an air-breathing insect that lives, not in the sea, but on top of it. It is *Halobates,* the oceanic water strider. This outlandish insect runs over the surface of the sea by means of its six long hairy legs; it is often found thousands of miles from land. The hemipteran hitch-hiker often uses the floating Sargassum as a temporary means of conveyance. The Sargassum world moves as though it were a colossal merry-go-round, but the little bug apparently does not mind because, like most of the animals of the Sargassum community, it is born and bred on the high seas. Halobates' eggs are found firmly attached to floating feathers of pelagic birds. Beebe picked up a number of feathery rafts of eggs and hatched out a swarm of Sargasso bugs in mid-ocean.

In the process of sorting the wealth of animal types picked up in Sargassum weed rafts I shook a bunch of the seaweeds over the basin; I felt and saw something fall to the water below. It looked like a weed fragment but plants do not move of their own volition and this Sargassum-like matter did move. While I was debating whether it was vegetable or animal, the ragged chunk of brown stuff turned sidewise, and I saw that it was one of the most fantastic of fishes, the famous Sargassum fish. The technical name for it, *Pterophryne* (I learned to pronounce it Ter-o-fry-nee), was bestowed upon the fish by one of America's greatest ichthyologists, Theodore Gill, the man who built the wonderful collection of fishes at the Smithsonian Institution at Washington. To keen-eyed Gill, the little fish with the large head and the many flaps looked like a finny toad, and its name, Pterophryne, is an allusion to these bold features.

Many fishermen of the tropics call Pterophryne the frogfish and some, even in the days before the fame of Walt Disney, called it the mousefish because of its curious antics, but to me it will always be known as the Sargassumfish because of its remarkable resemblance to the weed and because it is found only in closest partnership with it. When Pterophryne boards its algal trailer, it merges its animal identity with that of a low vegetable. This may appear to be a descent in its social level, but actually it is a definite step forward. When it graduates to the Sargassum status, it gains all the rights, privileges, and immunities pertaining to that status. In this biologic world Pterophryne may be difficult to see, but it sees everything. When live food in the shape of a juicy shrimp or marine worm, passes by innocent of danger, Pterophryne approaches it, not in the dress of a fear-inspiring, ferocious predator, which in reality it is, but in the guise of an innocuous vegetable.

Color changes

Pterophryne has the golden brown color of Sargassum. On its golden sides are broad, irregular, brown markings that resemble the branching fronds of the seaweed; and the round gold patches on the fish resemble the gas-filled bladders. Sprinkled over the darker brown parts are many white dots that simulate the white encrustations of tiny animals upon the fronds of the Sargassum.

Like an old-fashioned shawl, Pterophryne is fringed from head to tail. Tiny tabs of skin grow out from its head ornaments, its fins, and its body. And this fringed appearance of the fish matches the fringes and scalloping that arise from the Sargassum stems, fronds, and bladders. Curiously, the weed's small filaments are not part of the living substance of the weed, but are, in reality, colonies of small animals that have made their homes there.

Pterophryne has matched not only the appearance of the weed but the weed's tenants as well.

The Sargassumfish makes the most of its concealing coloration; it has been practicing the so-called modern art of camouflage for centuries—certainly long before man rediscovered its effectiveness during the Great War. Not only does Pterophryne have protective colors and deceiving shapes, but it practices the third and most difficult trick of the camouflage art—the trick of changing its skin coloring to match the background of its changing environment. And in this department of the art, the much-vaunted chameleon is a lubber in comparison with the speed of the Sargassumfish.

If some power of decay strikes the Sargassum home of Pterophryne and as a result the weed becomes deeper and deeper brown in color, the skin color of the fish is adjusted to a corresponding shade. And if the weed disintegrates, Pterophryne deserts it for a younger, healthier branch and again assumes the lighter color of its new home surroundings.

A cloak of invisibility is a devastating weapon in the employ of an aggressor. If Pterophryne alone of all Sargassum animals possessed it, the community as a whole would soon be destroyed. Fortunately, all the animals have, to some degree, the ability to simulate their weedy environment. And this is to the advantage of Pterophryne, paradoxical though it may seem, for while the fish's hunting is made more difficult, its hunting grounds are always richly stocked with a variety of game. The Sargasso Sea community is kept alive and thriving because Nature has struck a perfect balance of power among the animals.

Driven far from home

Pterophryne, like all ocean-going, wave-riding creatures, becomes a helpless victim of violent oceanic disturbances. When unusually strong southerly winds prevailed along the Atlantic sea-board early in 1897, they sent large rafts of weeds far north of their usual beat; later during the summer, off-shore winds of unusual force and persistence blew huge patches of Sargassum and their living cargoes inshore from the Gulf Stream. That year Hugh Smith, onetime chief of the United States Bureau of Fisheries and adviser on fisheries problems to the Government of Siam, caught twenty-two Sargassum-fish in Vineland Sound off Woods Hole, Massachusetts, by simply dipping up pieces of Sargassum with a net. In all, 100 Pterophrynes were rescued from derelict weed rafts, but how many fish were carried further north by the wind into the sphere of influence of the cold Labrador Current that sweeps down the coast of Maine from Arctic regions, nobody knows.

Often Pterophryne have been swept to uncongenial ports. Their journey's end has been recorded as far north as Norway. Outside the warm charmed circle of the Sargasso, neither the weeds nor their dependents can long survive. When the Sargassum floats are projected tangentially from the outer fringe of the Sargasso Sea, they are embarked upon a one-way ride. William Beebe's word picture captures the spirit of the sad exodus: "Bravely the fronds float along, day by day the hundred little lives breathe and feed and cling to the drifting home. But soon the gas berries decay and the fronds sink lower and lower as the current flows northward and the water becomes colder. Crabs move less rapidly, the fish nibble less eagerly at the bits of passing food. Soon a sea-horse lets go and falls slowly downward to be snapped up at once or to sink steadily into the eternal dusk and black night of deeper fathoms. Soon the plant follows and like its chilled pensioners dies."

Most of what we know of Pterophryne was learned by watching fish that were taken from weed rafts blown away from their normal course. Ichthyologists of the United States Bureau of Fisheries laboratory at Beaufort, North Carolina, and at Woods Hole, Massachusetts, have taken helpless fish into their aquaria when unfavorable winds have swept them to their shores. In the aquarium, behind glass walls, the fish are not happy at first, but when hunger gnaws, they forget their captivity and act in accordance with the dictates of their stomachs.

Fins of most fishes have many rays which stiffen them; when the fins move, they move as wholes, like open fans or paddles with perhaps a rhythmic ripple toward their tips. Pterophryne is one of the few true fishes that can close its flexible fins over objects, and this maneuver indicates a high rating in the scale of fish evolution.

Finger-like fins

Wilfred S. Bronson, the artist and author, who has studied the anatomy of Pterophryne, describes its fins, not in a text-book, but in a delightful children's book, "Fingerfins": "These marvelous fingers did not work the way our fingers do. In each of ours there is a cord which pulls to make it bend. We can bend each finger by itself. But the fingers of this little fish had to bend all at once because he had only one cord in each hand. It passed through the bottom of each ray or finger and when it pulled, they all closed together just the way a bag shuts up when you pull the cord at its neck."

So elaborately have the fins of Pterophryne been developed that terminology usually employed in the description of higher animals has been borrowed by comparative anatomists to describe their complicated movements. Professor William K. Gregory, outstanding anatomist of Columbia University and the American Museum of Natural History, and his assistant, Dwight Franklin, saw a Pterophryne thrust one of its "arms" downward, twist its "hand" at the "wrist," and with the "palm" turned outward, clasp a branch of Sargassum with its versatile "fingers."

Beebe has seen the Sargassumfish assume a score of unfishlike poses in as many minutes, swinging from frond to frond, hanging upside down, and generally giving a piscine imitation of a monkey in a jungle. But even a monkey has only five locomotor appendages. Pterophryne uses its two "arm" fins and two "foot" fins to hang on to its sea-jungle weeds; and when necessary, the top, bottom, and tail fins serve as props to keep it securely anchored to its ever-changing wind- and wave-swept weedy hammock.

In getting about in the water, Pterophryne frequently moves by a series of thrusts caused by the rhythmic jets of water being ejected from small round gill openings, one under each "arm." Its fins move gently in guiding its swimming movements which are relatively slow. It therefore relies largely on being able to approach its prey without detection. Strange, but true, fish-story teller E. W. Gudger saw a Pterophryne in stalking its living prey of alert fishes and quick shrimps, "with closed mouth draw near, and, opening its mouth suddenly, take in its prey with an instantaneous gulp."

A Pterophryne gulp is no ordinary gulp. When this fish opens its mouth to catch its victims, its jaws open so suddenly, so widely and powerfully, that a forceful current is created; the unfortunate prey is sucked down a capacious throat. Sometimes it uses the quick gulping technique for self-defense. If it is attacked by a larger fish, Pterophryne throws open its jaws, swallows water as it is on the point of being devoured, and instantly pumps itself up to an unexpected size. Thus the swallower is forced to cough up the swallowee.

Reluctant but fierce fighters

In its native haunts, Pterophryne is a strict individualist. It avoids intimate association with its fellows and will not tolerate their approach. If two Sargassumfish meet, they keep a respectable distance between them like two ships that meet at sea. But if two Pterophrynes are placed in an aquarium, a fight is sure to start. If they are of the same size, the battle goes on for days. The fish follow no wrestling code; no holds are barred. As they bite and tear each other, their fleshy head and body ornaments are ripped to shreds. Their hand-like and foot-like fins become frayed and their delicate fin-rays protrude like broken bones. With their body adornments stripped from them, they look like fish on their way to an aquatic nudist colony.

If a small Pterophryne is placed with a larger brother, the larger takes the smaller, not to its bosom, but into its stomach. Even the special trick of quickly swallowing water is of no avail in family quarrels. On one occasion, Hugh Smith saw a six-inch Pterophryne stealthily approach his four-inch relative, and then pounce on it, swallowing it at one gulp. If you stand sixty inches tall, can you imagine the task of swallowing your forty-inch baby brother, bones and all? I wondered whether there was room for the newcomer in the larger fish's stomach. Smith assures us that the bigger fish "did not seem particularly incommoded thereby."

In the aquarium this voracious glutton will take any fish offered to it, provided it is a wee bit smaller than itself. It makes no difference to Pterophryne whether the fish offered for its sacrifice comes from the Sargasso Sea or not. It makes away with all of them. And, strangely enough, when given a choice, Pterophryne selects its own relatives in preference to a different species. It is a perfect cannibal.

Beebe has a story of Pterophryne cannibalism on the Sargasso Sea. On his ocean laboratory, the *Arcturus*, he kept his Sargassumfish in a jar: "There had been three, sized like the three bears, but after half an hour we found that an inverted magician's trick had been performed—to my astonishment, where there were three, was now but one—a Pterophryne, very fat and gulping uneasily. The awful truth dawned upon us, but we never settled whether it was a case of Japanese boxes, each within the other, or whether the big cannibal had in turn engulfed his spiny and much tentacled brethren."

Family life unknown

The thought of Pterophryne's ferocious pugnacity toward its kin fish-folk is disturbing. We know that they must establish some kind of family life, for their young populate the Sargasso Sea. What psychological change takes place within their brains that calls a truce on belligerency for the period of their mating season? Is a parental instinct hormone released from their diminutive glands to calm their cannibalistic natures?

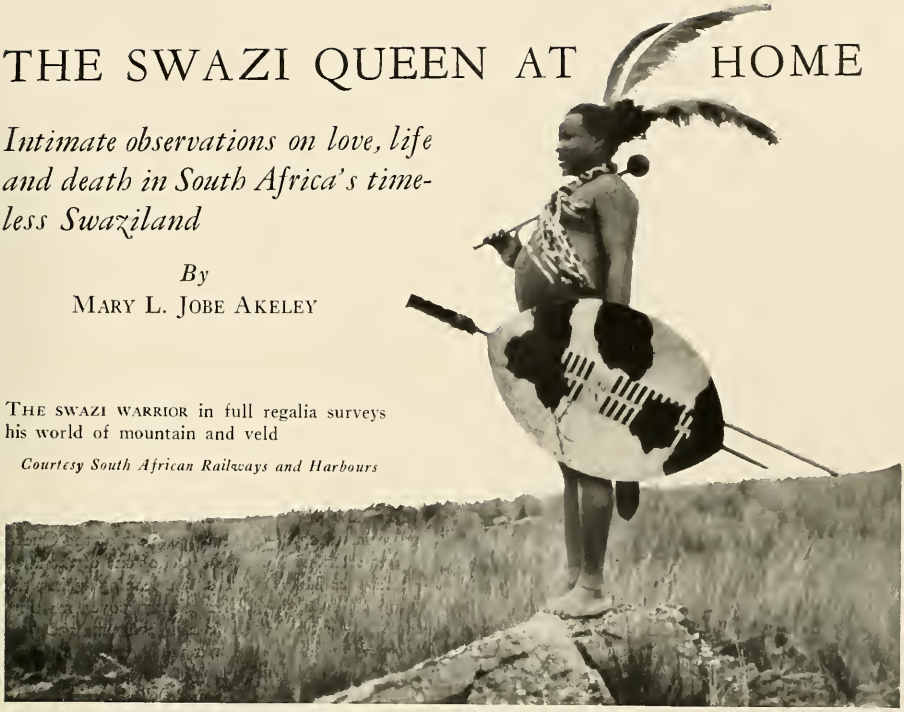
We do not know too much about Pterophryne's personal habits of life. Some of the Sargassumfish kept in aquaria by Smith at Woods Hole and by Gudger at Beaufort spawned. A ripe female Sar-

Continued on page 78

THE SWAZI QUEEN AT HOME

Intimate observations on love, life and death in South Africa's timeless Swaziland

By
MARY L. JOBE AKELEY



THE SWAZI WARRIOR in full regalia surveys his world of mountain and veld

Courtesy South African Railways and Harbours

I WAS sitting in the dense shade of an ancient tree at Lebombo in the very center of the Royal Kraal of the Queen of Swaziland. On one hand a semi-circle of rugged mountains rose 3000 feet toward the post of Mbabane, from which I had just descended by a steep, narrow road that wound above deep and narrow gorges.

There was reason enough for my waiting long under my shade tree, despite my credentials from the highest British authorities and the fact that the Swazi King Sobhuza himself had arranged my visit with his mother, the Queen—the Ndhlovu Kazi, or Cow Elephant, as she is called. For the Queen is the wisest and most honored woman in the land. Not only is she highly intelligent and trained in statecraft, but she has a gift of magic, handed down to her through a long line of queens. She is the Rain-Maker of Swaziland! Her ability to commune with the celestial powers is beyond compare. She controls the planting, the growing and the harvesting of the crops—the material destiny of her people. Not only, it is believed, can she make the rain to fall abundantly but she can also cause it to lessen and even to stop according to her will.

Now, at the very hour planned for my visit a messenger, the Queen's headman, had appeared before me:

"The Queen is engaged," he said, "in importun-

MARY L. JOBE AKELEY, widow of the celebrated explorer Carl Akeley, has won fame on her own account as educator, lecturer, mountain climber, and one of the leading woman explorers. She has conducted numerous expeditions both on this continent and in Africa, where the material for the above article was gathered during the winter of 1936. More detailed accounts of Mrs. Akeley's travels may be found in such of her books as *Carl Akeley's Africa, Adventures in the African Jungle* and *Restless Jungle*. An authority on international conservation, Mrs. Akeley spoke in May before Major Willis Robertson's Select Committee for the Conservation of Wild Life in the House of Representatives. She was appointed recently on the Museum's Trustee Committee for Akeley African Hall and African Collections.

—THE EDITOR.

ing the gods for the blessing of the rains. She cannot see you for some time."

It was no hardship for me to wait here in the midst of a strange and moving scene far more interesting than anything I had ever seen in Central Africa. The Great Kraal corresponds to a large village of the western world. More than 100 spacious dome-shaped huts lay before me. These are built on an artistically and strongly designed framework of saplings and reeds and are thatched with fine long grass. So carefully and strongly are they built that they easily withstand the heaviest rains and wildest storms and can be picked up bodily and removed to a new site. In fact after a serious illness or death the hut is almost invariably moved: no Swazi will continue to live on the same ground from which the spirit of one of his kindred has fled. Furthermore, moving the hut to a fresh site is an easy substitute for spring house cleaning.

Presently a beautiful young woman, Princess Sincababi, sister of King Sobhuza, came out to greet and entertain me. As she crossed the wide plaza she scattered a bevy of youngsters who had gathered at a respectful distance from me but who had been looking at me in wonder and amusement. For it is a matter of moment when a white woman visits Lebombo, especially when she arrives alone as I had done. Small boys entirely naked, their somewhat older brothers garbed only in a tiny apron of cat skin, little girls without clothing, except for strings of bright colored beads at neck and waist, smiled diffidently or gazed at me in wide-eyed wonder. Then, as if deciding upon a definite campaign, they had rushed at me holding out their beautifully slender hands and begging "a sweeta," "sweets" in the white man's vernacular.

A native princess

Sincababi's welcome was unmistakable. "My brother has told me of your visit," she said, as without a hint of race inferiority she grasped my hand and seated herself beside me. She was, indeed, an attractive personality in her brightly colored cotton shoulder draperies and billowing skirt of soft tanned leather—the wedding gown every Swazi husband gives his bride.

But I soon found that Sincababi's charm extended far beyond her regular and beautiful features, and her erect and imposing figure. She was not only highly intelligent, but she had been carefully educated as had her royal brother in the native college at Lovedale, Cape Province, and although she spoke English reluctantly, we became great friends in the following weeks and she proved an invaluable interpreter for me.

Now, in our own country no visiting stranger would be particularly pleased to be given a seat beside a cattle pen and made to remain for an hour or two. But as I chatted here with the Princess while awaiting my visit to the Queen, I got an inkling of the significance of the cattle kraal among these people. It is the civic and religious center of the village, both among the Swazis and the Zulus. Here the king or queen holds council. Here the elders meet. Here occur the general assemblies, and also the most sacred rites, ceremonials and feasts. Later on by the Queen's own invitation to the cattle kraal I was privileged to witness a meeting of the council of the elders in which they discussed the vexing problem of their own self-imposed taxes. Although given a seat such as I had never occupied before—a pile of dry cow dung, sun-baked and as hard almost as concrete—the seriousness and dignity of the occasion was unmarred by this unusual experience.

After enjoying Princess Sincababi's company for an hour or more, I was finally ushered with considerable formality into the Royal Presence. One of the Queen's ladies-in-waiting had come over to where I sat and now preceded me into the large central enclosure in which are the spacious huts of the Queen and her attendants. In the shade of one of the largest huts Her Majesty was seated leaning against the outer wall on a strip of beautifully woven matting. She smiled, extended her hand in welcome and then motioned me to sit on a mat which one of her women unrolled beside her.

"*Saku buno* (How do you do)," she said.

"*Saku, buno, Nkosi* (How do you do, Your Majesty)," I answered, and then, through an interpreter—for at that time I had learned only a few words of Swazi—I had my first audience with a native queen.

The Ndhlovu Kazi was indeed an imposing per-

sonality. She was past middle age, tall and large of frame. Her features were strong and her countenance bespoke both a forceful and intelligent mind. Her hair was dressed high, in the fashion of her tribe, and her lofty forehead was encircled by a fillet of small pieces of polished wood, in the exact center of which a scarlet feather of the sacred *sakubulu* bird stood upright. Unlike the women of her court, she wore not the smallest thread of white man's creation. Her voluminous skirt and her *mahea* (shoulder covering) were both made of soft black leather. About her neck hung amulets, while about her ankles were ornamental circlets, likewise talismans. She wore no sandals. Like all of her own blood her feet were small, beautifully shaped and meticulously cared for. Each day the feet of the Swazi women and men of high rank as well as those of middle class are scrupulously washed, massaged with oil and polished with a soft pumice stone. Sandals are disdained as impeding their always graceful carriage.

Her interest in the outside world

As the Queen Mother continued her gracious greeting and I informed her that I had traveled a long distance to see her and to learn a little of the customs of her people, it was evident that she was puzzled as to my nationality.

"But you are not English? From what country do you come?" And she looked me over carefully. Then I told her I came from America.

"Oh, is it from that land that sends us many missionaries?" she smiled.

"Yes, but I am not a missionary," I replied. "I have come to *learn* from your Majesty and from your people—certainly not to teach them."

In this same connection, I later heard a story told about the King, Sobhuza. One of the English residents of Swaziland asked him one day why he, an intelligent and enlightened man, did not attempt to have his people embrace Christianity. To this Sobhuza replied:

"Here in my country, or near by, are many missions—the Church of England Mission, the Mohammedan Mission, the Wesleyan Mission, the Nazarene Mission, the Methodist Mission, and the Catholic Mission. I am told that these missions do not agree with each other or in what they teach. I believe in truth and in right living. I believe in a god and in love for my fellow man. But how am I, only a native, to judge which of all these missions is the right one to follow?"

"What is it you most want to see," the Queen next asked me.

"I especially want to study the life of your people here in the Royal Kraal, and to know, also, of the life of your subjects who live in small kraals far away. I want to see your beautiful country, your high mountains, and the great wilderness of the Low Veld."

"But please tell me," said the Queen, "why are you traveling alone? Where is your husband?"

"My husband is no longer living," I replied. "He lost his life here in Africa while studying the great apes in the land far to the north. He loved Africa; he knew and loved the people and the animals, and spent many years here."

"That news causes me much sorrow." The Queen spoke slowly. "It is a very sad thing for a woman to be left a widow. That I know well. But I hope you have many children to comfort you?"

"No, I have no children."

"Then indeed you must be lonely."

In a moment, our conversation turned to Central Africa, that region from which her own Bantu ancestors had migrated in years long past.

"Now will you tell me about that great country by the Victoria Nyanza? Is it very different from our Swaziland?"

I described the equatorial regions—the lakes, the forests and the mountains.

"And what animals live there," she next inquired.

I told her that many of the animals were similar to those living in Swaziland and the Transvaal. "There are elephants and buffaloes and lions and many kinds of antelope."

In this information she seemed greatly interested. From the earliest days in her own country certain lands have been kept exclusively as hunting preserves for the king. And in these areas are staged great hunts in which a regiment of warriors drive the wild beasts in a vast herd before the king.

Next she asked about the climate of the far country, and whether there was much rain.

"It is often very hot, and when the rains fall, they descend in torrents. In the equatorial regions the climate is not nearly as agreeable as in Swaziland, where the temperature is so equable."

Thoughts of a rain-maker

At this the Queen laughed a little, saying, "Although I love my land, the weather is often too hot, and now and then far too cold."

The significance of the Queen's questions about the climate of other parts of Africa presently occurred to me. Her mind was on the problem of making the rains come at the end of the dry season. Then and there I resolved to find out as much as possible of this ancient ceremony.

Courtesy South African Railways and Harbours

SWAZI ELDER and "clothesline." Lovers of personal decorations, the men of Swaziland supplement their fuzzy coiffure on feast days with such fine feather garments as are seen airing on the walls of the hut above

(Left) NEIGHBORLY ASSISTANCE is required in applying the "head ring"—a two-inch-wide band made of beeswax, clay and plant roots which is sewn into the thick hair surrounding the shaven crown. This fashion is fast dying out and is now adhered to only by the elders *Photo by Mary L. Jobe Akeley*

South Africa's Timeless Swaziland

(Right) A HUSBAND waiting for the dinner his wives are cooking in the pot at left. His head is coated with white sand, a twofold Swazi treatment that gets rid of vermin and makes the hair curly

Photo by Mary L. Jobe Akeley

Photos courtesy of South African Railways and Harbours

(Above) YOUNG BLOODS preparing for the ceremonial dance. On reaching puberty, Swazi maidens shun male company during a 12-month novitiate which prepares them for a woman's duties

GRINDING MAIZE is typical of the Swazi wife's household duties. The husband is essentially a cattleman by trade; the wife sows crops and reaps them, weaves mats like the one on which she is kneeling, and brews beer. Arranging the puffy hairdress takes up her spare time

THE SWAZI QUEEN AT HOME

(*Right*) Some of King Sobhuza's Warriors. The tallest man is custodian of the King's wives

(*Below*) Commoner's wife, distinguished from royalty by plainer dress and coiffure. Polygamy prevails in Swaziland, and the commoner's first wife is automatically the headwife. But a chief may choose his headwife at leisure

Photos by Mary L. Jobe Akeley

(*Below*) Wives and their work. Constructing the intricate and durable windscreens here shown is a woman's task. Note the neatly woven rope binding on the beams. Uprights and crossbeams are peeled saplings; the thatch is made of reeds obtained from the river bank

(*Below*) Prosit! A Swazi elder, in ceremonial finery, prepares to sample a gourd of maize beer. Beer is important in Swaziland and is the visitor's customary gift to the Queen

Courtesy South African Railways and Harbours

Photos by Mary L. Jobe Akeley

(Above) WARRIORS AND WEAPONS. Most distinctive Swazi armament is the highly polished knobkerry and wooden throwing stick. Something like a crude brassie in appearance and made from a seasoned sapling with a part of the root chopped off roughly, the knobkerry is equally effective in killing an animal or braining a man

(Above) SONG AND DANCE are favorite pastimes of the Swazi regiments. Working hours are spent tending cattle, the main source of wealth of these pastoral people and their medium of exchange. A suitor must pay a gift of *lobolo* (marriage cattle) to his bride's father as security, but she is not his slave and he cannot sell her

Photo by O. Tugwell

THE SWAZI QUEEN AT HOME

(Left) DEBUTANTE with hand mirror for the almost constant primping that inevitably accompanies husband-seeking

(Below) SWAZI BATHING BEAUTIES. Careful of their personal appearance, Swazis indulge in frequent baths in their beautiful country's swift streams. Life is happy and unrepressed among the Swazis. Nature contributes generously to their needs, and when she fails, they have a rare type of social security. No man will go hungry as long as his friend has food

Courtesy South African Railways and Harbours

But right now, I was faced with a rather difficult and delicate proceeding. I had been told that I should present to the Queen a gift of the Swazi national beverage—beer made from fermented maize and kaffir corn. It was arranged that I should purchase a large pot of this beer in the kraal, and that three or four of the royal granddaughters in their early teens should bring my gift to the Queen. But before these children-in-waiting appeared, the Queen herself ordered beer to be brought from her own private cellar. A great black bowl was placed before us, and with a woven grass skimmer one of the young girls removed the froth from the newly made and still fermenting beer. I knew it would be discourteous to refuse to drink with the Queen, yet I was almost equally certain that I could not take even a sip of the beer. Then I had an inspiration.

"You must tell the Queen," I said to the interpreter, "that my doctor does not permit me to drink anything that is fermented."

The interpreter said to me, "Oh, try to go through the motions."

"No," said I, "I am afraid the Queen would catch me cheating."

Fortunately for me, the Queen appeared to understand my dilemma. She took up the bowl and drank, and then passed it to the interpreter, who drank valiantly. It was lucky that I had avoided giving any offense at such a time, since it would have impaired my welcome.

My own gift of beer was then brought in and presented to the ladies of the court. But I was glad when my first beer-drink was concluded and I could turn to the other gifts I had brought to the Queen.

I had brought some bright cottons and silks and a quantity of beads, among which were some large yellow ones. The Queen immediately selected these beads from among the others and, turning to one of the women, said: "These are exactly what we need to finish a small garment being made for my granddaughter's ceremonial costume."

Swazi styles

The garment, which was presently brought, was a little modesty skirt, consisting of a tie-around belt decorated with small brass buttons and beadwork, while on the lower edge of the belt was a deep full fringe of yellow beads not yet finished. The supply of beads in the only trading store in the community had been exhausted, and that was why my gift was so appreciated. In the distance the slender young girl who was to receive the garment stood smiling.

This costume, I learned, is worn for a few years by a child of twelve or more, and is especially designed for wear during the *incwasho* ceremony, which is a ritual preparatory for adult life and marriage, lasting throughout an entire year. During this time, these young girls are formed into groups and receive instruction in the building of huts and wind screens. And when they have passed the age of puberty, they must, for the first time, wear a shoulder drapery, which covers slightly the upper part of the body in front. During this ceremonial period, the boys are not permitted to speak to these young girls—although I have seen groups of these maidens giggling and casting sheep's eyes at the boys and acting very much like the young girls in our so-called civilized community. But if a boy so much as touches the costume of one of these maidens, he is subject to a fine and if he should transgress even further, he may be required to pay an ox. After the year's novitiate is completed, a great ceremony occurs, with much singing and dancing and feasting on roast oxen, and drinking of beer.

After another year or so passes, the girls are taught to cook, to weave, and to care for babies, in preparation for marriage and motherhood. At this time, they are permitted to sleep in their own quarters, to enjoy the society of the opposite sex, and to begin their lovemaking.

I was particularly attracted by the Swazi style of hair-dressing. The heads of the little tots were closely cropped, while the little girls of eight or ten wore their hair dressed in long ringlets. I noticed that many packed their hair in white sand for two or three days. It has the twofold virtue of causing the hair to fall in small curls and of destroying vermin.

Debutantes

Some time after the ceremony of *incwasho,* the maiden puts up her hair which indicates that she seriously contemplates marriage and makes it possible for any young man to pay his addresses to her. When I later watched these debutantes in the kraals or walking to and fro along the footpaths, there was no mistaking that they were "in the market." Gaily dressed, laughing and coquetting, these lovely creatures were by no means backward in showing their interest in the Swazi youths. The maiden, when she has decided to "get her man," will even go to the extreme of dancing before him and throwing to him her bracelet of beads—which, if he takes her seriously, he will wear.

Princess Sincababi explained that after marriage the elaborate high, puffy headdress is called *sicobo.* The hair is gathered up all around into a high knob, which in her case stood eight inches or so above her head.

"But how do you make it stay that way?" I asked her. "Is it rolled over something?"

"Oh, no," she replied, "just touch it."

The mass of hair was soft and fluffy.

"This is how it is done," she said, pulling out a heavy thread just above her forehead. "The hair is combed up to its full length and then this string is wound round and round. The height of the puff depends on the length of the hair."

Finally little strands of hair are pulled out from the binding with the aid of porcupine quills, so that it is concealed with fluffy hair. No woman can accomplish all this alone. They arrange each other's ringlets on forehead and neck, using a sticky decoction from a plant for fixing the fringe in a permanent curl. As a finishing touch, they pour on the hair a little perfume made from flowers. Highly decorative wire hairpins, seven or eight inches in length, are thrust through the amazing coiffure, and these are also used for scratching the scalp when the need arises. At long intervals the topknot is taken down for washing and for the extraction of vermin.

The Swazi women of high estate spend many an hour before their mirrors. As a rule, they have several young girls as servants, to assist in the household, in the care of their hair and in their frequent baths. The attention which these ladies give to their hands and feet alone consumes much time.

Native dandies

The desire to look smart is not confined to the women, because the Swazi men also dress their hair most elaborately. It is rubbed with sand and herbs for reasons previously mentioned, and is so regularly washed that the color is often changed from black to reddish brown as if henna dyed. The *induna* of the King's own regiment, whose hair was almost red and seven or eight inches in length, combed it into a soft bushy mass, reminding me of the Fuzzy-wuzzies of the Sudan. His hair was adorned with long hairpins decorated with bright red and blue beads. Like many another young unmarried man in his regiment, he frequently consulted a small hand mirror while dressing, and whenever he sallied forth, he carried the mirror in his hand together with his beautifully polished throwing sticks.

During the next two months I frequently revisited the Royal Kraal. One day, I found Sincababi at work in the courtyard about her dwelling, which was undergoing its weekly cleaning. The Princess and two or three assistants were in the midst of what seemed to my Western eyes a most peculiar undertaking. There was no scrubbing of the hard-baked surface. Some were brushing away all the loose dirt, while others covered it with fresh cow dung mixed with water. The Princess was carefully spreading this coating, which has the consistency of freshly mixed cement mortar. In fact, here in Swaziland it takes the place of cement mortar, for when the surface is dry it is not only hard and entirely without odor, but it also serves to exclude the grass ticks with which the veld abounds.

Sincababi was instructing a woman of lower rank and a young boy in the application of this natural veneer, and she brushed it here and there so deftly that not a speck touched her hands or feet. As she finished she walked over to me and said, laughingly:

"Oh, this has to be done every week. However, I don't mind, I only smooth the surface."

To the right of the Queen's courtyard dwelt the wives of the King who had taken up their residence here shortly before the birth of a child and who would remain here during the child's infancy or until summoned back into the King's own kraal 20 miles away. Since they were under the protection of a special officer of the King, I rarely had more than a glimpse of them. They are of very high caste, comely, often very beautiful. Their life is devoted to the rearing of their children, under the Queen Mother's guidance, and in directing their servants.

On the cattle standard

The wealth of these pastoral people is estimated in terms of cattle. Everywhere I saw cattle grazing on the hills, carefully tended by the herd boys; and woe betide the child who ever fell asleep and allowed the cattle to stray. The cattle of the ancient Swazi kings, accumulated by conquest or by raid, amounted to tens of thousands. Added to these were cattle given to the Queen for her rain-making, by Zulus as well as by Swazis, for she was also their traditional rain-maker. Then, when the daughter of a king was married, large herds of cattle were presented by the bridegroom or by his father, who being men of wealth and distinction, could give many.

Swazi youths as well as maidens are prepared for marriage. In their long novitiate they forego the society of girls, become careful of their personal appearance, and devote themselves wholly to physical training and to the attainment of man's estate. Then comes the period of courtship. If the suitor is accepted he speaks to the girl's father about the *lobolo*, or marriage cattle. If unable to pay all the cattle at once, he may "pay in earnest" one beast thus permitting the proper betrothal of the couple. Then they may be lovers for several years prior to their marriage. When the wedding approaches and the father of the bride-to-be receives the gift of cattle he promises to protect her in case of necessity either during the marriage or in the event of her widowhood; while the husband-to-be guarantees his good conduct toward his future wife. This custom, widespread among all Bantu peoples and practiced by Orientals from earliest times, is by no means a contract of sale. The husband is not permitted to enslave or maltreat his wife, nor can he sell her to another man. He may thrash his wife now and then, but he must be careful not to incapacitate her for child bearing or to cause her death.

When a severe dispute takes place, the father of the wife will go far to effect a reconciliation, because otherwise he will be required to return the *lobolo* cattle and also their increase. If, however, the husband should stray from the path of virtue and the wife returns to her father, the *lobolo* cattle will not be returned. In the happy society of Swaziland, there are no lone widows. After the period of mourning has passed, the bereft women are espoused to a brother of the deceased husband.

Polygamy

I was constantly impressed by the obvious happiness of the Swazi family. I would often see the head of the house laughing or chatting with his five or six wives while half a dozen toddlers rolled about the kraal playing with each other. I was told that since polygamy has been an institution among the Bantu peoples from time immemorial, there is no question in the minds of these wives as to the desirability of that ancient custom—in fact, that a first wife is not happy until her spouse brings home another wife or two. She is not honored to be the solitary wife of a man who cannot afford other wives. Then, too, the Swazis are a friendly, sociable people, and when the husband is compelled to spend much time away from home, the wife is far too lonely by herself.

In the case of the common man, the first wife married becomes his chief wife, responsible for the domestic life of the kraal and overseeing the younger wives in their work. This rule does not apply to the hereditary chief, who when advanced in years may choose a chief wife to become the mother of his heir. Her *lobolo* is not given by the chief but is made up wholly, or in part, by the tribe. And on her wedding day her status is publicly announced.

Sincababi explained the life of the family to me.

"You see," she said, "in every household there is a proper division of labor. The husband plows the fields, oversees the herds, builds and repairs the cattle kraal, slaughters an ox when necessary, and keeps the larder well supplied. He must also give his wife all utensils and clothing which she is unable to make for herself. The wife, on the other hand, attends to the sowing, the weeding, and the reaping. She must grind the corn and make beer—yes, much beer. She must prepare the food, weave the mats and the grass ropes, make the wind screens and keep the hut in order. Oh, yes, a Swazi woman is always busy."

Then she told me how in Swaziland there is no family dinner table. "The man eats alone or with his adult sons. His wife prepares and carries his food to him, and then returns to her own hut, where she and her little ones await the fragments which her lord will send to her when his own appetite is satisfied."

I found the Swazi people ever kind and courteous, and possessing an idea of generosity almost unknown in our own society. They have a rare type of social security. Never will a man go hungry as long as his friend is supplied with food. Nature contributes generously to their needs, and there is little repression, except for the observance of the simplest laws.

I had been many weeks in Swaziland before I had any adequate idea of the rain-making ceremony, in which the Queen Mother had been absorbed the day of my first visit. Finally one of the old pioneers and a counselor to the Swazi kings, David Forbes, told me the complete story. His vast estates in Swaziland and in the Eastern Transvaal adjoin the land of the Swazis, and he has been their confidant since boyhood.

Rain-making rites

Now and again, as I returned to Lebombo, light rains were falling and an occasional thunderstorm refreshed the land. The Queen had ventured to me, "It isn't raining yet, it's just trying to rain."

Now this is the story of how the rain is made:

The symbol of the rain-maker's power is a small sacred stone—carefully guarded and protected by a mat-like covering. This stone, handed down from one reigning family to another, *is the rain,* so they say. When the rains are due the stone is taken from its covering and placed in a large bowl of cold water where it is left until its potency has permeated the water. After this it is removed, and roots and herbs are added to the liquid. The concoction is then stirred until it effervesces and overflows the margin of the bowl. Then a broom or twig is dipped into the liquid, and the doorway of the Queen's hut is sprinkled with the foam. As the drops of water touch the doorway the moisture is taken by the winds into the heavens. This part of the ritual is called *iseqholo.*

During all this time the Queen may neither talk nor eat. If she speaks the spell is broken. This period of silence is called *fukumu,* which means "brooding" or "hatching out" as a hen hatches eggs. The Queen devotes her unremitting attention to this ceremony of "hatching out" the rain. Frequently the rain falls almost immediately after the conclusion of these rites and the belief universally obtains that the communion of the Queen with the heavenly powers is the direct cause of rain.

On occasions, even when the rains are due, the rain gods fail to acknowledge the Queen's supplications. Then the King will devote himself to similar rites. If the spirits continue obstinate, then will the King and Queen labor jointly. If even then there is no rain, resort is made to the witch doctors who go into a trance and declare that sacrifices are necessary at the tomb of the kings, in order to propitiate the spirit of some great grandfather, angry because he has been forgotten. This solution is in accordance with the religious belief of every Swazi, that while on earth he is constantly watched over by the spirit of his nearest relative, who, if neglected, can send disaster. When the rain-making is in progress Swazi chiefs, headmen and common natives send gifts of cattle to the Queen to insure rain for their own fields, for the rain-makers can control the distribution.

To stop the rain

When the rains are too abundant, the Queen Mother who has also the ability to prevent rain, goes into the open and brandishes a broom coated with red clay across the heavens. The rain clouds vanish and the sky will turn the color of the clay in a rosy sunset. Whereas the rains made by the Queen are usually light showers, those made by the King are heavy and violent and frequently accompanied by terrific thunderbolts.

According to the legend, the Basutos living on the Black Mboluzi River had the original power of making rain; but when they were conquered by the Swazis, the victorious King possessed himself of the rain medicine—the sacred objects of the rain ceremonial. The King, following Basuto custom, gave the medicine into the hands of his chief wife, the Queen Mother, and in her keeping it has resided ever since. The Basutos surreptitiously retained a fragment of the rain medicine, but so small a part that the chieftainesses of this clan today can cause only the lightest showers. Today when the Swazi King and Queen have in vain utilized their last and most potent rain medicine they are said to summon the Basuto rain-maker to join them in their efforts. When I was in Swaziland the rains were long delayed. All along the roads rain cattle were being driven into the Lebombo Kraal. More than once it was said that soon the Basutos would be called upon for help.

I was told that as soon as a Swazi messenger arrived at Lebombo with cattle, he would go into the cattle kraal and, lifting up his voice, would say something in this wise:

"What wrong have we done you of the Right Hand? We are dead! The country has decayed! We even lack water to drink!"

An *induna* then would conduct the lamenting Swazi into the presence of the Queen, where his complaint would be set forth more elaborately. The Queen Mother would sympathize with him, and if the rain-making was in the course of preparation she would tell the messenger to hurry home, but would order him not to wash in any water on the return journey, for if he should, the rain when it came would not fall beyond the place at which he bathed.

Just as the spirits control the rains and crops, I was told, so do the gods hold sway over the great events in human life. When a man has almost reached the century mark, and his death occurs, his descendants will not concede that he has died a natural death. "Poor old man," his son, a grandfather himself, will say. "Think of anyone taking the trouble to cast black magic upon him. He would have died in a year or two in any case."

"Smelling out" the wicked

Since a wizard is considered responsible for casting a spell upon an unfortunate person and causing his death, the witch doctor is called and a "smelling-out" occurs. This "smelling-out," described to me by two responsible eye-witnesses, takes place somewhat in this fashion. The clan is informed that the chief, for example, is ill, and that a spell has been put upon him. Unless it is removed and the wizard found and punished or executed, the chief will surely die. Rumors meanwhile have been afloat that a particular man or woman—someone who would definitely profit by the demise of the chief—is the wizard. The witch doctor takes his place in the center of the assembly, armed with a "divining rod." This is a stick about 20 inches in length on the end of which is fastened the brush of a wildebeest's tail. With this emblem of his super-natural powers held aloft in his hand he charges about the circle with his nose pointed now on this side and now on that, to detect if possible the culprit. To the witch doctor the evil wizard has a most horrible smell, which only he can detect, hence the term "smelling-out."

During all this time many natives in the circle are turning their thoughts on one suspected individual, who, quite innocently, at least according to our way of thinking, is sitting there wondering what is going to happen. He may be wearing a red shoulder covering. The witch doctor begins to perform carefully taking his cue from the excited onlookers. As he leaps about he will say, for example, "I see a man shaking his head." If he is not "warm," as the children say in their game of "hunting the thimble," the audience remains silent. If the witch doctor goes a bit nearer the suspected culprit and repeats, "I see a man," and so on, he will perhaps hear a murmur of approval. This is his cue. Finally, prancing about the circle, the witch doctor reaches the man condemned in the opinion of his fellows and repeats his formula, this time holding his nose because of the "dreadful smell." Whereupon the onlookers will shout in a loud voice, *"Si ya vuma,"* which means, "We agree."

Then the supposed culprit, seeing many eyes fixed upon him, will naturally display nervousness or fear; and when he does, all is plain sailing for the witch doctor. He then shouts, "He is wearing a red *mahea!"* and the audience literally howls, *"Si ya vuma."* There is nothing left now for the witch doctor to do but to flourish the wildebeest's tail over the man's head and thrust it in his face, crying, "This is the guilty man. This is the wizard."

So great is the authority of the witch doctor that the assembly is sure he has found the man who is causing sickness or death in the kraal, and the accused man himself is powerless to deny the charge. He remains overcome with the revelation of his crime, which until then he had never even contemplated. And as they lead him away to make restitution either by the payment of a very heavy fine or, as in an earlier day, by forfeiting his life, he only looks around him in astonishment and repeats over and over again, *"I never knew before* that *I was a wizard! I never knew that I was a wizard!"*

To the shades

When a great man dies, an hereditary chief or a king, his burial is the most impressive of all ceremonials. The deceased, placed in a sitting posture, is sewn into the skin of an ox; if he is very important, into the skins of several oxen. And after an appropriate period of mourning, he is carried in a great procession to the tomb of his ancestors, where his spirit will assume the role of guardian angel. There his body is seated facing east. About him are placed certain objects which the ritual of the nation demands must be buried with him. Any person touching these objects will be punished by death meted out to him by the departed spirit. In old King Mswazi's time, it is said that his snuff bearer, his butcher, his mat carrier, and one or two young girls were killed at the time of the King's burial and interred nearby. All of these high servants of the King were well aware during their lifetime that they were marked men. And in a still more ancient time, so the tradition goes, it was customary to bury with the kings two or more living maidens who would watch over the repose of his soul until they too joined the spirits of their forefathers.

In King Mbandene's time, however, he gave strict orders that this custom of his grandfather, old Mswazi, should be abolished, and that he be placed in his grave without any human sacrifice. And when Mbandene undertook his last long journey it was an occasion without equal for solemnity. His body was carried by men of royal blood followed by the great chiefs of the nation. The procession, lighted only by the stars, filed across the mountains near Mbabane to the royal tomb at Dhlageni, where, at the black hour of midnight, the body of the great King was placed in a natural vault of rock amidst the sepulchers of the ancient monarchs.

Where time changes naught

One day toward the close of my stay near the Royal Kraal I climbed far above the valley to a peak near Mbabane, which gave a view of Dhlageni. Here among the loftiest, the wildest and most inaccessible mountains of Swaziland are located the Tombs of the Kings. They are natural caves in a great rocky kopje, standing high above the surrounding country of rolling hills and meadows, cut here and there by wide rivers or small, swift-flowing streams. Here amid these towering crags lie the mortal remains of all the ancient Swazi kings; and here, too, the present King Sobhuza will one day join his glorious ancestors. The ground encompassing the graves is sacred. The last resting place of the great monarchs is guarded by a chieftain of exalted rank and no one dares approach the spot without his knowledge. All about is wilderness. No stick nor stone nor bit of vegetation is ever disturbed; no fire is ever lighted, and no loud noise is ever heard.

At wide intervals some Swazi in peril of his life will seek sanctuary in this virgin bush, and there he will remain until his pursuers depart and leave him free; or, if they refuse to do so, there he will stay until he dies. Save for this rare intrusion of the fugitive and the occasional visit of the worshiping descendants, the Swazi kings sleep on in unbroken peace.

THE PANDA: A STUDY IN EMIGRATION—*Seemingly a rare Chinese bear, Asia's most publicized mammal of recent years has been traced back to a pure American ancestry and turns out to be a cousin of our familiar raccoon*

By EDWIN H. COLBERT
Assistant Curator, Vertebrate Palaeontology
American Museum of Natural History

WITHIN the past few years America has become giant panda conscious, as a result of several elaborate and widely heralded expeditions that have gone out to bring back these animals, dead or alive. Dead for museum collections and alive for zoological parks. Consequently the public has been made more or less familiar with the black and silver coat and black spectacles of the giant panda of the western Szechwan mountains. But there has been such a hullabaloo raised about the giant panda that his small cousin, the little or lesser panda has been forced into the dark shadows that surround the limelight, even though he is occasionally to be seen in museums or zoological parks. And in spite of the fact that much has been said about pandas recently, because of the excitement caused by the arrival of live giant pandas in this country—the first to be successfully captured alive and kept in captivity—very little attention has been given to the zoological relationships of these animals. What is a panda, and why should it be such a zoological rarity?

To understand the pandas, both the lesser and the giant, it is quite necessary to know something about their sisters, cousins and aunts, not to mention their grandparents. The truest understanding of any animal is to be had first by a thorough appreciation of its affinities to its living relatives, either close or distant, and secondly by the knowledge of that animal's ancestry—in other words, its family tree.

Bear-like appearance

It has been a common practice for many years to regard the giant panda as a sort of glorified bear, perhaps one might say a bear once removed. Indeed, this view is well expressed by the alternative name whereby this animal is often called the "particolored bear." Certainly, in its size, its general proportions and its superficial appearance, the giant panda would seem to show many resemblances to the bears.

This idea of the giant panda as a member of the bear family is not without a great deal of merit, and many noted zoologists have subscribed to the opinion that the giant panda is merely a specialized offshoot from the bear group. But there has been another school of thought which has maintained that the giant panda is, of all things, nothing more nor less than an overgrown raccoon. And between the bear adherents and the raccoon favorers there has been a group of fence sitters that would regard the giant panda as an animal intermediate between the bear and raccoon families. So the question has stood for many years, with the bear proponents and the raccoon adherents and the middle-of-the-road group advancing their several arguments with the clearest of logic, while in the meantime the giant panda lives serenely in the mountains of Szechwan with never a thought about the zoological controversies he is causing by just being himself.

New anatomical studies

Recently Professor Gregory has made a new study of this problem, and it would seem that he has struck the solution of a knotty question by his clear recognition of a few basic facts. In the first place, Professor Gregory, confirming anatomical studies made by Mr. H. C. Raven, has shown that the relationships of the lesser panda serve as a key to the problem of the giant panda's affinities, and secondly he has shown that a true understanding of the zoological position of both of the pandas may be had by a study of the ancestry of not only these animals but also of the bears, of the raccoons, and even of so familiar an animal as the common dog.

Now there has been a general consensus of opinion among zoologists that the little or lesser panda is a specialized type of raccoon. Internally and externally this animal shows its raccoon affinities: internally in the skull, which is a raccoon skull that has become rather deep; in the teeth, which are robust exaggerations of raccoon teeth; and in the skeleton, which is a raccoon skeleton grown heavy; externally in the general size and body form, and particularly in the long, ringed tail—the common possession of so many members of the raccoon family.

How is a large, bear-like animal such as the giant panda to be connected with the rather small, raccoon-like lesser panda? The answer to this question lies in the fact that the giant panda is merely a lesser panda grown large, and the bear-like features of this animal may be attributed to what is known as convergence between it and the bears. That is, when a small panda grew into a large panda it became secondarily bear-like, mainly because of its increase in size and a change of habits.

The bear-like skull of the giant panda is due to the development of large crests and heavy structures for muscular attachments, as often happens among the larger carnivores. The teeth of the giant panda, perhaps the most bear-like of all its characters, are definitely specializations from lesser panda teeth, whereas the teeth in the bears have had a very different origin. Naturally the attainment of a large size by the giant panda has resulted in the development of a bear-like body, while the shortening of its tail, though constituting a resemblance to the bears, is undoubtedly due to the suppression of a long tail, such as is seen on the little panda.

Fossil history

This is all very fine, but how are we to know that these resemblances between the giant panda and the bear, attributed to a similarity of response to a given set of conditions—that is, convergence—are not due really to a true familial connection between the bears and pandas? The answer to this, as is so often the case in the study of our modern mammals, may be found in the fossil history of the pandas, raccoons, bears and dogs.

In upper Eocene times, perhaps some thirty million years ago, the ancestors of all of the modern carnivorous mammals developed from certain of the very primitive Eocene carnivores. These ancestral true carnivores of the upper Eocene are known as miacids, and they were small animals, very similar to some of the modern Asiatic civets in their general appearance.

During the Oligocene period there evolved a small, slender, dog-like carnivore, known as *Cynodictis,* an animal, perhaps no larger than a mink, characterized by its long, slender body, its elongated, heavy tail, and its short legs. These are primitive carnivore features, still preserved in some of the more generalized civets, or genets. The head of *Cynodictis* was long and narrow, with a pointed muzzle, large eyes, and probably large ears.

Certain descendants of *Cynodictis* developed long legs for swift running, the skull grew long and rather slender and the brain reached a high stage of development. These were the members of the family *Canidae,* the dogs, wolves, coyotes, jackals, foxes, fennecs and their relatives. They constitute the central, and in many ways the least specialized group of this general assemblage of dog-like carnivores. Some of the early dogs of Miocene age are clearly descended from the ancestral *Cynodictis,* and are just as clearly closely related to the later and more modern dogs that are familiar to us.

At the beginning of the Miocene period some fifteen million years ago, there appeared the first raccoon. This was an animal known as *Phlaocyon,* an offshoot from the ancestral *Cynodictis,* and indeed not so very different from the early, stem form. *Phlaocyon,* in turn, was very similar to the modern genus *Bassariscus* (often known as the cacomistle or the ring-tailed cat) now living in Mexico and southwestern United States. The ancestral *Phlaocyon* showed its primitive heritage in its small size, long, slender body and long tail, rather short legs, large eyes and pointed muzzle. It is probable that this grandfather of all of the raccoons had a ringed tail.

From this ancestral raccoon type the modern American raccoons evolved, mainly by an increase in size. Thus there came into existence the raccoon of North America and the coati-mundi of the more tropical regions of the New World. The kinkajou, another member of the raccoon family was evidently a separate and independent outgrowth from the ancestral type.

Migration to Asia

It would seem evident that some of the raccoons migrated to northern Asia by way of a land connection, which in upper Miocene and Pliocene times, some six to ten million years ago, bridged the Bering Straits. Spreading to the south these animals found conditions favorable, so that they grew in size and became specialized in various ways—particularly to new diets. Thus the lesser panda evolved from his raccoon ancestor. During the Pliocene the little panda, and some of his closely related cousins, now extinct, became widely spread throughout Asia, and extended to the west into northwestern Europe.

A few million years ago, some of these outgrowths from the little panda stock began to increase in size. As they became larger they became heavier, the tail was secondarily shortened, and gradually the giant panda evolved as a specialized descendant from a little panda ancestor.

Courtesy N. Y. Zoological Society

From its 'coon-like face to its ringed tail, the little or lesser panda *(above)* shows clearly its relationship to our familiar raccoon. But less obvious features had to be studied to reveal that the giant panda *(below)* is essentially a little panda grown large, rather than a type of bear as formerly supposed. Thus, although the pandas seem to be characteristic Asiatic animals, their ultimate ancestry probably was in America, the home of the ancestral raccoons. The little panda is wider in distribution than the giant, overlapping the latter's restricted range in western China by extending westward through Nepal, southward to Burma

A. M. N. H. Photo by Julius Kirschner

ORIGIN OF THE PANDAS

The Giant Panda *(above),* though it resembles a sort of glorified bear, is actually much more closely related to our familiar raccoon, through the ancestral raccoon, *Phlaocyon (at right)*. The giant panda is, indeed, a large modified edition of the little or lesser panda *(above right),* whose relation to the raccoon is apparent. The deceptive bear-like features of the giant panda result from convergent adaptations

The Grandfather of all raccoons *(at left)* appeared some 15 to 20 million years ago; and though it bore slight resemblance to the giant panda, it was destined in time to produce this animal also.

In another direction *Phlaocyon* underwent but little modification to give us the living cacomistle or ring-tailed cat of southwestern United States and Mexico (not shown here), a "living fossil" closely resembling its long extinct ancestor

Through the small, dog-like ancestor *Cynodictis,* shown at right, the pandas are more closely related to the modern dog tribe, here represented by the living wolf, than to the bears they appear to resemble.

This dog-like carnivore, that lived some 20 or 30 million years ago in the Oligocene period, is the ancestor of all the later dogs, wolves, foxes, fennecs (small African fox-like canids), and at the same time of the raccoons, coatis, kinkajous and pandas.

It was perhaps no larger than a mink and was characterized by its long, slender body, its elongated, heavy tail, and its short legs. The head of *Cynodictis* was long and narrow, with a pointed muzzle and large eyes.

The dogs retained to a considerable extent many of the characteristics of this primitive ancestor, but developed greater size, longer legs adapted to swift running, and a very high degree of intelligence.

The raccoons likewise retained many primitive characters in their general structural development but became specialized in certain ways. Their family became adapted to tree-climbing, an activity probably unknown to this ancestor of the Oligocene period, from which they are, nevertheless, clearly descended.

Only the giant panda, among the raccoons, grew to more than medium size

IN UPPER Eocene times, some 40 million years ago, this very primitive carnivore Miacis was the

THE MODERN CARNIVORES at left, seemingly so dissimilar, are in truth cousins of varying degrees of relationship. The first cousins of this clan are the raccoons and the pandas; the more distant relatives are the dogs and the bears

RECENT

THE DOG-LIKE ancestry of the bear is revealed in *Hemicyon,* shown at right. As large as a black bear, this animal possessed an admixture of dog-like and bear-like characters which make it an almost perfect intermediate form between the primitive "bear-dogs" and the modern bears

THE TRUE relationships of the living animals shown above are discovered by tracing their family history through bygone ages. In the Miocene period, which began some 20 million years ago and lasted about 12 million years, the immediate ancestors of many groups of modern mammals appeared

MIOCENE

THE PARTING of the ways between the bear stem and the panda-raccoon-dog branch occurred as shown below some 30 to 40 million years ago in Upper Eocene times.

Miacis, the common ancestor of these two groups, gave rise to *Cynodictis (at left)* and to a much larger contemporary animal *(not shown here),* which probably looked much like a big dog with a long, heavy tail. This animal, *Daphaenus,* was the first of the bear-like dogs and became the ancestor of all the bears.

During Oligocene times, *Cynodictis* and *Daphaenus* and their relatives were very much like each other, because they had not progressed far from the ancestral stage. It was not until the Miocene period that most of the carnivores began to show characters prophetic of our modern forms.

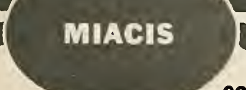
The miacids, from which our whole assemblage of modern carnivorous mammals developed, were small animals, very similar to some of the modern Asiatic civets in general appearance

THE LIVING CARNIVORES may be said to have had their earliest ancestry in the Eocene period (about 30 to 50 million years ago), to have become diversified in the Miocene (10 to 20 million years ago), and to have progressed toward modern types in the Pliocene (2 to 8 million years ago). It was then that the pandas, raccoons, bears and dogs became recognizable as such. In the Pleistocene period, or great ice age, these animals had taken on completely their modern form

By EDWIN H. COLBERT
AND
MARGARET M. COLBERT, ARTIST

NATURAL HISTORY MAGAZINE, 1938

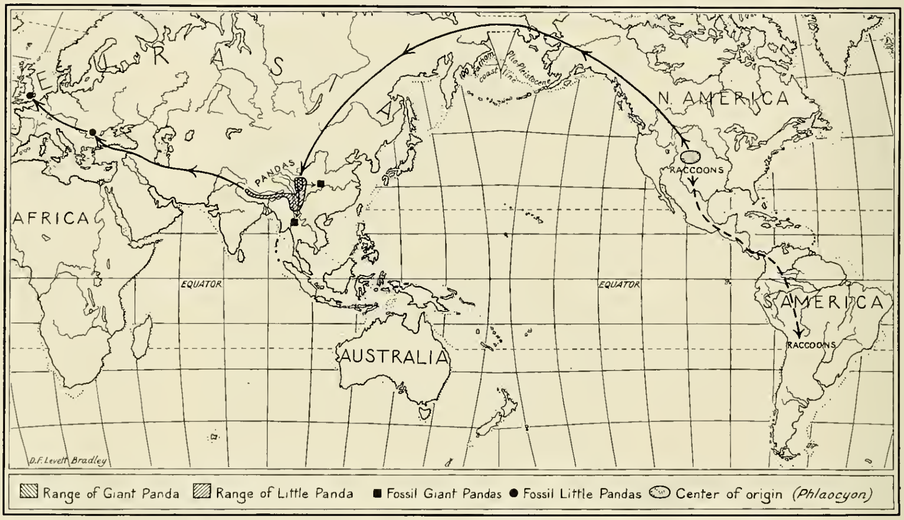
OLIGOCENE



EOCENE

common ancestor of the pandas, raccoons, dogs and bears

All during this time, while the pandas were evolving from raccoons, the bears were developing in quite another way. In Oligocene times, perhaps twenty-five million years ago, contemporaneous with the primitive dog-raccoon ancestor, *Cynodictis,* there was living a larger, dog-like carnivore known as *Daphaenus.* This animal, although living at the same time as *Cynodictis* must have evolved at no very great date previous to the Oligocene period from a *Cynodictis*-like ancestor. *Daphaenus* was much larger than *Cynodictis,* but except for the changes in proportion due to an increase in size, it was much like its smaller contemporary, for it retained many primitive characters that are seen in *Cynodictis.* Externally, *Daphaenus* looked very much like a large dog with rather shortened legs and a long, heavy tail, but even at this early date it had the potentialities in its structural makeup that were destined to lead its descendants along a line of evolutionary development progressively removed from the dogs.



This *Daphaenus* was the first of the "bear-dogs," so called because they would seem to combine the characters of both bears and dogs. In the Miocene there evolved from *Daphaenus* a large bear-dog known as *Hemicyon,* which is almost a perfect intermediate between the dogs and the bears. *Hemicyon* retained many of the primitive structural characters of the dogs—indeed this animal probably looked very much like an extremely large dog with a long, heavy tail. But in *Hemicyon* there were numerous bear-like specializations, particularly in the skull and teeth. And from this gigantic, Miocene dog the bears arose, at the beginning of the Pliocene, mainly by an increase of the body weight (*Hemicyon* was as big as a black bear), by a reduction of the tail, and by a change in the dentition from the more primitive cutting teeth of the dogs, to the more specialized grinding teeth of the bears.

So it is that the bears are the descendants of large dogs, while the pandas have evolved from small raccoons. The bear and the giant panda look alike because they have met similar problems in similar ways. And it is only by tracing their history far back into the dim stretches of geologic time that we find their common ancestor, which was the ancestor of the great complex of the dog, raccoon-panda, and bear group of carnivorous mammals.

Now it is a general rule that the teeth and digestive systems of the various mammals are more or less adapted to the types of food that they eat. Thus, carnivorous animals have tearing and cutting teeth, and to a lesser extent grinding teeth—but teeth on the whole that are well fitted to the eating of meat. Herbivorous mammals, on the other hand, have nipping and grinding teeth, for the purpose of cropping and chewing green material.

Of course, mammals are apt to be remarkably catholic in their tastes, so that carnivores, like bears and raccoons, eat all manner of things besides meat, while herbivores like pigs may devour with relish almost anything that is edible. But in spite of the departures from the more typical eating habits of their respective groups, the general rule of the adaptation of teeth to diet holds.

In the lesser panda the teeth are specialized away from the central, cutting type of carnivorous dentition, so that they have taken on a form more or less adapted to an omnivorous type of diet. The canines are strong and sharp, while the cheek-teeth have fairly sharp cusps, capable of cutting and grinding. In the giant panda the teeth are more specialized and bear-like—that is, the canines retain their strong structure, for tearing, but the cheek-teeth are elongated and blunt, more adapted to grinding.

The digestive systems of both pandas, though derived from the general carnivore type, have become specialized in many ways to cope with an unusual change in diet. This is particularly marked in the giant panda, in which the oesophagus has a horny lining, (as a protection against the sharp bamboo stems the stomach is thick-walled and muscular, the liver is small as compared with the large liver in most carnivores, and the gall-bladder has become small in association with a habit of continuous feeding.

These modifications in the teeth and the digestive systems of the pandas indicate a considerable change from the carnivorous or omnivorous diets of their raccoon ancestors. Indeed that change has gone so far that both pandas are thorough vegetarians, the lesser panda living on various fruits and green things and the giant panda subsisting entirely on bamboo shoots Thus the pandas, though derived from carnivorous and omnivorous ancestors, have become secondarily completely frugivorous and herbivorous.

Perhaps if the pandas were given a few more millions of years they might become even more completely adapted to a vegetarian mode of existence than they are at the present time. But alas, man is taking over the world at a rapid rate, and upsetting the apple-cart of evolution on every hand, and the pandas probably will not last for a length of time sufficient to undergo any marked evolutionary changes.

It would seem that the panda-branch of the raccoon family is on its way to extinction. At the present time the lesser panda inhabits a rather restricted range in the southeastern Himalayas, from Nepal to Yunnan, while the giant panda finds his home in a limited area in Szechwan. Formerly, during the Pliocene and Pleistocene the pandas were rather widely spread throughout the Eurasiatic continent. Relatives of the lesser panda extended through Europe into England, and ancestral giant pandas lived in China and in Burma.

Although the pandas seem to us as being characteristic Asiatic mammals, it is probable that their ultimate ancestry was in North America, the home of the ancestral raccoons. It was only after certain raccoons migrated from North America to Asia that they grew into pandas. Consequently when we read of the baby giant pandas coming to America, to grace the enclosures of some of our zoological parks, we can welcome them home to the land of their forefathers—of many millions of years ago.

WHAT YOU CAN DO ABOUT CONSERVATION—*Look into your local woodlot, glen or river; see if it is being kept safe for the wild life that depends on it. Nature needs you and you need Nature. Join a national protective society if you can, but be sure it is honestly protective*

By DONALD CULROSS PEATTIE

IN A SMALL TOWN in North Carolina, the local beauty spot was about to be sold to a sawmill. The enchanting glen, where a white sprite of a waterfall leapt into a gorge wooded with ancient beeches and hemlocks, was to be laid waste. After that, stumps and gullies, weeds and desolation.

The Garden Club of Tryon, this town of only 1500 people, went into action. Money was needed —and try to borrow from a banker with a brook for your security and orchids for tangible assets! The club women were not wealthy—and waiting at the entrance to the glen was the lumber company, with cash and with saws.

Four thousand miles away a naturalist, who had spent some of his happiest hours at this waterfall, heard of the impending disaster. He wrote from memory the story of every bird and tree, shrub and flower in that living green museum. The ladies took his plea, and their own, to a civic-minded local citizen, who dug into his depression-thinned pocket for the money to buy the glen. The Garden Club women are paying him off with admission receipts, by the sale of the naturalist's guidebook, and by garden shows and other entertainments.

Conservation begins at home

This was conservation on a small scale. But conservation begins at home. There is something everyone can do about it. Perhaps like Tryon your town has a beauty spot endangered or neglected—a wood, an island, a lake. Is it safe for posterity, or is it liable to selfish destruction? Are they dumping junk in that ravine? Are the ferns and jack-in-the-pulpits diminishing under the greedy hands of snatchers? Recently a complaisant marauder assured me that I would find no more of the stately lotus in the Calumet district of Indiana, as he himself had "cleaned out the last of them years ago"! Your river—is it still lively with game fish, or is factory waste killing every aquatic creature of value?

In America's national parks, Nature has been saved for the populace by Uncle Sam. Local government can supplement them with sanctuaries and playgrounds nearer home. Cook County, Illinois, which is mostly Chicago, moved in time to save its lovely woods from "development." It bought up river courses and small lakes, and linked them together in a green girdle where one can walk for hours on lovely trails without meeting anyone but squirrels.

Every community offers opportunities

True, Cook County is big and rich. Yet a small Indiana town bought up a pretty little lake, unsightly with junked cars and shot over by duck poachers, and made it a recreation spot for the whole community and an island of safety for the waterfowl. In Virginia a county set aside a tract of woods as a wildbower preserve. Paradise Key, in Florida, was the most beautiful everglade island in the country, the outpost of some of the rarest of tropical plants. The various proposals for disposing of it included turning it into an experimental station, a cornfield, a site for a bungalow town, grounds for a palace hotel, a sportsman's club. Instead, the women's clubs of Florida bought it and presented it to the state, to be kept as God made it. There is little doubt that as the loveliest thing in Florida it has repaid the state many times in tourist traffic.

Perhaps your town has available a piece of tax-delinquent woodland. Many a European community owns a town forest which, judiciously harvested, pays most of the taxes. Recently, in one of our mountain villages where handcraft toys are made, I was told that lumber costs kept the price of the toys high. Yet the local newspaper was full of notices of the sale of woodlots by the sheriff. These might yield firewood, timber for community buildings, lumber for the toy industry, and golden hours of recreation for everybody.

Conservation means conserving not only growing things, but wild life as well. All of us, for example, can do something for the birds. It is not difficult for a rich man, like one in Louisiana, to make an old backwater into a sanctuary where come even the rare and stately egrets. But a poor man in Iowa simply turned an old cattle wallow into his private paradise of wings by fencing it off and scattering grain. You may have no more than a windowsill, but you can feed the birds, and help get rid of the starving, wretched stray cats who are the foremost bird killers. When you plant trees, don't plant all of one kind; monotonous forestation makes for thin avian population. Dead hollow trees should be left standing; they are nesting sites for bluebirds and woodpeckers, swallows and owls. Leave the vines, cedars and milkweed along the fences, for only under such covert can the bobwhite live. All over the country, in Spring, the well-intentioned set brush fires, killing the native vegetation and letting in gangster plants — ragweed, burdock and thistle. True, pasturage may be improved by burning off the dead stems. My neighbors, however, started their fire so late that it caught the ground birds in nesting season. We found pheasant eggs and song-sparrow chicks roasted in their cradles.

Public opinion

Statutes are bootless without popular support. The man who breaks the conservation laws is a thief, stealing from the public heritage, and he should be condemned as such. Yet I know a southern banker who has spies telephone him from the local lake whenever wood duck alight. The Government has closed the season on these beautiful little survivors the year round; the banker thinks it a joke to serve them at his table. Public opinion should run that joke out of town.

The law of public opinion is its own police force. Around our national capital the dogwood, Virginia's state flower and the glory of the Maryland hills, was rapidly vanishing as truckloads rolled to market. The Wildflower Society started a publicity campaign each Spring; even the streetcars carried bright posters asking citizens to help save the dogwood by neither buying nor picking any. The campaign has been dropped now—victory was as complete as it was peaceful.

We need Nature, just as it needs us. A woman in Massachusetts, bereaved, crippled, on the verge of losing her reason, was brooding on her misfortunes when a chickadee alighted at her window, which overlooked a woodlot. She gave him crumbs, and he gave her hope. The sill became an unofficial station where birds were fed, banded, recorded. Then "improvement" threatened the woodlot. The woman appealed to the American Nature Association,[1] which broadcast an account of this simple sanctuary to its members. Today the lot is safe to posterity, administered by a board of sympathetic trustees. You can help preserve Nature by joining one of the many similar groups which are waging an organized fight for conservation.

Does it make you fume to see motorists coming home with cars heaped with wilting Turk's-cap lilies or lady's-slippers? The Wildflower Preservation Society[2] is fighting your battle. One of its many enterprises is the publication of lists of plants that can be picked in moderation without doing violence to the frail or rare. The Isaak Walton League[3] watches over all forms of water conservation and the pending legislation concerning it, fighting stream pollution and illusory drainage schemes. When it throws its weight behind legislation it speaks with the weight of thousands of Nimrods and fishermen who know there will soon be no more game if what we have is not preserved. Taller every year grows the American Forestry Association,[4] which has long battled for scientific management of our timber reserves, for use and not exploitation, for a cut that would be justified by the natural yield.

The National Association of Audubon Societies,[5] with branches all over the country, has done more to preserve bird life than any other organization in the world. During the spectacular fight for the egret, the Audubon Societies, with their own funds, bought up the principal nesting grounds and set wardens to watch them. Several of these protectors were brutally murdered by plume-hunters.

Game bootleggers

Game bootleggers are often otherwise criminal. Biological Survey men, in a battle which left several of them severely wounded, recently arrested a ring of southern game hogs, all of them already wanted for murder or larceny. You can back up such men as those who caught the criminals by buying a "duck stamp" for a dollar at your post office. Each issue is a philatelic item, for a famous artist engraves a new one every year, and all unsold on December 31st have to be destroyed. The dollar goes to pay wardens, feed game animals in time of scarcity, and establish refuges.

Best hated of all such groups is the Emergency Conservation Committee,[6] and its enemies are its best recommendation. At Hawk Mountain in Pennsylvania, local rifle gangs tried to clean the sky of

[1] 1214 Sixteenth St., NW, Washington, D. C.
[2] 3740 Oliver St., NW, Washington, D. C.
[3] Merchandise Mart, Chicago, Ill.
[4] 919 Seventh St., NW, Washington, D. C.
[5] 1775 Broadway, New York City.
[6] 743 Lexington Avenue, New York City.

Continued on page 69

Stings

The urban vacationist's seasonal return to our great outdoors carries with it the threat of encountering creatures more venomous than mosquitoes, less so than rattlesnakes. "Forewarned is forearmed": NATURAL HISTORY, therefore, presents two pertinent articles: one giving the testimony of a noted authority on the liabilities, effects and

The poisons of Scorpions and Spiders—their effect and treatment

By W. J. BAERG
Professor of Entomology, Univ. of Arkansas

SCORPIONS are common over a large part of the United States and quite abundant throughout the southwestern states, west of the Mississippi River and south of Kansas and Colorado. The majority of the 30 species known in the United States occur in these states. Scorpion sting cases are frequent but very rarely attract any attention. As a rule the effects of the sting are comparable to those following a wasp sting. A sharp keen pain immediately follows, a white disc develops about the puncture, and slight swelling in the general area. Usually the pain subsides in 20 to 30 minutes and there are no complications or general effects. If one is unfortunate to be stung early in spring when the scorpions have not had occasion to use their weapons the effects seem to be much intensified and last much longer. The pain may refuse to wear off in 4 or 5 hours.

Some of the larger species common in the tropics (*Centruroides margaritatus*) are a bit formidable in appearance and, for some persons at least, have a venom that produces a noticeable general effect. A member of the staff in the Ancon Board of Health Laboratory after being stung on the left hand by this scorpion felt a tingling sensation extending over the left arm and left leg and a lameness in the tongue that lasted for 24 hours.

Painful but harmless

An even larger species, 4 inches in length, (*Hadrurus hirsutus*), occurring in northwestern Mexico and extending into the southwestern corner of the U. S. inflicts a rather painful sting which, however, appears to have no general effects, not even on young white rats.

Most scorpions are easily induced to sting. The tail end of the abdomen is carried in an ever ready position and the scorpion stings on very slight provocation. A striking exception is a dark colored species of medium size, occurring in Panama *(Opisthacanthus lepturus)*. Its pedipalps, or pincers, are so much larger than those of other species that they look decidedly awkward. However, this scorpion uses them well, employs them for both catching prey and warding off enemies. This species, so far as I could determine, will not sting under any provocation. The tail end of the abdomen is much reduced, and the poison when injected into white rats produced no effects.

The relative harmlessness of scorpions in the U. S. is generally known. Occasionally the sting is regarded as involving grave possibilities and the victim takes no chances. A press dispatch from Denver, Colorado, a few years ago reported a case of a fruit dealer who, while cutting bananas, was stung by a scorpion. When the local effect soon became quite severe he calmly cut off the first joint of the affected finger and later went to a physician to have the wound dressed.

Drastic as the measure is it probably would fail in the desired effect because the venom of the really dangerous scorpions is a neurotoxin and spreads throughout the system with great rapidity.

South of the Rio Grande

Of these dangerously venomous scorpions Mexico appears to have almost complete monopoly. No less than six kinds, species and varieties, are commonly fatal to children. These scorpions are found throughout southwestern Mexico, representing the states Durango, Nayarit, Guerrero, Colima, Michoacan, and Morelos. One of the species, *Centruroides noxius* characterized by a dull red color in the tail and appendages, is not uncommonly fatal to adults. It occurs near Tepic in Nayarit. Section hands of the Southern Pacific get stung when picking up a tie and if not treated very promptly may succumb to the venom.

Of the several poisonous scorpions occurring in Mexico, the one common in and about Durango is perhaps best known. The literature regarding this

Continued on page 45

cures of spider and scorpion attacks; the other, the revelations of a poisoned physician who refused treatment during his illness, though stricken with severe pain, fever and loss of memory, in order to discover exactly how it feels to be bitten by a Black Widow spider.

How it feels to be bitten by a Black Widow—a case history

By CHARLES BARTON, M.D.
Assistant City Health Officer, Los Angeles

[Dr. Barton, who had the forethought to record in detail his symptoms as recounted in this article, believes that his own case of Black Widow spider bite differs in certain respects from others which have been described. The usual fever, swelling of the injured part, and spreading of severe pain were experienced as might be expected. But a reaction which is perhaps not generally connected with the bite is noted in this particular instance in lapses into extensive periods of forgetfulness even after the major symptoms had passed.—ED.]

LIKE many physicians, I thought the bite of the Black Widow spider was less dangerous than some of the newspaper accounts had made people believe. While poisonous, I contended that the creature could not inflict a serious wound, some of the extreme symptoms being presumably due to hysteria.

Having been bitten, I am no longer a skeptic. The Black Widow wields a lethal weapon and woe to anyone who crosses her trail.

An unforeseen encounter

My unfortunate experience came just after I had decided to spend my summer vacation at home. Mrs. Barton, on the other hand, scorned my plan to loaf away the time in southern California and was led by a feeling of wanderlust to travel East. It was the very next morning that I encountered the ebony queen.

I stalked into the backyard, surveyed the landscape, and discovered a tangle of honeysuckle vines which drooped from a picket fence and covered old boards against the garage. Several vines had become entwined in the lumber and while extracting one I felt a slight prick in the knuckle of my left hand. Glancing at the injury, I discerned only a tiny red spot and concluded it was a sliver from dry Oregon pine. The job, a pleasant one under a balmy sky, was completed at 11 o'clock. But the hand, now aching considerably, needed attention, so I painted it with a strong solution of tincture of iodine.

The troublesome ailment persisted, notwithstanding, and I began to wonder. I tried to forget it as I planned how on the morrow I would mow the lawn, prune the trees, and overhaul the car. But I had not reckoned with the Black Widow.

By noon of that eventful day the hand had grown worse and become greatly swollen. The back where the skin adhered to the knuckles appeared smooth and glossy, as if affected by erysipelas. My mind searched through the annals of medical lore, from Hippocrates to Mr. Puck of Kalamazoo, but found no satisfactory answer in ancient or modern diagnoses. I therefore became simply a patient whose symptoms must be charted. The necessary pencil and pad, ruled forms, and clinical supplies rested upon a small table. The ever-ticking clock, indicating 1:00, declared that the moment had arrived for further checking. The pain, extending to the elbow, suggested additional remedies, and I soaked the hand and forearm for thirty minutes in a concentrated solution of Epsom salts.

Two hours passed, and the whole body, as in a severe case of influenza, groaned with the so-called muscle and bone aches. Temperature had arisen to 101°. I was helpless and quite ill, so I called in a brother physician.

The verdict

He looked me over, maliciously thumped me here and there and glared accusingly but said nothing.

"Well, what's wrong?" The secretive silence disturbed me, the professional nodding of the head, the continued pacing. "I am no infant, tell me," I demanded.

"You have been bitten by a Black Widow spider," he blurted out.

The naked and unadorned statement had an ominous ring. There flashed through my mind the many legends, tales of horror and woeful death, which had been chalked up to this fifth horseman of the Apocalypse.

"What's to be done?" I said.

"A little morphine. . . . Yes, possibly the hospital."

The rule is, of course, to obey the physician, but there are few physicians who could reassure their patient with an affirmative answer to the question, "Are you a Black Widow spider doctor?" Therefore I bluntly protested: "No morphine. And let's postpone the hospital. For a while, anyway." I did not want to miss my own show.

As a parting gesture, he warned, "When you get worse, call me—if you are able." Factory whistles screeched four o'clock.

In the throes of the poison

A sudden, excruciating pain, similar to being hit by a club, struck at the base of the skull, followed by dizziness, a stiffening of the neck, nausea, and vomiting. Lancinating cramps, agonizing and gnawing, attacked the stomach, and the sole relief was pressure from the hands.

Determined to continue my observations and attempting to be scientific and impartial as toward a laboratory specimen, I proceeded to jot down my condition at 6 P. M. The hand, swollen still larger, tingled with pain when touched; the fingers stood out rigid, but the thumb proved flexible. Just before retiring at seven, I obtained a half pint of hot water, and mixed into it a teaspoonful of soda bicarbonate and ten grains of aspirin.

Abruptly, about midnight, I awakened, startled and confused. My pajamas, the sheets, and the pillow dripped with perspiration, and intense thirst clawed at the throat. I hastily changed, drank two glasses of water, and crawled into another bed.

Merely my diary, feebly scrawled, exposed the wreckage that morning. The aftermath, naturally, annoyed me: weakness, nervousness, and a dull, steady ache in the hand and arm. But the terrific pains, those resembling huge tidal waves, seemingly had vanished upon the coming of the day's sun.

Now other irritations, both physical and psychical, overwhelmed me. Ordinary street noises, usually unheard, echoed loudly, and the ring of the telephone sounded like a fire gong. Food, even the thought of it, was abhorrent.

I arose, steadied myself, dressed with difficulty, and attended, only a short distance from the house, the 12 o'clock weekly Kiwanis meeting. I remember a single fact, that of refusing to eat. Who participated, what was said, and how I acted will forever remain a mystery. I trudged slowly home, like an aged man, and dug into my pockets for the key. It had evidently been misplaced, so I summoned a locksmith. Upon entering and walking the length of the hall, I found the rear door ajar. Amnesia, that strange phenomenon of forgetfulness, had crept upon me, and did not disappear for two long weeks. I groped about like a blind man, recognizing neither names, events, nor faces. Fate tempered her punishment, nevertheless, for the fang had injected its hypodermic poison into the thumb, a spot where virus is absorbed slowly.

The second night eerie dreams, together with excessive sweat and subnormal temperature, interrupted my sleep. I slumped out of bed in the morning and a flare of lights which had burned all night blazed into my eyes as I entered the living-room. A canteloupe, uncut, stood on the radio cabinet. Where the melon came from, who put it there, and for what purpose, perplexed me. Though my memory gave no answer, my reason declared that I, a victim of the Black Widow spider, had alone occupied the quarters.

The culprit

By Thursday morning my curiosity was aroused regarding the culprit. Why not explore the lumber pile, corner my enemy, and slaughter her! Surely this daughter of Arachne, America's only dangerous spider, had done sufficient harm.

I pried the timbers loose, uncovered a quantity of débris, and exposed the ungallant foe. A coal black spider, with eight wiry legs, dangled from a coarsely woven web. I viewed her from another position, and saw, beneath the abdomen, a scarlet insignia shaped like an old-fashioned hourglass. Three egg-sacs, each containing several hundred spiderlings, nestled in close proximity. From Maine to California, and in country and city, the black marauder slinks under rubbish, stones, mantle-pieces, and hidden crevices. Deliberately, and with forethought, I aimed, fired, and squashed my holiday spoiler.

THE POISONS OF SCORPIONS AND SPIDERS

Continued from page 42

species dates back to 1784 when the Gazeta de Mexico published an account concerning the shipment of "snake weed" to Durango where it was to be used in cases of scorpion stings.

Since 1785 the city has been more or less regularly paying a bounty on scorpions brought to the City Hall. The price paid ranged around 5 centavos for a female and 2½ centavos for a male. Such an offer brought results, in scorpions delivered—in some years 100,000 or more—but apparently not in a reduction of scorpion population, for in 1925 the so-called *alacraneros* brought in 116,000 specimens. In 1926 when hunting for scorpions in and about Durango I found the poisonous species very plentiful in the ruins of the San Francisco Cathedral. Incidentally, bounty was paid on *all* scorpions. The Durango neighborhood provides no less than six species of scorpions and all but one are harmless. It seems like an especially mean trick on Nature's part that the five harmless species are found living mainly under stones in the country, while the poisonous one is synthropic, i.e., lives almost exclusively in and about human dwellings.

Children the most frequent victims

In the earliest reports from Durango, 1785, Cavaroz stated that out of a population of 15,000 the scorpion took an annual toll of about 200. This is probably an exaggeration even for those early days when the practice of medicine was far below its present state of efficiency. More reliable reports covering the period from 1890-1931, state that the scorpion toll was 1719 deaths. These cases are almost exclusively children, for adults very rarely succumb to the venom of this scorpion.

Tests with white rats and guinea pigs leave no doubt of the toxicity of the Durango scorpion's venom. A white rat, stung several times in the hind leg, became much agitated 8 minutes later, in 15 minutes it had convulsions and these soon became so severe that the rat rolled over backwards, sideways, jumped to the top of the cage and squealed at frequent intervals. These symptoms lasted for an hour after which the rat gradually recovered.

A full grown guinea pig after being stung several times, began to sneeze vigorously in 2 minutes, convulsions set in after 20 minutes and death occurred in 57 minutes.

An injection of the extract of the glands of one scorpion in physiological salt solution into a white rat about 2 months old brought convulsions in 5 minutes, and death in 25 minutes. An autopsy of a rat killed in this way showed the stomach blown up with air that had been swallowed, heart and lungs somewhat congested with blood.

The symptoms in man have been described by a number of authorities. Briefly summarized they are as follows. Immediately following the sharp pain produced by the sting is a feeling of numbness or drowsiness, then there is an itching sensation in the nose, mouth, and throat that makes the victim distort the face, rub the nose, mouth, and sneeze. There is at first an excessive production of saliva. This and the curious sensation of a ball of hair in the throat induce the victim to swallow as rapidly as possible. The tongue is sluggish, so that communication is often by signs. The muscles of the lower jaw are contracted so that it is difficult, if not impossible, to give medicine through the mouth. There is a disorder of movements in the arms and legs. The temperature rises rapidly to 104° or 104.8° F., the salivary secretion now diminishes and urine secretion practically stops.* The senses of touch and sight are affected, hair feels rigid, face bulky, a veil seems to be interposed between the eyes and various objects. Luminous objects such as a candle are surrounded by a red circle. Frequently there is a pronounced strabismus.† There may be a hemorrhage of the stomach, intestine, and lungs. The convulsions come in waves, increasing in severity for an hour and a half, or in severe cases till death sets in. In fatal cases the heart continues to beat for a full minute after respiration has ceased. If the patient survives for 3 hours he is usually out of danger.

Treatment

Many different kinds of treatment have been applied, some of the older forms are properly described as nasty. A popular and not very ancient remedy is turpentine, a spoonful on a lump of sugar.

Most reliable treatment prior to the use of serum was the use of chloroform. The victim was given 8-10 inhalations which would put him to sleep. This condition was kept up by additional inhalations at such intervals as necessary. Anasthesia was usually maintained for 3 hours. To eliminate the poison the patient took a dilute solution of tincture of iodine and hot water baths.

Beginning in 1928 serums prepared by the Public Health Service in Mexico have been regularly used with the result that but 7 fatal cases were reported from Durango that year.

*Souchard in his "The River Gabon," etc., describes a sort of judgment of God applied by the natives. The accused is stung by a scorpion. If he can produce any urine during early symptoms caused by the venom he is declared innocent.

†Squinting, cross-eyed or wall-eyed.

The serum is made by treating horses with a series of injections beginning with ¼ of the poison obtainable from one scorpion and finishing with about 1200 times that dose. A quantity of blood is then drawn and the serum prepared by a somewhat complicated process. At least three kinds of serum are made available, intended to be specific for as many kinds of scorpions.

It is obvious that this procedure demands large numbers of scorpions, many thousands of them. But scorpion hunting in the regions where scorpions are deadly is a well-known sport. The representative of the Public Health Service readily finds enough capable assistance to gather the desired number of scorpions.

The chemical and other properties of the poison have been studied by various authorities. It is a transparent liquid, when agitated produces froth, is acid in reaction, when evaporated leaves scaly flakes of dark yellow color which are soluble in water, normal saliva, glycerine, and dilute alcohol. Pure alcohol, iodine, ether, ammonia, and tannin precipitate the poison, as does lead nitrate and silver nitrate.

The toxic principle is a tox-albumin. It has a hemolytic action on nucleated as well as non-nucleated blood corpuscles. Death results in a paralysis of the respiratory muscles followed by a paralysis of the heart.

Tarantulas

Historically the word tarantula is a treasure not only in the English but in German, Italian, Spanish, French, and Portuguese. Based originally on the name of an Italian town, Tarentum, it is in Italy applied to a considerable number of spiders. Linnaeus used it for the specific name of a somewhat notorious wolf spider, *Lycosa tarantula,* the bite of which was formerly believed to cause in man a nervous frenzy known as tarantism.

In spite of repeated protests coming especially from English authorities the term tarantula is now generally applied to the large hairy spiders belonging to the family Aviculariidae. It is used in the various languages mentioned above and is the popular name for the large hairy spiders wherever they occur. In Mexico, even in those states where most of the population have but limited knowledge of Spanish, the term tarantula is commonly used. In the states of Guerrero and Oaxaca no less than 90% of the people know the tarantula by this name.

The sound of the word tarantula, it seems, denotes evil or a sinister enemy. Thus John Fiske wrote many years ago.

> "Under the exquisite rose
> Dwelleth the hideous tarantula."

Nietsche in "Thus Spake Zarathustra" devotes a chapter to the tarantula and applies the term to the "preachers of equality," saying—"Tarantulas are ye unto me, and secretly revengeful ones."

The tarantulas in the United States are limited largely to those states south of the Mason and Dixon line and are most common in the states west of the Mississippi River. Elsewhere in the world they occur commonly throughout Mexico, Central America, much of South America, as well as in Africa, Madagascar, Java, West Indies, Haiti, Puerto Rico, San Domingo, Martinique, and elsewhere.

Legends

Wherever tarantulas occur they are generally feared, credited with a highly virulent poison. Some of the legends regarding method of attack and capacity for doing harm are quite remote from actual facts and in addition very firmly established, not only in the minds of ignorant natives but in the minds of intelligent and educated people.

The well-known legend concerning the ability and tendency of tarantulas to jump distances ranging from two or three to 25 feet is so well established that some arachnologists have subscribed to it. Tarantulas have very narrowly limited vision. They cannot recognize each other's presence when but half an inch apart. About all they see is a difference between daylight and darkness. They hunt mainly by sense of touch.

Probably of more interest as folklore than science is the legend prevalent in Mexico and Central America according to which tarantulas cause the loss of hoofs in horses and mules. During the rainy season this loss is not uncommon. The prevailing opinion is as follows: The tarantula climbs over the hoof, cuts off the hair in a narrow strip surrounding the leg. If allowed to do this undisturbed, no damage results. (In another version the damage comes incidental to the cutting of the hair.) If disturbed the tarantula bites and this is followed by the loss of the hoof. It is believed that the spiders use the hair thus acquired in the construction of a nest. According to other variations of the legend the loss of the hoof is caused by the urine of the spider, *mierda de arana,* also by the *excreta de arana.*

Scientific investigators of the United Fruit Company inform me that abrasions in the skin near the hoof, occurring most commonly during the rainy season, provide entry for *Bacillus necrophorus* or one of its near relatives, and this is responsible for the loss of the hoof.

The poison of tarantulas has not been seriously investigated so far as its chemical and physical properties are concerned. Recently when a technique for extracting the poison by electrical stimulus was developed in the Department of Entomology of the University of Arkansas, some preliminary studies were undertaken. The work was done largely by two students in Organic Chemistry, F. M. Lewis and P. F. Mark. According to their findings the poison is acid in reaction, of a protein nature, composed chiefly of albumins and globulins.

With no more evidence than hearsay the tarantula has long enjoyed an almost world-wide reputation for being dangerously poisonous. This combined with its alleged capacity for jumping gets quick and drastic response from one who finds himself lined up for a victim. The following episode based on a newspaper account will illustrate. A man riding along in an open car suddenly observes a huge tarantula on the floor. Without troubling to stop the car he takes a flying leap for safety. The car is badly damaged when it, too, leaps down an embankment, but the man feels grateful over a lucky escape.

During the last 20 years evidence has been gradually accumulating on the effects of tarantula poison on man and various experimental animals. At least four species have been studied in Brazil and the findings briefly stated are that tarantulas quickly kill cold-blooded animals, but have no serious effect on warm-blooded ones. Only one of these was known to have bitten man and the resulting symptoms were not serious.

Tarantula colony

For about 20 years tarantulas have been one of my sidelines at the University. This is not long enough for a complete life history study because the longevity of the female is probably near 25 years. A number of native tarantulas have been maintained in the laboratory all this time and by one means or another I have built up a small foreign colony.

Concerning tarantulas of Central America, Mexico, and the United States I have made various tests with at least fourteen species. All but two of these may be described as essentially harmless to man.

A large dark brown or blackish species *(Sericopelma communis)* occurring in Panama may be considered poisonous, though perhaps not dangerously so. On man the bite, with about a half a dose of poison, produces moderate swelling and rather severe pain. The effects are, however, local and readily subside if the bitten hand is immersed in hot water.

On white rats the poison has general as well as local effects. After being bitten, the rat soon collapsed, lay flat on its belly making but very feeble attempts to move. The bitten area was considerably swollen and purplish in color.

On guinea pigs the poison had a more serious effect. The animal showed no striking symptoms for about 35 minutes then died suddenly. Another guinea pig died 23 minutes after it was bitten.

Another poisonous, or at least a doubtful case, is a species of tarantula occurring near Santiago, state of Nayarit, Mexico. It is characterized by a warm brown color of the tibiae (probably *Eurypelma emilia).* Two tests have been made with white rats and both ended fatally. Additional tests are needed to determine the status of this tarantula more definitely.

Far less dangerous than supposed

As shown quite conclusively in tests with the local tarantula, *Eurypelma californica,* white rats are unreliable in so far as indicating the probable effects of the venom in man. A considerable number of tests have been made by means of the bite as well as by means of an injection of poison (made by macerating the glands in normal saline solution). Every bite and every injection was followed by significant symptoms and in a number of tests the rats died. Yet on man the bite produces no other reaction than what normally follows the stab of a dull pin. Equally harmless are all the other species so far studied. These have been collected in southwestern United States, north central and western states of Mexico, Panama, and Honduras.

A few species in this lot are more emphatically harmless because they are not at all inclined to bite. Most tarantulas require but little coaxing to bite as directed. A few will bite without any provocation. One species in my foreign colony can sometimes be induced to bite, but requires much provocation and coaxing. It serves as excellent demonstration material when I wish to emphasize the harmlessness of tarantulas. Along with its gentle nature it has also the most attractive color pattern of all tarantulas known to me, viz., three orange colored bands on the legs and palpi (probably *Eurypelma smithii*).

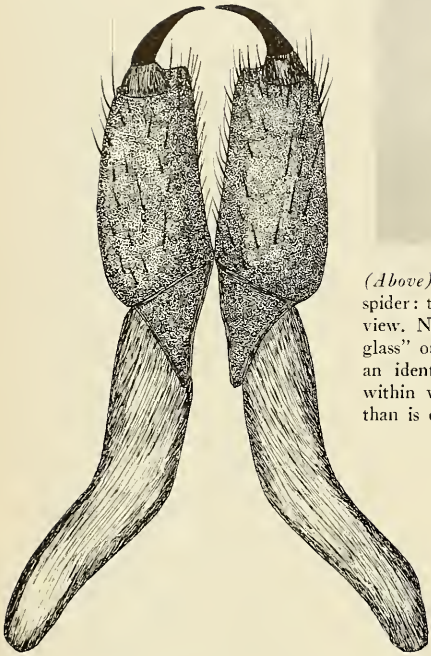
Another emphatically harmless species is a curly haired tarantula from San Pedro, Honduras. This spider tentatively known as "Curly" has so far declined to bite in spite of repeated and persistent coaxing.

The harmless list includes the large medium brown species *(Dugesiella crinita)* occurring commonly in the Laguna district in the northern part of the state of Durango, Mexico. This species weighs about 3 times as much as our local tarantula (18:54 grams).

My searches for tarantulas have been vacation

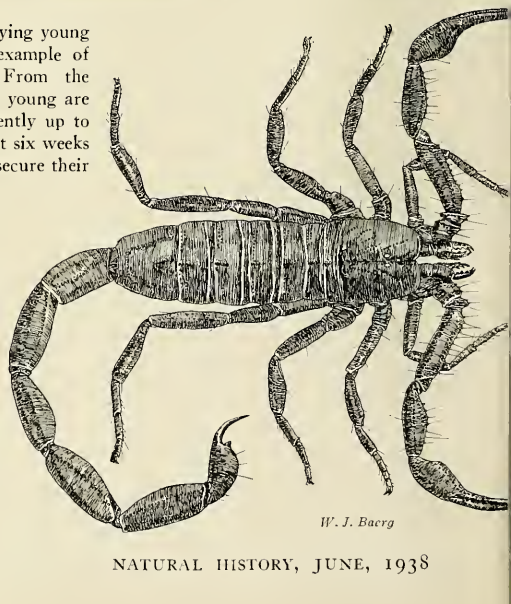
(Above) AMERICA'S most unpopular spider: the female Black Widow, ventral view. Note the characteristic red "hour-glass" on the under side which serves as an identification mark. The bite varies within wide limits but is less dangerous than is commonly believed.

(Above) THE LESS DEADLY of the species: the male of the Black Widow. Red dots and other markings, as well as his smaller size, distinguish the male from the female. He is believed to be harmless to man, though his bite is effective against insects



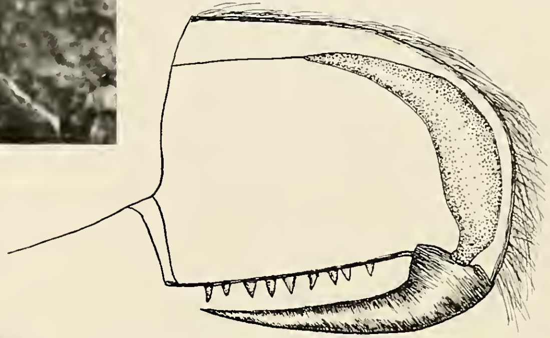
(Left) POISON APPARATUS of the Black Widow. The bite itself may be unnoticed and only visible as two small red dots, sometimes slightly swollen and surrounded by a white area. Aching and other symptoms develop in from 15 minutes to several hours. Calcium gluconate, 10 cc in 10% solution, in intramuscular or intravenous injection is apparently the most effective drug. Frequent hot baths are recommended. The branching lobes are the poison glands; above them are the "jaws"

(Left) SCORPION carrying young on back: a striking example of parental protection. From the time they are hatched, young are carried thus intermittently up to the time they are about six weeks old, or until they can secure their own food



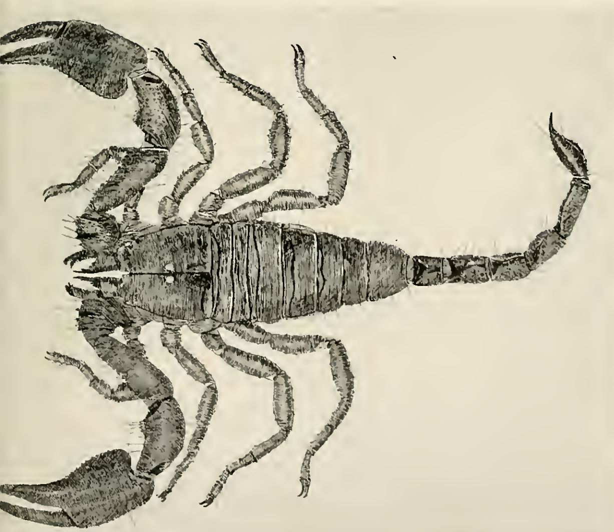
(Right) A LARGE SCORPION *(Centruroides margaritatus)* common in the tropics, whose sting is noticeably poisonous. No dangerously venomous scorpions are known in the United States

Tarantula with cocoon. With no more evidence than hearsay the tarantula has long enjoyed an almost world-wide reputation for being dangerous. Actually, it is unlikely that any tarantula has a poison that produces dangerous general symptoms in man. A few tarantulas are poisonous to man but the effect is local. In the United States tarantulas are limited largely to the states south of the Mason and Dixon line and are most common west of the Mississippi

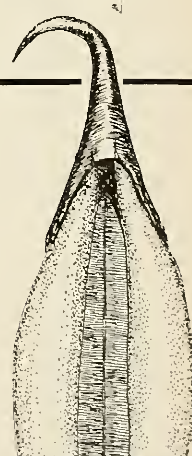


(Above) The poison apparatus of the tarantula, showing the poison gland (stippled) curving around the chelicera or "jaw"

(Left) The gentle nature of some tarantulas, which exhibit a strong disinclination to bite, is a further reason to regard them as far less terrible than their appearance or reputation would indicate



(Left) Most scorpions carry the tail end of their abdomen in an ever ready position and are easily induced to sting, but a striking exception is noted in a dark-colored species of medium size occurring in Panama, *Opisthacantus lepturus*, at left



(Right) Poison apparatus of the scorpion. The most reliable treatment for the sting of dangerous scorpions, which in North America are restricted almost completely to Mexico, is by serum. At least three kinds of serum are available, intended to be specific for as many kinds of scorpions

trips; they have been brief, and over relatively small areas. Additional trips will yield tarantulas that have not been studied, and among these there may be a few poisonous species. One general conclusion, however, I may probably venture to record even now. No tarantula has a poison that produces dangerous general symptoms in man. A few tarantulas are poisonous to man but the effect is local.

The Black Widow

The Black Widow *(Lactrodectus mactans)* has a remarkably wide distribution extending from southern Canada to Tierra del Fuego, occurring also in the Hawaiian Islands, the Bahamas, and the West Indies. *Latrodectus geometricus,* one of its near relatives is a cosmotropical species, supplements the black widow in tropical America including Florida. Its venom is said by Brazilian authorities to be more potent than that of *L. mactans.* Three other species of *Latrodectus* are known; occurring in the following regions, New Zealand, Australia, Madagascar, East Africa, India, southern Europe, and northern Africa.

All the species of *Latrodectus* in the various regions where they occur have approximately the same reputation, and are equally feared on apparently equally good evidence. The species occurring in New Zealand (also in Australia) has, to quote Berland, the sad privilege to be the only poisonous animal of the island.

In some countries, within the Black Widow area, this species receives relatively little attention, for various reasons. In Mexico the venomous scorpions far outclass it as a public enemy. Furthermore there are apparently very few Black Widow bites on record in Mexico. The majority of such bites in the United States happen in the outdoor toilet, a type of farm building that is not at all common on the other side of the Rio Grande.

In 1935 when the Black Widow reached an unprecedented popularity, or notoriety, in the United States papers, journalists in Mexico developed an interest. A Torreon paper reported on the matter under a heading stating that Torreon was being invaded by Widows. On the following day the heading read, *Siembran el Panico.* However, no cases of Black Widow bite were discovered.

The poison glands, according to some authorities, Kobert and Sachs, are merely sacs in which the poison accumulates and is stored till needed. They believe that the so-called glands do not secrete the poison but absorb it from the surrounding tissues. Ancona of the Mexican Public Health Service after making a histological study of the glands regards them as glandular in function. Other investigators who have studied the body fluids of *Latrodectus* find that, although they may be regarded as poisonous, they do not have the same effect as does the venom coming from the glands. The former result in proteolytic responses and pronounced skin reactions, but do not produce the specific *Latrodectus* effects.

Chemical and physical properties so far as known are based on studies made not of the product of the poison glands but of the body fluids and extracts. The poison is a neurotoxin, probably a toxalbumin, possibly a poisonous enzyme. The toxicity is destroyed by heating to 159° F. for 45 minutes. It cannot be crystallized since desiccation destroys it. In glycerine it may be preserved for several months.

Black Widow a reluctant biter

Contrary to the view expressed in such headlines as "Angry Widow Bites Laboring Truck Driver," *L. mactans* does not rush out to attack anyone who comes near, neither does it bite on slight provocation. When attempting to study the effects of its venom, the investigator usually finds it quite a task to induce the spider to bite. Aside from experimental studies, the Black Widow bites only under certain peculiar conditions.

These are best described by citing some cases. In one case that occurred near Fayetteville in 1935 the spider had hidden in a shoe. When the shoe was put on the spider felt imprisoned in an uncomfortably tight place and bit.

In another case occurring in the same region in 1936, the victim after playing with his children among some lumber shavings, found that the spider had somehow gotten into his shirt sleeve, crawled to the shoulder where it felt itself caught, and there it bit.

In addition there are the well known and the most common cases in which the victim is attacked while in an outdoor toilet. Here the bite is due to vibrations set up in the web underneath the seat.

Arachnid poisons (i.e. including both spiders and scorpions) are readily grouped into two categories; those producing local effects and those resulting in general symptoms. All the tarantulas and most of the scorpions belong in the first category. The poisonous scorpions of Mexico, the Black Widow and its immediate relatives (i.e. other species in the genus *Latrodectus)* belong in the second.

The poison has relatively slight and not clearly marked symptoms on white rats. In guinea pigs there is a quick response, in half a minute sneezing and coughing set in, convulsions soon develop, the diaphragm is apparently paralyzed. The heart beat is rapid but faint when the respiratory system becomes completely paralyzed and stops in a convulsion.

Post mortem examinations (as recorded by Herms, W. B. et al) "showed the stomach wall ruptured in two out of five cases, the small intestine filled with a bloody fluid, the diaphragm contracted and rigid. Heart walls showed dark areas, blood clots present in heart and large blood vessels, the lungs had a multitude of minute hemorrhages."

When considering the effects of the venom of *L. mactans* on man it should be remembered that these may vary between wide limits. To most people the sting of a bee is not a serious matter, a few persons get somewhat ill, and some rare individuals are likely to die from the sting of a bee or a wasp.

Deceptive symptoms

The usual symptoms following the bite of *L. mactans* are rather well marked, yet to practitioners not familiar with them Black Widow cases have been diagnosed as ruptured gastric ulcer, acute appendicitis, renal colic, food poisoning, and other disturbances.

The bite itself may not be felt. The two small punctures may be visible as minute red dots, and these may be slightly swollen and there may be a white area immediately around the punctures. The pain may spread *more* or *less* rapidly. One victim assured me that in fifteen minutes she suffered intense pain all over the body. In another case it took 20 minutes for the pain to extend from the finger to the armpit, and several hours for it to become general. A third victim bitten about 9 p.m., *went to bed* soon after and slept till about 2 p.m., when he awoke with serious difficulties in breathing.

Briefly stated the usual symptoms are a severe and sharp pain about the punctures, a dull aching muscular pain practically all over the body, developing in a few hours or in less time, and lasting for 2-3 days.

Difficulty in breathing, apparently due to a partially paralyzed diaphragm sets in after 3-4 hours and lasts for about 6 hours. In some victims inhaling is not only difficult but also very painful. Nausea may be so strong that the patient cannot take any food, not even coffee, for 24-36 hours. In some persons nausea is relatively slight. There is usually a low fever, the temperature varying between 100° F. and normal. Shooting pains commonly occur on the second day; abdominal spasms may be so severe that urination is very nearly impossible.

A less common but somewhat alarming symptom is a varying degree of amnesia. This is well described in the report by Dr. Barton published elsewhere in this issue of NATURAL HISTORY.*

One of the victims that I have had occasion to observe, Mrs. C. reported that when friends called during her convalescence she was unable to follow the conversation, would frequently forget the subject under discussion. Later, in fact for several months, she seemed to be unable to remember the spelling of common words in her vocabulary, to the extent that she refrained from writing any letters.

Reports of sloughing off of tissues, or to put it in popular terms "rotting out of the flesh" are painfully frequent. This is often claimed to have followed not only Black Widow bites but also the bites of tarantulas, other spiders, and centipedes. Competent authorities seem to agree that this reaction results from improper treatment, not from the action of the poison.

What to do

Treatment has improved greatly in recent years. The well informed doctor does not waste time with potassium permanganate, and he does not use an excess of some sedative when it fails to reduce pain. Calcium gluconate, 10 cc in ten per cent solution, in intramuscular or intravenous injection is apparently more effective in relieving pain, than any other drug that has been tried. From personal experience I recommend hot baths, prolonged and frequent, till recovery is about complete.

Fortunately Black Widow bites do not leave any noticeable after effects. The patient always recovers (excepting possibly infants) unless hampered by serious complications such as a very weak heart, or a syphilitic condition.

---

*Page 43.

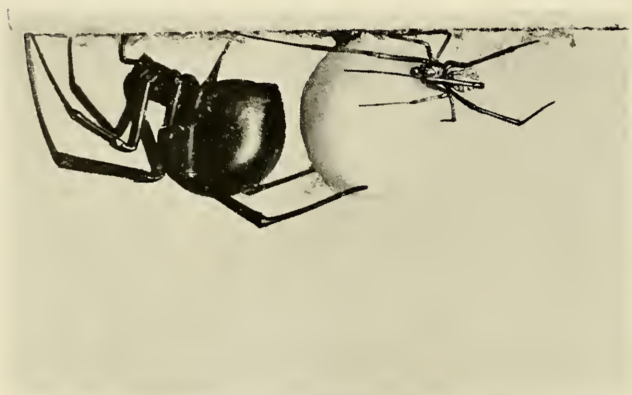
The Birth of a Baby Black Widow

AND ITS ENEMY, A SMALL PARASITIC FLY

By GEORGE ELWOOD JENKS

This notorious arachnid, *Latrodectus mactans,* sometimes called the shoe button spider, is the only dangerous spider found in temperate North America. It is a secretive animal which hides under stones and in burrows or lurks in the shelter provided by cellars, garages, and barns. It has been estimated that about one of every 20 persons bitten die from the venom, which is more potent, drop for drop, than that of the rattlesnake. Fortunately, the retiring habits of the spider preclude the possibility of its becoming much more than an undesirable neighbor except in localities where it is extremely abundant.

3 AN OPENING MOVE in the mating activities: the male approches very cautiously, reaching out his long front leg to give her a tentative touch



4 IF SHE HAPPENS to be in a receptive mood, the preliminary tactile caresses are tolerated and the male is relatively safe from attack

7 WITHOUT ACTUAL CONTACT of primary sex organs, the fertilizing fluid is carried to the sperm receptacles of the female by the syringe-like palpi of the male

8 WHEN THE SEXUAL IMPULSE of the female has subsided, the male is in the greatest danger, and should he tarry too long in his amorous pursuits, may be killed

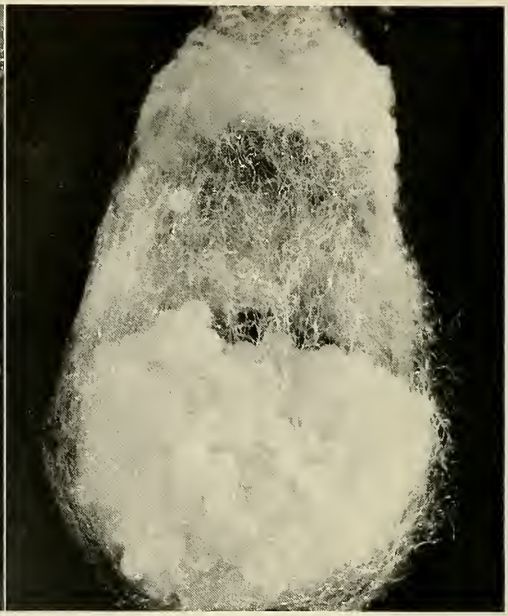
1 BEHIND THE DOOR of your garage or mine—almost anywhere in the United States—or in some other sheltered corner of our premises, the black Amazon may be found

2 THE BRIDEGROOM APPEARS. As shown below, at right, he is a tiny little fellow in comparison, and is believed to be quite harmless to man, though he bites insects for food

5 SHE RETREATS and he follows, stimulating her with his long front legs and growing bolder as she makes no attempt to molest him

6 FINALLY she hangs motionless and submissive, seemingly completely hynotized by his persuasive advances. The spiders are enlarged here about three times

9 IF SO, all that soon remains of this insatiable little husband is a dry and empty shell, hence the name Black Widow. Many males, however, escape from the clutches of their fickle mates. (Photograph greatly enlarged)

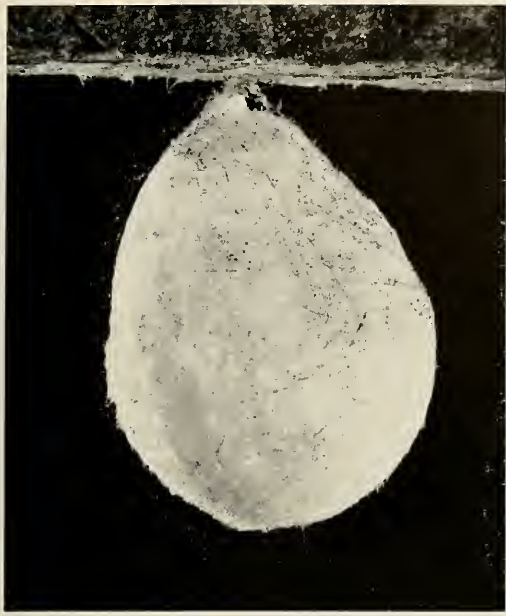


10 Next the nursery is built. The Black Widow first spins an inverted cup for the "roof," then hangs below it and lays the eggs upwards, in a sticky mass

11 She next pulls down the loose ends, spins more threads, and completes the framework of the sac. None too soon! The eggs quickly fall apart and drop

14 Above, the spiderlings have grown, made their first moult, and taken on the immature Black Widow markings. Now they are about ready to gnaw a hole in

15 the fabric of the sac and come popping out like bullets from a miniature machine gun, as shown above—



12 FINALLY, with about 2000 separate applications of strands of silk, she reinforces the framework and completes the sac about two hours after she began it. Then she mounts guard and takes a well-earned rest

13 IN ABOUT TEN DAYS or two weeks the eggs hatch and the sac is filled with squirming spiderlings, transparent as spun glass. Here they continue development for from two to six weeks, depending on temperature

16 —to scatter quickly to the four winds. There are some two or three hundred to the sac, and the Black Widow averages four or five sacs per season! The Black Widow has a remarkably wide distribution extending from Southern Canada to southernmost South America, occurring also in the Hawaiian Islands, the Bahamas and West Indies. Four other species of *Latrodectus* are also poisonous

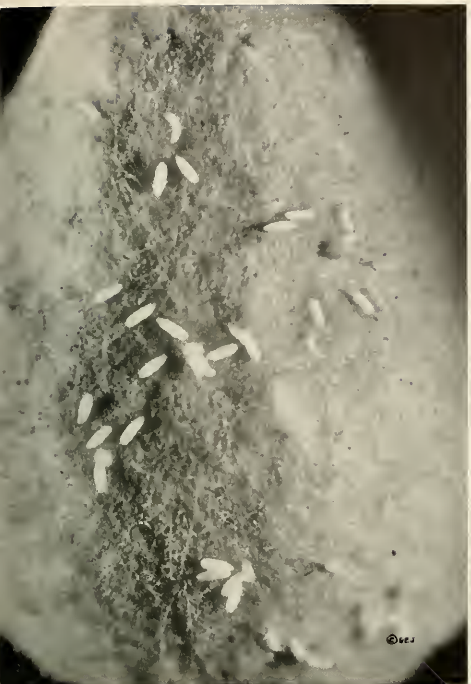
but . . sometimes (perhaps once out of 50 times) a rare little parasitic fly, *Pseudogaurax signata* (Loew) [= *Gaurax araneae* (Coquillett)], happens along and finds the Black Widow's pretty little sac

17 Ah! It is just what she is looking for! In fact, it is her destiny in life to seek and find the egg sacs of certain spiders

18 Right under the nose of the guarding Black Widow the tiny fly proceeds to lay her eggs upon the surface of the egg sac, as shown above

21 On this concentrated food the larvae grow rapidly. And the Black Widow's eggs are going fast!

22 Having eaten everything in sight, the larvae proceed to pupate in the Widow's snug nursery



19 In two or three days the eggs hatch, and the tiny maggots (larvae) "worm" their way through the fabric of the sac—

20 —and proceed to feast upon egg-nog *à la* Black Widow!

23 In a few weeks the cocoons burst and the adult *Gaurax araneae* flies emerge

24 Gnawing through the Black Widow's sac they hurry off to find and destroy others

WHERE WINTER AND SUMMER MEET—*A new nesting ground of the Greenland Wheatear is discovered on an eventful voyage to Baffin Island with the 1937 MacMillan Expedition*

Courtesy "Technology Review"; photograph by M. J. Buerger

(Above) An unusual photograph of a luminous cloud-glow enveloping the Grinnell Ice-Cap 30 miles distant across Frobisher Bay. In the foreground: the expedition schooner, Gertrude L. Thebaud, *anchored off Brewster Point*

By JOHN RIPLEY FORBES

We had not been long on board the *Gertrude L. Thebaud* before we had a taste of the strong tides, dense fogs, treacherous storms and impenetrable ice packs which issue a challenge to the scientist who seeks to explore Baffin Island.

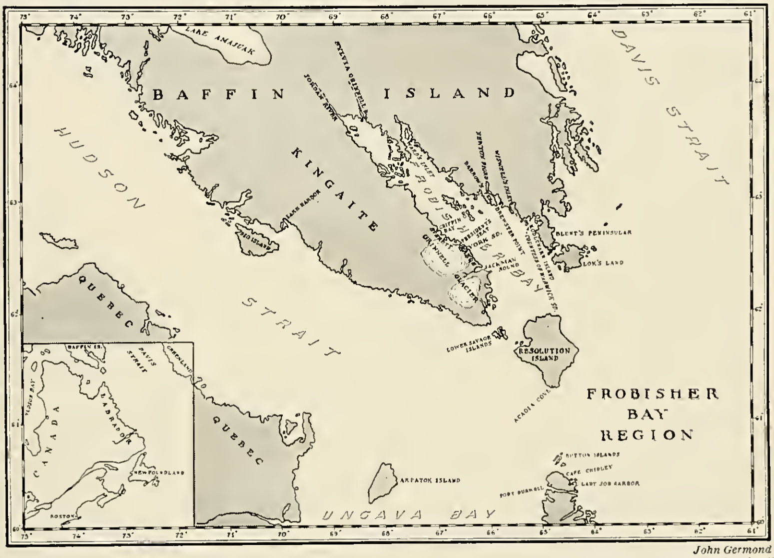
I had been wondering how much farther we could proceed, against the ice which was growing constantly thicker, when a command issued to the man at the wheel gave the answer. We were swinging into Bowdoin Harbor near the northern extremity of Labrador, so named after Bowdoin College by our commander, Donald B. MacMillan. This was his 16th expedition into the Arctic. Our vessel, a famous Gloucester racing and fishing schooner, carried a student crew of 23, and six scientists.

In the days that followed, Cape Chidley lived up to her nickname, the Cape Horn of the North. One attempt to proceed ended in a forced retreat to Bowdoin Harbor. A day later we succeeded in reaching Lady Job Harbor, and pushed our way cautiously into the ice-blocked shelter. In the distance, as far as one could see, were solid impenetrable ice-fields which would have destroyed our boat in no time had we ventured forth. Scarcely an hour after we had anchored in the harbor, we found ourselves sealed up, for, with a change of wind, the pack ice had moved in and closed the entrance of the harbor.

All this fitted in with what I had expected of the Arctic, but a few weeks later in Baffin Island when I looked down on beautiful rolling hills covered with green grass and many flowers and found myself in a veritable paradise of bird life, I had to revise my ideas somewhat. The Arctic has two distinct faces.

The day after we entered Lady Job Harbor we climbed nearby hills and saw that ice conditions were unchanged. Late that afternoon the wind began to blow and a storm started to come up which made us thankful for the shelter. Our anchor started to drag and a second anchor was used. The storm hurled itself down upon us from between the hills with such force that it cut the tops of the waves off and flung them into the air in a fine mist. During the evening the storm increased until the wind was blowing about 75 miles an hour. We hauled our anchors in several times to clear the chains and finally left the harbor under power to search for four boys, who we feared had been blown away in a dory. Nothing could sail that night. Under bare poles our scuppers were under water! But we found the boys and returned to our anchorage.

The following day we found the storm had opened our harbor entrance and there was no sign of the great ice floes, which had completely blocked the harbor only the day before. How even this storm could have moved such masses of ice was a wonder to us. Once we were well out from Labrador, the ice floes began to increase and we proceeded slowly and with caution. Just beyond the Button Islands* we ran into a great field of ice which we worked through slowly, finding the weak spots where the passage was just wide enough for the *Thebaud* to pass through.



John Germond
Courtesy, "The Technology Review"

Once we were caught in the ice by a sudden shift of the wind. Unable to make progress we stopped our engines and drifted along with the ice for a short time. During this time, as the ice ground against the sides of the vessel, we all felt the sensation which until this time we had only read of in books about Arctic exploration. We had all heard of vessels being crushed in the ice and literally turned inside out. The ice we were trapped in, however, was thin shelf-ice, otherwise our wooden ves-

*See "To the Strange 'Buttons,'" by Alfred O. Gross, NATURAL HISTORY, September, 1935.

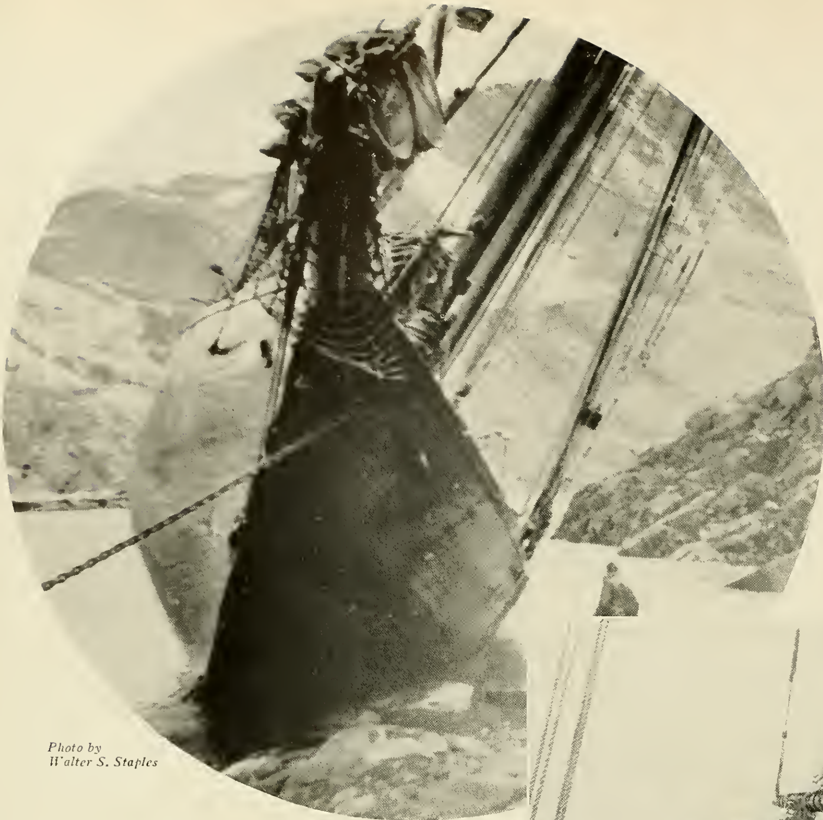


Photo by
Walter S. Staples

(Above) A DISTRESSING RESULT of Baffin Island's tremendous tides: the trim Gloucester schooner, *Gertrude L. Thebaud*, home and transport of the MacMillan Baffin Island expedition of 1937, stranded in Frobisher Bay. The returning sea, which rose 26 feet in six hours, filled the port cabins to the ceiling, and the vessel was believed lost. As S.O.S. signals were being sent, the ship partly righted herself, and after a ten-hour battle she was saved

Photo by Richard Warren French

BEARDS grown in the tradition of the bleak Arctic were found strangely at variance with the abundant flowers and balmy climate of Baffin Island. Above, members of the expedition snapped during their ecological survey of this interesting island where winter and summer join hands.

THE SUMMER TENTS of these Baffin Islanders are replaced by snow igloos in winter. Note raw seal meat on the tent out of reach of the dogs. Eskimo life revolves around the seal, which provides shelter, clothing, food and fuel

Courtesy "Technology Review"; photograph by M. J. Buerger

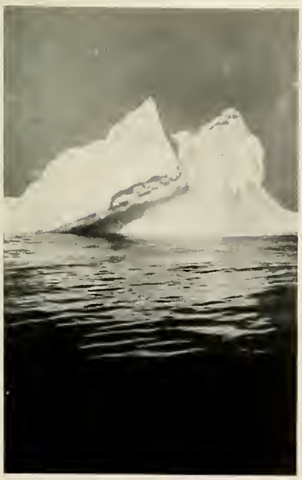
(Left) Camera shyness dulled the high spirits of this Eskimo girl after her delight over gifts of chewing gum. The women were said to be "as happy over the gift of a single needle as we might be with a new car"

Photos by J. R. Forbes

(Right) Despite their awe at curious shipboard activities and buzzing movie cameras, these Eskimo boys thoroughly enjoyed their visit on the expedition schooner *Thebaud*

(Above) An excellent example of a pure-blooded Eskimo of Brewster Point, Baffin Island, who responded affably to Commander MacMillan's cheery *"Awksha-nai"*—the native greeting

Courtesy "Technology Review", photograph by M. J. Buerger



Shedding its heavy frozen load after the Ice Age, Baffin Island rose 180 feet above the present sea level, as evidenced by the wave-cut wall shown in foreground above. It is thought to be still rising

(Left) Giant icebergs floated majestically through the chill waters around Baffin Island providing the true Arctic touch, and though ice floes *(right)* off the craggy coast balked the ship's progress at several points, a varied summer flora and fauna awaited investigation on the Island itself

Photos by J. R. Forbes

Photographs by Alfred O. Gross

NESTLESS EGGS. The murre lays eggs as shown above *(left)* on rocky ledges without benefit of a nest. Here Nature has produced an egg that is slightly flattened on the sides and pointed toward the end, so that it rolls in circles and cannot drop off. Note the variety of the markings

(Above) YOUNG MURRES, recently hatched. The abundant and varied bird life of these Arctic islands is a constant source of wonderment, and the manifold nesting activities permit observations not possible in the temperate zones

(Left) THE RARE GREENLAND WHEATEAR. The recording of eleven specimens of this wary bird hints that it may be more plentiful on the island than has heretofore been believed

Painted by A. Thorburn, "British Birds," Vol. I

(Right) ECHELON CREVASSES or tension cracks in a Baffin Island glacier caused by the tearing away of the faster moving central ice from the side ice which is slowed by friction with the rock walls. Note the relative size of the human figure. Expedition geologists had opportunity to study glacier flow phenomena in Frobisher Bay

(Below) A VIEW between vertical rock walls down one of the glaciers from the edge of the ice-cap 2000 feet above sea level. *Within circle:* the expedition ship, *Gertrude L. Thebaud,* dwarfed by the grandeur of the setting. The white specks in Frobisher Bay are small icebergs. Amidst such bleak scenes, colorful Alpine flowers, delicate butterflies, insects and small mammals flourished in abundance

Courtesy "Technology Review"; photograph by M. J. Buerger

sel might have suffered such a fate. Before long the wind shifted, and the ice began to loosen its hold slightly. The ship was sent into reverse and then thrust forward; the bow drove up on a piece of ice, which broke off, and by using this as a battering ram, we forced our way into clear water.

At length we came to Resolution Island, located off the shore of Baffinland near Frobisher Bay. It is very dangerous territory with its uncharted coast-line, excessive tides and dangerous currents, and landing is a most hazardous procedure. During our brief stop we found that it consisted of many islands rather than one large island as listed on the present-day maps. This large area is literally honey-combed with channels and consists of three large islands and hundreds of small ones. The tops of the hills were covered with glacial boulders.

The following day we passed many large and small icebergs, and sighted the Savage Islands which are a short distance from the entrance of Frobisher Bay, Baffinland. Keeping a sharp lookout and making soundings, we advanced along the western shore of Frobisher Bay until we arrived at the entrance of Jackman Sound. About five o'clock we hove anchor in the sound and soon a party was ready to go ashore and make its first acquaintance with Baffinland.

A milder Arctic

Jackman Sound was a fine sheltered harbor guarded by high rugged cliffs. Here, only a few degrees south of the Arctic Circle, we had our first taste of Lady Arctic in a softer mood. Glaucous gulls nested in a fair-sized colony at the mouth of the sound, where their beautiful chalky white bodies stood out sharply against the brown of the cliffs. Responding to their mood in the lovely surroundings we felt that no perversity could be ascribed to these birds for choosing the Arctic exclusively as their nesting place. Inshore we saw a number of black guillemots swimming about, which apparently had chosen the nearby cliffs for their nests. The guillemot is a colorful bird with its black plumage, white wing patch and bright red feet and mouth. Landing on the beach we went inland over a long stretch of rather level country which gradually rose to hills and steep cliffs. As we walked along we could not help but admire and wonder at such a beautiful spot in the so-called "barren North." All about us was a large area of luxurious green vegetation, numerous small pools, streams, etc. Only a few snow banks lingered among the lower hills to remind us of the harsher Arctic through which we had come.

Here and there as we moved along we would flush the little pipit which nested among the Alpine plants and mosses. As they flew up we could see their white outer tail feathers, the characteristic field mark of this little bird. We recognized them as old friends, for they spend their winter months with us and are commonly seen about our fields, salt marshes and beaches until spring, when they return to the north to nest. As we passed by, they would fly to nearby rocks where they would walk back and forth, continually wagging their tails as they uttered their characteristic call note.

On one of the numerous inland ponds a common loon was seen. This bird, often called the Great Northern Diver, is well known to most of us and is about the size of a small goose, with shiny black head and black and white patterned back. Far more common in the North is the red-throated loon which we found in large numbers all along the coast of Labrador and Baffinland. A pair of these beautiful birds nested inland but a short distance from our anchorage, and we often saw them flying out over our ship, emitting loud cries. No doubt one of our party had flushed them from their retreat. In many of the places where we stopped these loons were found nesting nearby, usually having two young which would keep diving as we approached, while the parents circled about uttering shrill cries of protest. The red-throated loon is smaller than the common loon, with beautiful gray head and rufous-red throat patch.

Arctic pet

The lemming, an Arctic rodent, was seen here and there as we made our way among the small rocks near the end of the valley and, after a lively chase, two of these attractive little animals were captured and brought back to the ship for pets. The lemming is about the size of a meadow mouse and in shape and looks resembles a guinea pig. They are most attractive little animals and were often seen scurrying under rocks and vegetation as we approached.

Along the hillsides we found the beautiful snow bunting, but we had arrived too late to see their nests as the young were already about and able to take care of themselves. It was a much different snow bunting than we had seen at home, for these birds visit us during the winter months dressed in a somber mantle of brown. Here, however, as if to contribute their share to our new impression of the North, the male birds appeared in striking white array, with rich black-colored wings and tail for contrast.

It was a beautiful day, the sun's rays making us wish we had left our coats behind, especially when climbing up among the rugged hills. One of our parties ascended one of the higher hills overlooking the sound and saw a rather unusual sight at the very top of the hill. A cairn, no doubt built by some recent expedition, was found at the crest of the hill, and atop the cairn perched a female Harlequin duck. The height of the cairn was 1970 feet and this duck certainly seemed out of place at this height on its singular perch. An Arctic fox was seen in the distance and heard barking, but was too wary to allow a close approach.

Hawks with young

A pair of American rough-legged hawks had been seen circling about some cliffs not far distant from our anchorage. Following an inland stream from the mouth of the sound between steep hills, I located the nest, about half way up a rough and steep cliff. Upon approaching it, the adult birds would dive at me with shrill cries of protest, coming back to repeat time and time again. Climbing out on a ledge, I pulled myself up to the level of the nest and found five young birds of varying sizes huddled together on their lofty perch. They remained entirely motionless, watching me with their sharp eyes as I neared them. In the nest, I found four lemmings, no doubt just brought there as food by the parents before my arrival. After taking pictures of the nest and young, I retreated to the foot of the cliff, making my way down the valley through a snowbank to a nearby stream surrounded by rich Alpine plants and mosses. The slopes of the hills had lovely plants and beautiful beds of moss on them.

Walking along the beach toward our boat, I ran across a good-sized flock of semipalmated plovers feeding about the small pools on the beach. A number of them were feeding in the shelter of a large iceberg which had been left on the shore by the tide, and was slowly melting with the warm temperature. The plovers are beautiful little birds, best described as small ring-necked shore-birds with brown above and white below. They are about half the size of the common killdeer and have a single ring about their necks rather than the double ring of the latter. When approached too closely the flock would fly up as one bird, circle about, and alight further down the beach. Earlier in the season we had come across these birds with their young, and their efforts to drive us from the region were indeed interesting. The birds would drag their wings and act as though injured, uttering sharp cries as they attempted to attract our attention. We managed on several occasions to capture the young which would run about in wild fashion on their long, awkward legs.

Returning to our vessel once more, we talked over our day's exploration and examined and prepared the many specimens collected. The following morning we weighed anchor and continued on our way along the shore of Frobisher Bay.

As we moved along the west shore of Frobisher Bay, we came in sight of the Grinnell Glacier, which we could see winding its way among the mountain tops. Most of us have read of the glacial period in our own country and one need but observe the landscape to see ample evidence of its work. Actually to see such glaciation going on was one of the highlights of the expedition. As the *Thebaud* cruised along the mountainous coastline, dwarfed in comparison by the lofty peaks of Baffin Island, we sighted the great ice sheet coming ever nearer as we approached York Sound. Entering the sound, we saw a part of the glacier—a discharging glacier—which had worked its way down between two steep hills to the sound, where it broke off ever so often, the ice drifting down the bay as bergs.

Ice-cap shrinking

A party ascended the ice-cap, climbing to a height of 2880 feet and made many important observations and measurements. It was found that the ice-cap consisted of two glaciers rather than one as heretofore believed and illustrated on present-day maps. The twin ice-caps of almost equal size are about 100 square miles in area. Several small glaciers discharge into Frobisher Bay from the northwestern ice-cap. By comparison with previous observations and measurements made on other expeditions of Commander MacMillan, the ice-cap shows unmistakable signs of dying, and it will probably eventually disappear. The geologist made many important findings during his study of the ice-cap and deduced that Baffinland is slowly rising out of the sea as a result of the diminishing weight of ice.

Near York Sound flocks of Eider ducks, both male and female, were seen in the shelter of several islands. They could also be seen flying along the shoreline in string-like formation, the white of the males contrasting with the brown of the females. Eider ducks are large and heavily built and the only ducks with black below and white above, which make them an easy duck to identify. Their slow flight always close to the water is another characteristic of the species. It is the Eider which furnishes the well known "eider-down" used for so many commercial purposes. The duck plucks this down from its breast for construction of its nest and the protection of its eggs.

Leaving York Sound, the *Thebaud* continued on her way along the bay and hove anchor at nearby

Griffin Bay. Here, the following morning, we had the distressing experience of almost losing our vessel due to an unexpected drop in the tide. However, what explorer and scientist does not expect the Arctic to play some strange and unexpected tricks?

Sometime before 4 a.m., Friday, July 23rd, the wind and tide had caused the *Thebaud* to drag her anchor toward the cliff, and with this sudden drop of the water her keel was left in the bottom. Efforts to pull the schooner off were fruitless and no amount of straining of her powerful motors could move her. As the tide dropped the schooner began to lean to port, her towering masts listing toward the cliffs. Soon she was lying on her side at about 35 degrees. Before long the tide started its rapid rise of 26 feet in six hours. As it rushed and swirled about the hull, the sea was soon up to the lee scuppers, over the rail, and finally creeping up the deck. With the vessel filling rapidly and port side cabins filled to the ceiling, we prepared to abandon the ship.

A dismal prospect

All hands worked against time to fill the dories with much needed supplies for our long trek back to civilization. A long line of men in bucket-brigade fashion rushed food ashore to a point above high tide. Our radio man, standing by his post, sent out the S.O.S. as water swirled about him up to his waist. As we heard his key repeating our dismal message and heard his voice sending our distress message over the mike, we were prepared for the worst.

As the last men were about to leave the doomed vessel, Commander MacMillan noted that the port rail was rising slightly, and the tall masts began to sway once more. With a glad cry all returned and worked without rest for six hours to save our grand vessel. The first question we all asked was whether the ship would float with so much of the sea in her. But water poured from her as she began to straighten up, and slowly, painfully slowly she rose. After gaining on the water, we were able to make progress, and that afternoon ten hours after our vessel grounded we were limping out of our harbor with the aid of our tender *Mir-o-Mac*. Once clear of the cliffs we set our sails (the engine was, of course, temporarily disabled, having been covered with salt water), and that evening we anchored once more at Jackman Sound where a safe anchorage awaited us. It was a very thankful and weary party that turned in that evening.

Our first real, full-blooded Eskimos sailed out to greet us as the *Thebaud* approached Brewster Point. Their pitiful little settlement of five sealskin tents was visible on the shore as we drew near, and their excitement on boarding a vessel from the south almost surpassed ours in the anticipation of meeting and knowing these picturesque people dressed in their primitive, sealskin clothing.

Commander MacMillan greeted them with the cheery welcome, *"Awk-sha-nai,"* and was soon talking with them in their native tongue and passing out gum, candies, pipes, tobacco, and other presents. The women were as happy over the gift of a single needle as we might be with a new car.

During the winter our Eskimo friends lived in snow igloos, built on the rocky shores wherever the best fishing and hunting might be found. With the arrival of warm weather they erected their crude but effective sealskin tents and live in the manner in which we found them. During our five-day stay we saw a good deal of the Eskimos, for they came aboard to inspect the wonders of our ship as often as possible, and we visited with them in their dimly-lighted tents for many hours. Their tents were lighted by the primitive seal-oil lamp, and the natives all sat about on skins laid over the bare ground.

The purple sandpiper, which nests only in the North, was seen in good numbers feeding along the shore of the many small rocky islands about the point. Ravens were frequently seen about the point as we had seen them at many other places throughout Labrador and Baffin Island.

Greenland wheatear

But the rarest ornithological find of the expedition was made while we stopped at Brewster Point, Baffinland. During a field trip, but a short distance from the Eskimo settlement, I ran across a number of small birds which were strange to me. They were flying about in a small valley surrounded by cliffs, only a short distance from me. With the aid of my field-glass, I soon made them out to be the rare Greenland wheatear. These birds were very difficult to approach and were most suspicious as they flew about uttering their sharp call, which sounded like "chack chack" and was most easy to imitate. They would fly about, going from one rock to another, and perching on top of the most prominent places. They are shaped somewhat like a bluebird but smaller, having olive brown above (the adult male, gray above), and light cinnamon-brown underparts. Their wings are dark as are their cheek-patches. The most prominent field-mark is their white rump which, with the white along the sides of the tail, in contrast to the brown central tail feathers and

Continued on page 78

THE INDOOR EXPLORER

The story of a modern pioneer

"BEYOND the Alleghenies lies America." The coiner of this Napoleonic paraphrase poured into it a shrewd comment on the social development of the American people. East of these mountains, he implied, they had lost touch with the soil. Only in the western half of our country did the memory of a frontier heritage live on.

But in our own time even this geographic barrier has crumbled. Steel rails, concrete highways, radio waves, and droning airplanes have spread an industrial culture like quick-flowing veneer over the entire continent. And doubling back from the Pacific, the last frontier, a million miles of celluloid film have stamped our minds and manners with a spurious cosmopolitanism. Now at last the wind has shifted. Today many American people are turning back to the wilderness—the source of their spiritual traditions. And in this movement we find that an idea which one man had ten years ago, played no little part.

It is impossible to examine each contributing factor to this nationwide renascence. But the importance of Nature Trails and outdoor local museums cannot be overemphasized. Almost every week brings the announcement that a new unit has been opened by one of the state or national parks in response to an enormous public demand. Yet one of the earliest Nature Trails is only ten years old and was opened not "beyond the Alleghenies," but only 45 miles from Manhattan in the heart of the effete East.

At the foot of Bear Mountain, on the west bank of the Hudson lives William H. Carr, who has been Director of Trailside Museum from its start. Nearly half a million visitors from every social stratum crowded into these 57 acres last summer—significant evidence of "America's return to Nature"—and a still greater influx is predicted for next summer.

Administered jointly by the American Museum of Natural History and the Palisades Interstate Park Commission, Trailside is designed to combine the facilities of a permanently housed museum with the opportunity to observe nature "at work." Trees, plants and animals live *naturally* before your eyes in its rolling woodlands, while exhibition material is open for study in the several low stone buildings comprising the sheltered section. But there are no exotic "wonders" at Trailside.

"Our purpose is to teach people the natural everyday wonders of their own particular locality," Director Carr emphasized as he led the writer over the grounds.

In the Geology Building he pointed out that the mineral collection served a broader purpose from the local study point of view than it conceivably could in any other way. Visitors were enabled to go out along the trails and up into the vast Bear Mountain Interstate Park itself, pick up sample rocks, and check their findings with the representative collection in the building.

"You can see the local flourescent minerals in this gadget," he said, pointing to a wooden box equipped with a crank, "only it does not work automatically the way you have it in the American Museum. You have to turn this crank. But we believe that more people will pause and learn just because they enjoy working the thing themselves instead of having it all done for them. People like to use their hands as well as their eyes. We apply that principle to a lot of our exhibits. Take our electric bird identifier, for instance; we fixed it so that a buzz could be heard when you touched the correct answer. And when we go out on the trails, I'll show you some of our hidden labels. That sounds odd I know, but they're simply ordinary wooden tree labels with a weighted cover over them that snaps back in place after anyone lifts it up to read the descriptions. You'd be surprised how curious people get about those things. They've just got to lift the cover and find out what's underneath."

The geology exhibit illustrates one

of the three methods of public instruction at Trailside Museum. Director Carr calls it the "tactile" method, or "touch system," by which he means that it is so arranged as to permit free handling and close examination of the exhibited material.

"Since they're not valuable, we don't have to keep them under glass," he said. "Of course, people occasionally walk off with them, but we can always get more; in fact they could steal all our exhibited specimens, living and dead, and we could still get plenty more where they came from—that's one big advantage in having only local material."

Visitors are given every opportunity to ask questions. Members of the staff will give free guide service and will answer all questions, but they will *not* give formal lectures. So the question and answer is the second of Director Carr's methods of public instruction—that is to say, the audible. Then thirdly there is the visual. At Trailside Museum, people can see birds, snakes, fishes, and mammals indigenous to this part of the country, living their daily lives in simulated habitats as closely corresponding to Nature's design as it is possible to make them.

Blazing the trails

How did the Trailside Museum start? In 1926, months before the construction of the original museum, a single stone building at a junction in the trails, William Carr had brought his pretty bride, still in her teens, to a 57-acre plot of raw woodland, tangled and pathless and largely untouched since the days when Fort Clinton occupied the site during the Revolutionary War. Here under conditions like those of frontier days began the task of building the picturesque Trailside Museum of today.

"There were no Indians," said Mr. Carr, "but aside from that one detail, we felt pretty much like the earliest pioneers."

The young couple came up in the spring of the year. Their first home was an abandoned construction shanty, and their first job was to "blaze" the lovely woodland trails, one of which is now part of the great Appalachian Trail System covering all of the mountain territory from Mt. Katahdin in Maine down into Georgia. Every day, rain or shine, Director Carr armed with a hatchet and accompanied by his bride carrying little wooden signs bearing information about various plants and trees, left the tent and went to work on a trail. Mr. Carr selected passages through the brambles while Mrs. Carr affixed the discreet little descriptive labels at points he indicated by bits of string tied to the bark. But there was one sharp point of departure from the pioneer methods—not a tree was felled. The trails were made on patterns mapped out by Nature. Even on hot summer Sundays when boatloads of noisily amused New York picknickers flooded in upon them, the

young naturalists worked steadily, planning the trails with an eye to the maximum natural effect.

For six years, the Carrs came up every spring about the middle of April and stayed until October, living largely in tents and in a shack left by workmen on the then recently completed Bear Mountain Bridge until the park commission built them a very serviceable cabin. Gradually, Trailside Museum began to take shape. The annual budget would permit few if any additions to the staff. Nevertheless, the Carrs found eager volunteer workers so plentiful that they were soon turning them away. Enthusiastic young high school naturalists accumulated the collections under Mr. Carr's direction, threw up cleverly constructed exhibition cages and cases, cleaned and cared for the animals, and worked on the trails. Rapid as was the progress, it could not keep pace with the ever-increasing multitudes of visitors who began pouring into Trailside not only in study groups from nearby towns and schools but simply as unofficial tourists from every state in the union.

Rough going

No admission was charged, of course, and despite the museum's astounding popularity and all the faithful and able assistance of the volunteer workers, the Carrs soon found that the budget was cutting dangerously close to the line. They worried about it a little but carried on successfully each spring and summer—successfully, that is, if you measure success in terms of the natural science education of thousands of school children, the development of many promising young naturalists from the corps of volunteer workers, and the healthful outdoor entertainment of countless casual visitors. The Carrs feel that too high a tribute cannot be paid to the early staff workers for their part in all the various projects and their cheerful devotion in often working ten hours each day and seven days each week.

But by the fall of 1934, the slender margin on which the Carrs had conducted their Trailside enterprise had dwindled away. The "Trailside Account" in the American Museum of Natural History could yield no more and it looked as though they would have to gather up their belongings and let the brambles overrun the trails they had watched grow in size and popularity for six years. But there remained one way out. Since Trailside was being operated within the Bear Mountain state park to the benefit of park visitors, it seemed only right that the state should contribute to its support. So a bill was drawn up and introduced to the New York State Legislature, staunchly supported by the American Museum of Natural History and the Commissioner of the Palisades Interstate Park, as well as numberless individuals and small organizations, all of whom dutifully wrote to Albany on its behalf. The bill finally was passed on May 15, 1935, and for one more season the Carrs sank their tent pegs in Bear Mountain soil.

Fortuna smiles

This marked the turning point in their fortunes. Not long after the bill was passed, along came the Temporary Emergency Relief Administration with the labor necessary to construct four permanent instruction and exhibition buildings, as well as a home for the Carrs. They now live in a comfortable one-story stone bungalow, remarkable for the historic hundred-year-old interior wood which was rescued from a dismantled barn.

Director Carr is overjoyed that his visitors have come here to learn not only from the trails but from the animals as well. Animals can teach volumes about themselves, he maintains. And it is easy to understand that by watching beavers *live* for an hour or two, you can learn far more than by reading heavy tomes on *how* they live. The beavers, incidentally, were entirely hunted out of this region and were far less familiar than zoo lions, until reintroduced around 1920 through the efforts of Major William A. Welch, Chief of the Interstate Park, a far-seeing park planner who saw a need for these "engineers of the animal world" on whose dam-building activities many other forms of wild life depend.

Not a zoo

Nearly all the local wild animals are represented at Trailside. But Director Carr was careful to make it plain that he is not running a zoo.

"The best term I can think up for it is 'animal concentration' " he said. There are more wild animals in type and number around these 57 acres than you would ordinarily find in an unsupervised area, but whenever practical, they are left to work out their own destinies, much as they would under purely natural conditions.

Perhaps the most remarkable thing about Trailside is the unsparing effort on the part of the staff to cultivate what is technically known as "rapport" with their visitors. The whole idea is to stimulate genuine interest in Nature and to find out the best possible means of doing it. To this end, Director Carr, and other staff members, often mingle unobtrusively with the crowds as they file along the trails or elbow their way into the exhibition houses. They are ever on the alert to discover some new angle which would make the exhibits more comprehensible, the investigation of Nature more enticing; and these angles are often suggested by hints inadvertently dropped in the course of the visitors' remarks and conversations.

At Trailside the customer is always right. An incident that symbolizes the staff's attitude came up in connection with the tendency of some visitors to become a bit too enthusiastic over Director Carr's "touch system" methods. It seems that by encouraging their tactile proclivities, visitors were tempted to drum their fingers on glass-top snake exhibits or bang peremptorily on the wire cages of crowd-weary foxes. Staff Assistant Kenneth Lewis conceived the brilliant scheme of curbing these desires by providing a means for their vicarious satisfaction. He built a dummy contraption containing both glass windows and wire mesh. Then he placed a placard underneath reading "if you must tap on wire or glass, we suggest you tap on these instead of the animal cages."

This same spirit of subtle guidance rather than high-handed coercion is apparent in the labeling along the trails themselves. These labels, while clearly legible to the interested observer, are so colored as to blend pleasingly with the surrounding foliage. They are a far cry from the blatant advertising slogans that deface much of our countryside. There is in them no implicit striving to "high pressure" the stroller into enlarging the horizon of his knowledge. Their wording is always "you may" in tone, never "you must." This is shrewd psychology, and the results of the program have been, on the whole, very gratifying. The little signs seldom stimulate their readers to scrawl pseudo-witticisms on their surface after the manner of many advertising displays, and they tell a quiet little story whose interest grows as the reader passes from sign to sign. Some of them are frankly arranged in a series form; others are complete in themselves; but all dwell on the larger theme of the intricate and wonderful interdependence of plant and animal life.

Consumer analysis

In recent years, Director Carr has made a constructive hobby of charting his visitors' reactions to these labels. And after careful observation, he and his associates have estimated that 40% of those using the trails show little interest in Nature. They simply want a picnic ground and a "good time." Another 40% will go so far as to read perhaps 10 labels out of every 100. Eighteen percent are really interested and will stay for two or three hours, examining nearly everything and asking many questions. And then, there is the one and a half percent of the visitors that stay on and on, taking full advantage of everything there is to offer. And remember that one and a half percent of 400,000* is 6000 people. That leaves around 2000 people who are, so to speak, charter members of Trailside. They come back month after month, year after year, and many of their names and faces have become familiar. They sit around the offices, carry on correspondence, bring in specimens, and even act as guides.

In the past few years, Trailside has spread a tremendous amount of knowledge, not only among the city dwellers of limited income who come up from New York to discover that tramping through the woods with your eyes open and your ears alert can be really exciting entertainment, but—and this surprised the writer—among local farmers as well. It seems that the farmer is not the "nature's nobleman" he is cracked up to be. Certain over-sentimental contributors to our past and present literature have painted the farmer and the rural resident in general as deriving a mystic understanding and a great spiritual fulfilment from his direct communion with Nature. But according to Director Carr's experience, the farmer is scandalously deficient in a knowledge of natural history. Broadly speaking, he wants to decapitate every snake and shoot every hawk he sees and it was only after repeated and painstaking lessons in fundamental ecology, that Director Carr was able to make much headway in his determined effort to combat these prejudices. But at last he has managed to get across such ideas as the fact that hawks keep down rodents who cause the farmer far greater loss than the occasional chicken he must be prepared to sacrifice for protection.

Yet short-sighted ignorance was never the conservationist's steepest hurdle. It was indifference—the mighty transcontinental indifference to America's wildlife, everywhere apparent until a decade ago. East and west of the Alleghenies, America shrugged her shoulders and went to the movies. Then suddenly something happened. America came out of the movies into the scorching glare of a great financial depression. After a moment's blindness, she began to see things she'd never noticed before. It was a great time for taking inventory, and when she blinked at the figures on her wildlife, things began to look up for the Cassandras of the conservation movement and other friends of Nature who had gone so long unheeded.

Director Carr attributes a good deal of the ever-increasing interest and attendance at Trailside to the depression, which restricted traveling ambitions in many quarters. Easterners who yearned for California, compromised on Bear Mountain. Thus an ill wind blew them an opportunity to become intimate with wildlife that they might otherwise never have had.

* Conservative estimate of '37 attendance.

And familiarizing them with wildlife is the best way there is of teaching conservation. The Trailside experiment and the conservation idea have grown side by side since 1928. And both are intimately tied up with the world-wide "boom" in Nature-interest during the same span of years. The whole tendency in natural history education the world over is toward outdoor instruction.

Numerous instances of this undoubted fact can be cited. Both Brazil and Argentine, for example, are developing national park systems, which when completed, will dwarf those of the United States; and in each locality they are planning an outdoor educational unit along the lines of the Trailside enterprise.

Ancient precedent

"But don't get the notion that I or anyone connected with this place started the idea," Director Carr demurred. "Aristotle, if memory serves me, had a labeled nature trail and he probably wasn't the first. As to the modern world, I have a hunch that the idea was reborn in Switzerland, although I haven't much to go on. Anyway, the Trailside Museums have certainly mushroomed during the last decade in this country."

Several units, he pointed out, have grown up with our national parks. Many colleges are increasing their curricular field trips out of all proportion to activities in these channels ten years ago. Organizations like the Audubon Society, the Boy and Girl Scouts and kindred groups have increased their membership many fold and tripled their outdoor ventures correspondingly.

"Why, right now," Mr. Carr said, "the demand for trained nature councilors in summer camps, both paid and

volunteer, is simply tremendous. We get inquiries accompanied by very attractive offers all the time. Ten and fifteen years ago most directors were mainly interested in good baseball and swimming coaches—your Nature man was a sort of sissy. Now the worm has turned. But we've only just begun. We've got to coordinate the movement."

Director Carr's ambition for Trailside is to develop it into a sort of Woods Hole for the field, instead of marine, biologist. Close to New York City and yet with ready access to the entire sweep of Bear Mountain Interstate Park, Trailside Museum would be the perfect spot to found such a school—as complete a natural laboratory for the study of ecology as could be found anywhere.

Such an institution would probably be the only thing of its kind in the world. Yet even the present Trailside is the object of international attention. Countless emissaries from foreign countries—including two who recently arrived from Tasmania—as well as every state in the union have come to Trailside Museum to learn the tricks of building Nature trails with adjacent museums. There is, therefore, a certain responsibility of leadership of which Director Carr is keenly aware. And although there seems no immediate likelihood of funds for even a modest beginning to so far-sighted a program, Director Carr each year manages to take at least one small step in the direction of his ideal.

For every taste

But to the average visitor, Trailside already offers more than enough. The botany-minded will probably spend much of their time in the newly built fernery where samples of the 36 native ferns grow on either side of a circuitous path. Bird lovers will tramp the trails with a sharp eye, a keen ear and an opened field book. Whatever your Nature hobby, whether camera faddist, fossil hunter, or merely someone who's tired of the local zoo, you will find what you're looking for just 45 miles from Manhattan at the western end of the Bear Mountain Bridge.

WHAT YOU CAN DO ABOUT CONSERVATION

Continued from page 41

lofty-flying falcons, eagles and ravens as they skimmed above the rocky peak on their yearly migration. The belief that all birds of prey are pests has been utterly disproved; most are actually beneficial to rodent control. Out of its slim funds the Committee bought Hawk Mountain and declared it the first sanctuary ever set up for birds of prey.

Space does not allow mention of all the groups well organized and honest. But other groups exist for the purpose of blocking conservation measures. Many are backed by immense wealth, advised by canny legal talent, and skilled in the tactics of lobbying. They all call themselves "conservation" societies, putting a little salt of conspicuous benefaction on the tail of the birds they are after. They fill the seats in once unquestionable forestry societies with henchmen of the lumber barons. They long for control of the Biological Survey, Forestry Service, and the National Parks, for these government forces are blocking the way to further depredation.

How can you and I be sure, when we give our dollars to conservation, that they will be honestly used in the fight? You can make certain of the genuine article just as you do when you buy a diamond or a fur—by going to an established and reputable firm. And for about the price of taking the family to the movies, you can join any one of these regiments drawn up to fight for American Nature.

It is conscience, in the end, that is the beginning of conservation. When you move to save wild life, the sheltering trees, the fowl of the air, the waters upon the earth, "and all that in them is," you are saving America.

SCIENCE IN THE FIELD AND IN THE LABORATORY—*Spider Hunting in Florida—The Black Fly Menace—Doctor Chapman's Semi-Centennial—Fossil Teeth—Museum Host to Teachers*

Spider Hunting in Florida

Curator Lutz and Assistant Curator Gertsch have recently returned from a very successful collecting trip in Florida. Using the back seat of their automobile as a traveling laboratory for the care of both live and preserved specimens, they covered more than 2,200 miles in the "Sunshine State." Particular attention was paid to the several interesting and well-kept state parks in the central and northern sections. Of course, spiders and insects were the things that chiefly interested these members of our Department of Entomology. As a matter of fact, it was very largely a spider trip, although numerous insects were collected, including a quantity of live mole crickets for a study of their biology and to serve as models in making a habitat group in which they and their environment will be shown sufficiently magnified to enable our visitors to appreciate more easily the curiously modified structure that justifies the name "mole crickets."

In addition to collecting spiders during the day by sweeping through the vegetation with a stout bag fastened to a net-frame, by digging them out of burrows, by looking under boards and stones for them and by just looking, Doctor Gertsch went out at night with a head-lamp and "shined their eyes." No one who has not tried it can realize the thousands of bright, glowing specks that can be seen bejewelling the ground in a good location, each speck the eyes of some spider. If your object is to get specimens, all that you need do is to walk up to a speck, stoop over, and pick up the spider. (No. Very few spiders make any attempt to bite; of those few still fewer succeed; and of those that succeed, only the Black Widow is to be seriously feared.)

There is little doubt that, when the catch made on this trip is sorted over and carefully studied, specimens will be found of species that have not been previously known. Others, although taken before, are distinct "rarities." One of these is what Comstock called "The Lost Atypus" *(Atypus bicolor)*. A few had been taken near Washington, D. C., and one in Florida. Practically nothing was known of the habits of this species, the largest and most colorful of the genus, although it was inferred that it would live in a tube like that of the common species of peninsular Florida. On Easter Sunday, while waiting for church to begin in Quincy in the "net-handle" of the State, Doctor Gertsch wandered into a near-by woods and located a large colony of *A. bicolor.* He did not go to church but he did get a number of fine specimens of the spider, also of the tubular nests and a bad case of ivy poisoning.

It is difficult to say which of Florida's Parks is the most interesting. Much depends on the viewpoint. But certainly Torreya, on the eastern bank of the Apalachicola River, near the little town of Bristol, has strong claims on the interest of naturalists. It is the home of two conifer trees not known to occur much beyond the limits of this park. What is more, its steep, deep ravines are favored by the presence of the rare *Cyclocosmia truncata*, a spider that has the rear end of its abdomen very flat, leathery and the color of soil. Those features could mean only one thing according to theorists who "explain" every modification by mentioning a use it might or does have. *C. truncata* belongs to the group whose members typically make a "trap-door" at the top of their burrow. So, without bothering to find a nest, the idea grew that this spider had substituted the end of its abdomen for a trap door. In a recent number of the American Museum's *Novitates* Gertsch and Wallace spoiled this pretty story and in soil in a jelly-glass on the back seat of this expedition's sedan an Eastern specimen confirmed the spoiling by making a burrow topped with a perfect trap door.

More about these and other spiders may be told in an early number of NATURAL HISTORY.

The Black Fly Menace

Attention is focused at this season on the Black Flies, which present so serious a detriment to the enjoyment of hunters and fishers. Numerous cases of serious poisoning resulting from the bites of hundreds of these insects have occurred, and men have been so badly bitten that their eyes were almost closed. The flies attack not only man but various wild and domestic animals, and when very numerous may seriously impair the health of their victims. Even now these pesky insects are taking their toll of sportsmen's blood along rivers and streams in the United States, but their attacks here are mild in comparison with their ravages in the wilds of Ontario and Quebec.

In order to determine the various species of Black Flies *(Simuliidae)* occurring in the Province of Quebec, Father Ovilla Fournier, of the University of Montreal, spent the week of April 11th at the American Museum studying specimens. Father Fournier brought with him a collection of these insects from the Province and made slides necessary for their determination under the supervision of Doctor Curran. Several specimens not represented in the Museum's collection were donated, and others will be added when Father Fournier has completed his studies.

Doctor Chapman's Semi-Centennial

On March 1, Dr. Frank M. Chapman completed fifty years of continuous service with the American Museum. On that date, in 1887, he became assistant to Dr. J. A. Allen, following some earlier activity as a volunteer. When the Department of Ornithology was created as a distinct department of the Museum, in 1908, he became its Curator, in which position he has remained uninterruptedly.

At a dinner given by the Trustees of the American Museum, on April 2, Doctor Chapman was tendered a resolution from the Trustees commemorating his half-century of service to the institution.

Doctor Chapman responded with a talk about interesting incidents and developments in the Museum during his period of service. At the close of his remarks, he presented to the American Museum the numerous medals which he had received in recognition of his various attainments in the field of ornithology.

Dentition of Fossil Studied

Dr. William K. Gregory and Dr. Milo Hellman, accompanied by Doctor Gregory's bride, the former Miss Angela Du Bois, will sail on June 4th for Capetown, South Africa, *en route* for Pretoria. There, through the invitation of the Transvaal Museum and the courtesy of Dr. Robert Broom, they will have the opportunity of studying the dentition of *Australopithecus transvaalensis* Broom. This fossil anthropoid is of great interest, since it approaches the older fossil races of mankind, especially in the construction of its teeth. After making field and museum studies in and near Pretoria the party will proceed to Johannesburg where the fossilized skull of another *Australopithecus* is to be examined by courtesy of Prof. Raymond Dart. It is hoped that sufficient information can be gained to permit at least a tentative restoration of the palate and bony face of the adult *Australopithecus.* Later in the season it is planned to visit the *"Cynognathus* zone," near Burghersdorp, Cape Colony, where the highest mammal-like fossil reptiles are found.

Museum Host to Teachers

The American Museum of Natural History will be host to several groups of teachers during the Annual Meeting of the National Education Association, which will be held in New York City the last week in June. This is the first time that the NEA has been held in New York since 1917. The Department of Secondary Education will hold its meetings at the Museum on June 27, 28, and 29.

The Department of Visual Instruction is also holding its meetings at the Museum on Monday afternoon, June 27th, in conjunction with the Department of Secondary Education, with separate meetings Tuesday and Wednesday morning and afternoon. It is expected that these meetings will be attended by more than three thousand high school teachers from all over the United States.

YOUR NEW BOOKS

MODERN DAYS OF SAIL • RELATIVITY REVEALED • FIGHT TO LIVE • INDIANS, THEIR CHIEFS, WARS AND LEGENDS • ANCIENT EGYPT IN ITS OWN WORDS • BIRDS, HERBS AND TRAVEL

FIFTY SOUTH TO FIFTY SOUTH: the story of a voyage west around Cape Horn in the schooner *Wander Bird*

- - - by Warwick M. Tompkins, F.R.G.S., Lieut. U. S. N. R.

W. W. Norton & Company, Inc., $3.00

THE title of Lieutenant Tompkins's book has but one meaning for all sea dogs, namely, the passage from latitude 50° S. in the Atlantic to the same parallel in the Pacific, around the Horn. It means something particularly vivid to the reviewer, who has seen and heard a square fore-topsail blow away and fly above the driving spray for perhaps a half mile before it slumped into these same waters, and who has helped rig canvas sacks of seal oil from South Georgia to subdue the crests that were flaying a vessel hove-to in the wild winds from Drake Strait. Furthermore—while being personal—the reviewer's great-uncle commanded the clipper ship *Live Yankee* during a record passage east to west from fifty to fifty, and then onward to the Line.

But Lieutenant Tompkins's *Wander Bird* was no clipper. She was a superbly staunch and sweet-lined pilot schooner, and this journal of her conquest has earned a place among the classics of voyages under sail.

The key of the author's prelude is pitched so high and exultantly that the reader at first looks forward with trepidation to 158 pages at such Homeric levels. When one passes into the account of "the twenty-eight days," however, all fear is jettisoned; from this point the book moves into the category of those that cannot be laid down. The description of rounding the Horn is superb, terrible, and triumphant. It likewise reflects some of the finest episodes of history, exploration, seamanship and human values. Seven men, one woman and two young children in a perfect craft, well found and flawlessly handled. What a foundation for the high tale the author has made out of it!

But this book is much more than one of the best yarns of adventure. It also represents one of the most useful short treatises on rigging, gear and ship-handling that has ever been turned out. *Wander Bird's* rough log follows the narrative; the latter is, indeed, only a gloriously transfigured smooth log. The last quarter of the volume (pp. 201-268) is devoted to a wise veteran's entertaining discussion of matters about which every deep-water man will sooner or later need to know.

To find flaws one must be meticulous indeed. Tierra del Fuego—"Fire Land"—was named not by Lord Anson in the 40's of the eighteenth century, as the author believes, but by Magellan himself in 1520. No albatross attains a wing spread of 17 feet and a weight of 35 pounds. Eleven feet four inches is the maximum expanse, but the persistent error of the *Encyclopaedia Britannica,* rather than any fault of modern seamen, is responsible for the endless repetitions of that silly old yarn. It is a pity to see the photograph of a bewildered Giant Fulmar pictured on p. 96 as "a smaller species of albatross." The true bearer of the name Albatross appears, however, in two of the other illustrations.

The word "illustrations" is the sign of another climactic attainment in this book. If such incredibly faithful and beautiful photographs "off soundings" have ever been made, they have at least never before been brought together in one place. There are 102 of them, some reproduced in cinematographic series which show successive stages in the mighty onslaught of Cape Horn seas, and others devoted to life above and below decks, the crew, babes in the rigging, the picturesque accoutrements of a wooden vessel equipped according to the best traditions, porpoises, sharks, sea birds, seals and much more. Read it, and take the author's dig that most of us want our struggles and dangers vicariously, in an armchair!

R. C. MURPHY.

THE FIGHT TO LIVE

- - - - - By Raymond L. Ditmars

Frederick A. Stokes Company, $2.50

THE FIGHT TO LIVE is a title to be remembered and the book itself teems with vivid word pictures of the interminable struggle among the hosts of the living world. The author holds no brief for any particular theory as to how all this struggle, of attacker and attacked, of parasite and host, has come about, but he does record many phases of it which he has seen or experienced during his distinguished career as curator of mammals and reptiles in the New York Zoological Park.

Doctor Ditmars first gives perspective to his story by outlining the past history of the earth and its inhabitants up to the coming of man. Chapter I, "Man's Fight for Life," refers briefly to the modern progress in fighting cholera, malaria, yellow fever and other diseases. The second chapter, on the anthropoid apes and monkeys, stresses the wastefulness and want of foresight of the apes in contrast with the opposite qualities of beavers and squirrels. But why should gorillas be frugal in a land of plenty? Are even Americans much wiser?

If, as the author complains, the story of the evolution of the primates is full of inconsistencies, the fault we may be sure lies not in nature but in the story. No doubt the author realizes that "highest" and "lowest" as applied to the classification of animals means chiefly that *Homo sapiens* is the one that calls himself "highest" and, therefore, puts himself at the top in a linear classification. Doubtless also the author is well aware of the fact that the relationship of the anthropoid apes to man is not a mere arbitrary assignment "by the scientists who arrange the scale of zoology," but a well founded inference based upon an all pervasive identity in anatomical and physiological ground-plan, underlying extreme differences in habits and mentality.

Truth and Error, although normally incompatible, have frequently united and produced a varied brood of half-truths, myths and misconceptions. And among the half-truths few have led to more misunderstanding than the bare statement that man is a unique organism, who can speak, think, and describe himself and the rest of the universe in words. This is the chief basis for that inflexibly dualistic philosophy to which our author, in common with the vast majorty of mankind, gives ready credence. He comments indeed on the fundamental similarity of the ape brain to that of man but does not note that modern man has from three to four times as much brain tissue as the gorilla, or that this size factor may very well be prominent among those that make it possible for the individual human to learn the system of speech and writing which has been built up by our predecessors.

But it is ungracious to ask for more where so much has already been spread before us. The catalogue of a museum of crime would list an array of clubs, daggers, spears, hypodermic needles, etc., their no less deadly prototypes, as used by animals, are well described in Doctor Ditmars' book. Likewise the apparatus of defensive-offensive warfare, such as fortresses (moving and fixed), smoke screens, camouflage and the shifting world of make-believe, find their close counterparts in the animal world and man's often unconscious plagiarism of these devices has not escaped the author's attention. Perhaps the best chapters are those on poisonous snakes and their enemies and the struggle of the amphibians.

Writers on evolution sometimes blame Darwin for letting lose on the world the allegedly degrading doctrine of the struggle for existence. But would there have been less fighting in Ireland, less raiding in Arabia, less slave-making in Africa, if Darwin had never written? *The Fight to Live* again brings us grim reminders of the "dog-eat-dog" code of morality which still persists even among the largest-brained divisions of *Homo sapiens*. It is to be hoped, however, that someday Doctor Ditmars will write a sequel, "The Urge to Give," showing what sacrifices the individual animal unconsciously makes for the good of others.

W. K. G.

The Evolution of Physics

- - - - - - by Albert Einstein and Leopold Infeld

Simon & Schuster, $2.50

THE EVOLUTION OF PHYSICS is a popular discussion of "the growth of ideas from early concepts to relativity and quanta." The volume will be welcomed by all those who are interested in science, especially by those who have forgotten most of their mathematics, for there is not a mathematical formula in the entire book. It is the more valuable because written by a master in his own field.

"The discovery and use of scientific reasoning by Galileo was one of the most important achievements in the history of human thought, and marks the real beginning of physics."

Beginning with Galileo, the founder of experimental physics, the development of scientific ideas is traced through to the present day. As stated by the authors in the preface, the book is a simple chat between the readers and the authors, the hope of the latter being that it will give "some idea of the eternal struggle of the inventive human mind for a fuller understanding of the laws governing physical phenomena."

In a fascinating story the rise of the mechanical view is traced, after which are outlined the reasons for the decline of the mechanical view. In these discussions full credit is given to Newton and the other intellectual giants. Practically all of the mathematics has been left out, and the illustrations are simple and clear.

The second half of the book is devoted to Field, Relativity, and Quanta. These subjects intrigue the mind of the layman, who hopes that he may have at least a glimpse of the status of modern physics. It is generally felt that no one has been better able to explain to the popular audience the contributions of Professor Einstein than the master himself. Many have tried to clarify his theories, but we still turn to Professor Einstein's own books or to his original statement for the press. Here we have in a volume of some three hundred pages the simplest and clearest non-technical treatment of these abstruse subjects, as a part of the story of the evolution of physics.

Clyde Fisher.

The Bannock Indian War of 1878

by George Francis Brimlow, M.A.

The Caxton Printers, $2.50

TO those interested in the history of the frontier in the Columbia River drainage—our last North West—this account of the so-called Bannock Indian War should be a prized addition. It is not a thrilling book, like the accounts of stiff fighting with the Modocs under "Captain Jack" in 1872-73, Custer's campaign in 1876 and Chief Joseph's 1,000-mile retreat in 1876-77. Those were exciting times. But the Bannock War in 1878 was drab by comparison; it was the last back wash of Indian defeat in the North West. The concentration of U. S. troops in the area, operating from all sides, made the affair one of routine rather than anything approaching a real fight. Note that Howard, Crook and Forsyth, even then famous in Indian warfare, and all officers of high rank were in the field. The serious reader will find a convincing factual analysis of the causes of the trouble and good data on the present distribution of Indians in the area. The text is well documented.

Clark Wissler.

Journey to Manaos

- - - - - - - - - by Earl P. Hanson

Reynal & Hitchcock, $3.00

EARL HANSON, in *Journey to Manaos*, has given us a splendidly faithful picture of a remote and romantic, but almost forgotten, region deep within tropical South America, and that he has given very full measure, is the first thought as one finishes the eager reading of it.

The official purpose of this journey along the Orinoco and the Rio Negro undertaken for the Carnegie Institution of Washington was the re-occupation of stations at which observations had been made some years before, all toward a better understanding of the vagaries of the Earth's magnetic field.

The entertaining travelogue which he has given us would quite of itself have been reason for *Journey to Manaos*, but this literary effort takes on greatly added importance from the stirring narrative of recently current Venezuelan history bristling with political intrigue, despotism, tyranny and revolution to which the author's actual contacts give gripping reality. It will, however, undoubtedly be remembered longer and be referred to more as a valuable contribution to sociology and economics—of interest not only to the region traversed but to tropical America in general. He skillfully interprets and coordinates his observations with the interesting result that his soul becomes deeply stirred by the age-old and very infective lure of empire-building, but at the same time his fine zeal is tempered by an appreciation of the extraordinarily intricate nature of such an enterprise and its appalling responsibilities.

The mortal fatigue, the devastating depression, and the lurid fantasies of the semi-delirium of his malarial fever are described with almost terrifying effectiveness.

To the reviewer, a very pleasing feature that threads its way through the entire book is the author's kindly understanding and appreciation of the South American Indian, among which people, *with proper approach*, one usually finds sterling qualities and not infrequently great nobility of character.

H. B.

Legends of the Long-House

Jesse J. Cornplanter, of the Senecas

J. B. Lippincott Company, $2.00

THAT an Indian has written and illustrated his own book of legends is hardly news when we consider the tide of Indian art and literature that has risen during a century. There have been Indian ethnologists, but only scholars read their genuine contributions to knowledge in various monographs; and the general reading public only comes to know Indian informants who publish books for popular consumption. Jesse Cornplanter obtained his education serving as his father's interpreter to various Americans who visited Cattaraugus Reservation thirty years ago. The curriculum was the tribal lore, and he soon commenced illustrating myths and folk-tales for Arthur C. Parker and carving wooden masks for Museum collections. He has leant a patient ear and replied earnestly to the queries of all comers, and now, a bit tired of always playing second-fiddle to literati who sometimes remember him with a footnote, he has turned to writing. His product is a unique human document.

Cornplanter draws sixteen legends from his "story bag" and narrates them in a series of letters to a White Sister (Mrs. Walter A. Henricks)—Sah-nee-weh by virtue of adoption. He illustrates them with convincing pen-and-ink drawings where sometimes, as in the buried skywoman from whose body food grew, he employs unwittingly devices of the surrealists. Besides many references to Indian notions on animal behavior of interest to NATURAL HISTORY readers, the legend of "The Naked Bear" describes the early adventures of Indians with a gigantic predatory carnivore. Whether fact or fiction, this composite tale, in which a no-account lad proves himself a hero by ridding the country of the monster that devoured peace messengers and young women enroute between villages, offers another instance wherein aboriginal literature associates man with some possibly extinct North American mammal. It also offers an explanation for the origin of the expression "burying the hatchet."

Cornplanter thinks in Seneca and writes in "Reservation English" for the benefit of "pale-faces" who will not master the native language. The book is a handsome one and it deserves a place on every shelf of aboriginal Americana.

WILLIAM N. FENTON.

CHANCO. A U. S. Army Homing Pigeon

- - - - - - By Helen Orr Watson

Harper and Brothers, $2.00

THE story of Chanco is woven around the life and training of a homing pigeon in the service of the U. S. Signal Corps at Fort Monmouth, New Jersey. The general routine of the pigeon lofts, the nesting activities of the birds, how the fliers are taught to return to "traps" on their return from flights, the training for pigeon races, and various experiments with the flying birds are among the details brought into the account. Although the hero of the story is a fictitious bird, its experiences are drawn from those of various actual individuals to make a complete picture.

The author's method could well be a model for people who write books around the lives of individual birds. Although the avian characters are shown in a wide variety of activities and associations, they are not made to talk and act like human beings. The reader does not lose sight of the fact that birds are birds.

The book is intended for young people, but there is much of interest for older readers as well. Several items are of some biological importance. Such is the fact that female pigeons make the best night-fliers and that when trained for night-flying they do not fly so well thereafter in the daytime. One of the experiments mentioned in the text relates to plugging the ears of the birds with cotton and finding that this affected their sense of balance and sense of direction. Blindfolded birds thrown from an aeroplane sought the ground immediately and refused to fly further until the bandage was removed.

A detail that has been on record for many years but which has received little attention, if any, regarding its bearing on hormonal reactions, is that pigeons often begin the incubation of a second set of eggs while they are still feeding the young of the first brood; the latter are independent before the second set of eggs are hatched.

The book is well illustrated with photographs of homing pigeons, equipment, the loft at Fort Monmouth, and similar subjects.

J. T. Z.

LOGBOOK OF MINNESOTA BIRD LIFE, 1917-1937

- - - by Thomas S. Roberts, M.D.

The University of Minnesota Press, $3.50

DURING the twenty years from 1917 to 1937, Doctor Roberts was a regular contributor to *Bird-Lore*, sending to this well-known magazine detailed periodical reports on the bird life of Minnesota. These reports were drawn up by Doctor Roberts from his own observations and from contributions by other numerous observers throughout the state, and they constitute an almost daily record of the seasonal development of nature in Minnesota. *Bird-Lore* sometimes found it necessary to curtail portions of the reports, owing to lack of space, but the volume here presented has the complete account.

Although primarily concerned with birds, there are innumerable references to other forms of life—the first piping of the frogs in the spring, the first mourning-cloak butterfly, the first chipmunk, the earliest hepatica to burst into bloom, the last roses to survive the approach of winter. Underlying these activities of nature are the meteorological records of late or early frosts, storms of snow or sleet, periods of drought, forest fires, and all the varied changes of weather that followed the passing seasons. These are all duly noted, together with Doctor Roberts' comments on the effects which they may have produced on the local world of nature. Not only is it possible here to trace, in the course of a single year, the immediate results of some outstanding disturbance, but the tale of the following years often shows clearly how recovery came about, speedily or slowly, or how a lasting impress may have been made on the fauna and flora of the region.

With the birds themselves, there is the greatest wealth of detail. During the seasons of migration there are complete calendars of "firsts" and "lasts," but even these are far from bald lists of names, painting, as they do, a mental picture, in the mind of the reader, of the seasons which they describe.

In spite of the statistical nature of the book as a whole, the text is eminently readable. One may browse through the volume, gleaning stray bits of interesting information here and there, or he may read through the year, watching the turn of the seasons from winter's cold through opening spring and full-blown summer to the first snow flurries and the return of winter once again. He may consult the copious index and follow a certain species of bird through its local history over a period of a fifth of a century. He may compare certain dates over a period of years and study the curves of migration "waves" or other movements of life. For naturalists in Minnesota, there can be no question that this volume will prove to be a mine of information, but students not within the state should realize also that here is a work of reference which they would do well to consult for important data on seasonal activities of birds and other living things.

Mention must be made of the illustrations by Walter J. Breckenridge that add much to the attractiveness of the volume. The half-title page and each of the twenty chapters are headed by a lively vignette showing some characteristic birds, wildflowers, small mammals, or bits of Minnesota scenery. For a frontispiece there is an excellent reproduction of a dry-point etching showing a Duck Hawk on a dead tree overlooking a lake. A map of the life-zones of Minnesota, prepared by Doctor Roberts, shows the localities where the records of the succeeding pages were secured.

J. T. Z.

STRANGE BIRDS AND THEIR STORIES

- - - - - - - - by A. Hyatt Verrill

L. C. Page & Company, $2.50

THIS volume forms one of a series of nature books by the same author, of which studies on sea shells, insects, and reptiles have appeared earlier. The book is designed for young people, to tell them something about a large variety of birds, selecting those species which have some striking peculiarity of form, plumage, or habit. Part of the account is drawn from the author's personal experiences, part from other sources.

In general, the text is reasonably accurate and some of the errors that appear are sins of omission rather than commission. Thus the description of the colors of the Trumpeter applies to only one of the various forms of this interesting bird. Likewise, the Hoatzin is found in many places outside of Venezuela or British Guiana, although the text might give the opposite impression. The account of the flightless Steamer Duck of Patagonia, Tierra del Fuego, and the Falkland Islands actually concerns two species, since the Steamer Duck which occurs over this entire range is still a third species which is not flightless. The story of the curious nesting habit of hornbills should be amplified to state that not all hornbills have this habit. In any case, it is now believed that it is the female who walls herself in the nest, not the male who performs this service for her.

Other errors noted are that the Bowerbirds belong in the family of starlings, that the Peruvian Condor is very much larger than the California Condor, and that there are many genera of ostrich-like birds in Oceania.

The illustrations, drawn by the author, are not always satisfactory. Since the book is not likely to be used as a manual for the identification of species, these errors may not be too serious, but it is unfortunate that they occur. Mistakes of this sort have a habit of being picked up and perpetuated in future publications.

The author seems puzzled by the often limited distribution shown by creatures which are capable of powerful flight, overlooking the fact that it is the very powers of flight which enable them to get back home when they are accidentally carried away by storms and other forces. Without some impelling force necessitating an extension of range, birds are likely to maintain their ancestral range with little alteration.

The text is entertainingly written and should serve to stimulate an interest in birds by showing the great variety of appearance and habits which they possess in various parts of the world.

J. T. Z.

GOODBYE WEST COUNTRY

- - - - - - - - by Henry Williamson

Little, Brown & Co., $3.00

GOODBYE WEST COUNTRY is written in journal form, telling of the author's last year in Devon, where he lived with his wife and four children.

Henry Williamson is a naturalist, but not a scientist. He admires the wonderful flight of the falcon, the silvery beauty of the salmon, and the skill of the otter. He is, however, not troubled with the curiosity that urges the scientist to seek deeper, challenging old theories, and building up new. Being a very gifted writer, he is able to see and describe accurately, and spice his work with humor and imagination. His style is simple, and clearly reaches for his ideal, truth.

"If I can only write the simple, natural truth, it will be understood by everyone in the world."

Like a small boy, gazing out the window during class on an early spring day, Williamson sits at his desk to write. Soon we are out with him and his trout rod. If we could walk with him and read his mind, we would find such expressions as: "jackdaws wind-whirled about . . ." And the raven calls to his mate: "It's only a man and a girl up there . . don't bother to leave the nest." Or perhaps a buzzard will glide by, "a solitary soaring kind of a meditative bird. . . ."

The tales and descriptions of wild life are interspersed with sincere impressions of his acquaintances, letters, and trips, as well as many amusing incidents when usually the joke was on himself.

The book is easy to read, humorous, imaginative, slightly philosophical; a book that leaves the reader with definite pictures to recall. So long as there are people who dream of the true country, and want to leave the "mass-blast of pavementism," *Goodbye West Country* will be a success.

CARDINE E. BOGERT.

BENEATH THE SURFACE. The Cycle of River Life. (The Design of Life Series)

- - - - - by H. E. Towner Coston

Country Life Limited, London: Charles Scribner's Sons, New York, $2.00

"LIFE in water begins first as plant, secondly as animal life. Both must be present to support the fish. The plants provide a collecting surface for food and protection for the lower, microscopic forms of animals. This is the commencement of the vicious circle, or food chain. The third and fourth factors . . . are light and oxygen. . . . In spite of the inevitable overlapping, the annual cycle of the water world can be, like ours, divided . . . into four sections." The book opens in mid-autumn with the mating season of the salmon family.

Into a small, non-technical handbook, the author has compressed a large amount of accurate information about water life in general and about the structure and habits of fishes. He has gone into the life histories of the salmon, grayling and eel in more detail, and there are also interesting paragraphs on stocking and on flood control.

If one can survive its over-chatty style, perhaps intended for juvenile readers, the book is an excellent guide to where, when and how the unscientific but interested child or adult can observe a lot of every-day but fascinating things not beyond anyone's power to see for himself.

F. LAM.

FLORIDA WILD FLOWERS

- - - - - - - by Mary Francis Baker

Macmillan Company, $3.50

THE popular *Florida Wild Flowers* by Mary Francis Baker proved useful in its first edition and is now much improved in text and illustrations. Four genera of insectivorous plants, most* of the twenty species of which have this remarkable habit, make Florida one of the most abundant areas for this strange class of beings. The descriptions of these species include 800 of the more common and popular of the 3,000 in Florida.

Five species of *Drosera* are found, four of them extending northward, but the fifth *(Drosera Tracyi)* is exceptional in its tall thread-like leaves, sometimes 24 inches high. Five Pitcher-Plants occur, including the two yellow species *(Sarracenia minor* and *flava)*, extending to North Carolina and Virginia; and two purple forms *(D. Drummondii* and *psittacina)* limited to the Gulf States.

Seven species of the Bladderwort occur in Miss Baker's list. The *Droseras* capture insects by glutinous secretions on their leaves; the *Sarracenias* by hollow leaves which attract insects to their entrance by the color of the leaf and prevent escape by downward pointing hairs; but the aquatic species of the Bladderworts operate by tiny lobster traps which catch and digest the unwary insect. The Florida flora also has three Butterworts *(Pinguicula)* which are covered with a powerful glutinous digestive secretion. *Pinguicula* is rather rare in the Middle Atlantic States, though locally abundant on limestone cliffs in Quebec, and is quite common in Florida.

RAYMOND H. TORREY.

LITTLE LIVES—The Story of the World of Insects

- - - - - - by Julie Closson Kenly

D. Appleton-Century Co., $2.50

WHEN one writes about insects it is possible to mention only a few of the unusual things connected with them. To tell even a small portion of the marvels of insect life would take many volumes. So, in her story of the world of insects, Mrs. Kenly has selected a few of the creatures whose life habits appeal to her fancy, and has written about them in

*Exceptions are the terrestrial forms of the Bladderwort which live more like ordinary plants.

her own simple style. The work is not entirely original, having been largely gleaned from the works of others, but then, no one can write a book dealing more or less with the whole gamut of insect life, based upon his or her own observations, because such a book would be too limited in its scope to cover the whole field.

It seems likely that the average reader will greatly enjoy *Little Lives* because it is well written and not only imparts knowledge but provides food for thought. The critical scientist, however, will find fault with a few things, the most glaring of which is the oft-repeated statement that insects have no brains. This is anything but true, as anyone who has dissected insects knows. It is unfortunate that this has been stressed because it does not increase in the least the fact that insects have some of the most astounding habits to be found in the animal world. It is also unfortunate that the artist showed the Black Widow Spider climbing up grass to a web of an orb weaver despite the fact that the text distinctly states that this creaure does not build a web of this kind.

There is no doubt that each chapter will have its appeal to different individuals. The ones that appeal most to the reviewer are those dealing with "The Talented Flea" and the "Blister-beetle Baby." The account of the training of fleas for flea circuses is both amusing and instructive, while that of the Blister-beetle recounts the life history of one of the European Blister-beetles in its precarious struggle for existence under the most difficult possible conditions. *Little Lives* will no doubt prove of interest to many readers and will introduce some to a world about them that they never knew existed. It should prove an incentive to those who are anxious to know what goes on in the grounds and fields surrounding them and lead, perhaps, to discoveries of things that no one else has ever observed. The insect world is full of unknown things.

C. H. C.

NEVER TO DIE

- - - - - - by Josephine Mayer and Tom Prideaux

Viking Press, $3.50

ALTHOUGH barely 100 years old, the science of Egyptology has made available most of the literature of the Ancient Egyptians. The translations being, however, in various languages and for the most part scattered in the journals and monographs of the profession, they are not easily accessible to the general reader.

The compilers of the present book have brought together the best examples of all varieties of Egyptian literature, including popular tales, religion, poetry, history and even medicine, so that the reader may without trouble obtain a comprehensive view of practically all the writings which have come to us from the ancient civilization of Egypt.

The authors have illustrated their selections with line drawings and halftones taken from various publications on Egyptian art and life. The pictures are well chosen and indeed the only criticism which can be made against the book is that occasionally the captions are not so appropriate as the illustrations. For example, in two pictures the fattening of animals by hand feeding is described as the ministration of veterinarians. Nevertheless, the book is highly to be recommended to all who have an interest in the past.

AMBROSE LANSING.

OLD-TIME HERBS FOR NORTHERN GARDENS

- - - - by Minnie Watson Kamm

Little Brown & Company, $3.00

HERBS! What a varied mental picture comes to mind at the mention of that word; witches' brew, talisman of primitive peoples, bitter teas, concoctions for many and divers ills and pleasures, spicy foods, perfumes for the linen or possibly an old-fashioned garden that grandmother owned.

The term herb has an elastic meaning. To some an herb is any plant used for medicinal purposes, to others it may mean seasoning for food or fragrance. In this book herbs are classed as those plants which have been grown in gardens as condiments or medicinals and stored for the benefit of the household. The discussions are limited to some two hundred herbs that can be grown in our northern gardens.

The author has brought together a wealth of interesting data bearing on such topics as the length of time the plant has been used, its native home, where mentioned in literature as well as its place in the garden of today. She tells us of herbs, still in demand, whose use dates back to the dawn of history. The odoriferous garlic is known to have been used in China as early as 2000 B. C. Moses had to listen to the complaints of the Israelites in regard to its odor on the breath of the Egyptians, and it is known to have been used throughout the Middle Ages by the poor to cure aches and pains. Today, as we know, it still holds a high rank as a condiment and the extract of garlic is prescribed for pulmonary afflictions.

It is interesting to note such facts as these: seeds of Caraway, *Carum carvi* L., were found in the Swiss Lake dwellings; Persia is the native home of the Garden cress, *Lepidium sativum* L.; Wood sorrel, *Oxalis acetosella* L., is boiled in milk by Laplanders and stored for winter food; Spearmint, *Mentha spicata* L., an American plant, is grown in Michigan and thousands of pounds of oil are extracted annually for commercial purposes.

The plants described are arranged under their respective families and many are illustrated by line drawings and photographs. However, the author seems not to be primarily concerned with identification but rather with giving, in a very readable way, information on early and present-day uses of herbs—a distinct contribution to that field.

FARIDA A. WILEY.

THE AMERICAN BISON

- - - - - by Martin S. Garretson

New York Zoological Society, $2.50

THE vast herds of bison that once covered the prairies, plains, and mountain grass-lands of North America from the Alleghenies to Oregon and from northern Mexico to the Athabasca region were saved from complete extermination by the unselfish efforts of a few men and institutions. It is fitting that the story of the bison should have been written by one of these men, a Secretary of the American Bison Society and Curator of Heads and Horns of the New York Zoological Society, two of the most active of the organizations which preserved the species.

The book is written in an interesting style and the illustrations are very well chosen. Four drawings were made by the author himself, based on well-corroborated accounts of the herds. Photographs of the buffalo killers at work and the plains covered with bones are impressive documentary evidences of the great destruction.

Various estimates have been given of the numbers of bison that existed in North America before the eighteenth century. The author concludes that a minimum number might be sixty millions. This seems to be rather conservative but it is quite impossible to more than guess. Probably the African veldt did not support more life than the American plains.

The enemies of the bison were few in kind. After man, Mr. Garretson states that wolves were chief, although it is probable that only old, young or sick animals fell to these hunters. Natural disasters such as ice breaking under the herds, prairie fires, and storms accounted for many. Although the bison was so gregarious, there was very little disease known in the wild herds.

There follows the story of extermination. By about 1820 no bison were left east of the Mississippi. Up until after the Civil War the western herds were little reduced, but thereafter hide and tongue hunters and sportsmen began their decimations. In twenty-four years the western herds were gone. The last wild buffalo in the United States was killed in 1897.

Finally the book gives an account of the struggle to build up the few remnants of the species. In 1889 there were about 1,000 buffalo left. Gradually the species has come back until now there are some 21,000 individuals, most of them in natural surroundings and relatively free. The bison is no longer in danger of extinction. The people of this country and Canada owe a great debt of gratitude to the men and organizations which accomplished this result.

JOHN ERIC HILL.

JOHN OF THE MOUNTAINS

- - Edited by Linnie Marsh Wolfe

Houghton Mifflin Co., $3.75

THROUGH his books John Muir was able to convey something of his appreciation for the beauty and majesty of the scenic wonderlands of the western mountains of United States and Alaska. This was the land where he became a blazer of trails, a discoverer of peaks, glaciers and waterfalls, and where a peak, a forest and a glacier bear his name; the land in which, through his efforts, such areas as Yosemite Valley and Sequoia forests were set aside as National Parks, for John Muir was one of the pioneer conservationists of our country.

This book is made up of unpublished journals edited by an understanding and able author. Among others, it contains notes on his sheep-herding days, his several trips to Alaska, his many exploratory trips through California. Characteristic of Muir philosophy, the following quotation on the Sequoias seems very timely in view of the recent drive to save the Sugar pines in the State of Washington: "Through all the eventful centuries since Christ's time—and long before that—God has cared for these trees, saved them from drought, disease, avalanches and a thousand storms; but he cannot save them from sawmills and fools; this is left to the American people!"

These journals cover the period between 1869 and 1911, when John Muir conceived and proved the then revolutionary theory that glaciers had been the greatest factor in reshaping contours of the West; the period when he acted as guide to President Theodore Roosevelt on his trip through Yosemite Valley, and also the period when he was fighting for the preservations of forests and the forming of National Parks in his beloved mountains.

FARIDA A. WILEY.

PLANT HUNTER'S PARADISE

- - - - - - - - by F. Kingdon Ward

Macmillan and Co., $3.50

MR. F. KINGDON WARD has written an illustrated book of travel and adventure which must appeal to the general reader. Although all his books have this appeal, Mr. Ward's business in life is to search Asia for rare plants, and some of his books are more definitely botanical. But *Plant Hunter's Paradise* is a great adventure in a remote part of Asia. It is interesting to know that many seeds from this part of the world are now growing in the gardens of England and elsewhere, readily adapting themselves to their new environment.

The author's traveling companion was Lord Cranbrook, a keen naturalist and collector; it is obvious that very little escaped the notice of these observing travelers. It was not only a plant expedition; mammals, birds, insects ("daddy-long-legs with six-inch wings"), and anything of collecting interest seen on the journey was grist for the mill. Mr. Kingdon Ward naturally concentrates on his specialty, rhododendrons, and the description of the various species, particularly epiphyte rhododendrons, is of distinct value.

Hill tribes are dealt with, particularly the Hkanungs, Darus, Kachins. One becomes acquainted with them all, their customs, blood feuds, and manner of living. Descriptions are vividly given without exaggeration—for instance, of the early morning: ". . . at dawn the gibbons greet the day, the muffled chatter of birds . . . the baboons cough and grunt very discreetly at each other." Again: "Exploration means days of boredom punctuated with moments of ecstasy." This is definitely true. These moments of ecstasy are one of the eternal appeals of exploration and the description of them helps to make this book what it is.

There are many delightful references to birds, sunbirds in particular; for instance it was noted: "They are the jewel-birds of the temporate rain forest regions," and the observation of "one little fellow, brilliant in scarlet and orange, with violet throat and ultramarine cap . . . his wife dressed in dark green with a pale green breast" speaks for itself.

A part of the country which Kingdon Ward names "East Hanging Valley" (this at thirteen thousand feet) became a popular mountain resort with the travelers. Here in this tiny valley five hundred species of flowering plants were found belonging to seventy-five genera.

The story is vividly told and will appeal to the traveler, the lover of nature and of the out-of-doors.

ARTHUR S. VERNAY.

TALES AND TRAILS OF MARTHA'S VINEYARD

- - - - - - - - - by Joseph C. Allen

Little Brown and Co., $1.75

THIS is a brief summary of those interesting historical legends that make Martha's Vineyard Island just a little different from any other part of the world.

Probably no one is better equipped than Mr. Allan to write such a book. A true "Vineyardite," newspaper man and contributor, he has done more to bring attention to this lovely little island off Massachusetts than anyone else in the past years. W. W. L.

GREAT INDIAN CHIEFS, A Study of Indian Leaders in the Two Hundred Years' Struggle to Stop the White Advance

- - - - - - - - - - - by Albert Britt

Whittlesey House, McGraw-Hill Book Co., $2.50

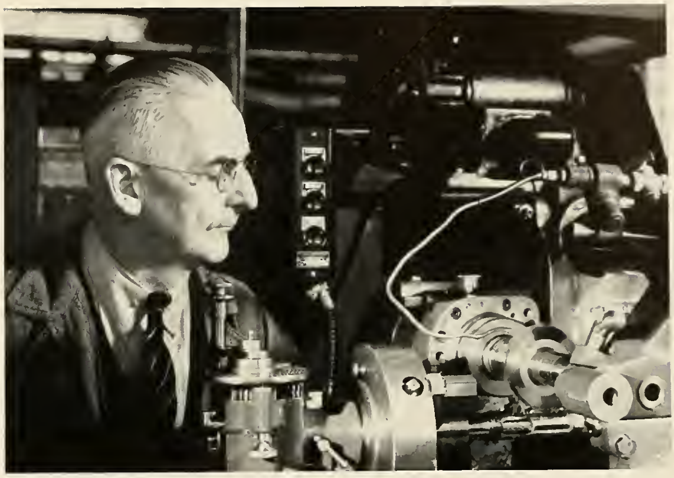
IN this attractive book, we have an Indian "Hall of Fame" including eight famous Indian leaders, described by Doctor Britt who was formerly President of Knox College, which is located on Black Hawk's old stamping ground. The subjects of these well written biographies are: King Philip, Joseph Brant, Pontiac, Tecumseh, Black Hawk, Sitting Bull, Captain Jack, and Chief Joseph. While we would not wish to have any one of these omitted, we should like to nominate a few other candidates for the roll of honor—Osceola, Geronimo, Pushmataha, Logan.

In a preliminary chapter entitled "The Tragedy of the Indian," the author sets forth with understanding the hopeless struggle against the land-hungry white man. On Indian religion, he says: "A basic error is in the assumption that the Indian was without religion. As a matter of fact, he was intensely religious. . . . At the crises of his life, the Indian was likely to seek his god alone, without companion or mediator. . . . As contacts with the whites increased and became more intimate, he was puzzled and often repelled by the multiplicity of faiths held by the whites. It seemed to him like quarreling about God and there was no understanding a religion in which such a quarrel was possible."

In the chapter on King Philip, the author quotes the opening sentence of Increase Mather's *Brief History of the War with the Indians in New England* as a characteristic picture of the White Man's attitude toward his red brother: "That the Heathen People amongst whom we live, and whose land the Lord God of our Fathers hath given us for a rightful Possession, have at sundry times been Plotting mischievous devices against that part of the English Isreal. . . ."

Although the author does not pretend to understand the Indian, nor does he assume that he knows what constitutes a great Indian, these brief, readable biographies of Indian leaders give convincing pictures of outstanding red men, and are fascinating stories of their highly adventurous lives.

We regret the unfortunate sub-title to the chapter on Sitting Bull. No doubt he had the human failings of all men, but it little behooves the white man with his record of unfulfilled promises and broken treaties, to use the word "swindler" in this way, even though he puts a question mark after it. In the light of the thorough research of Stanley Vestal, we believe that the author's doubt about the sincerity of Sitting Bull is not justified. TE ATA.



AFRICAN HUNTER

- - - By Bror von Blixen-Finecke

(Translated from the Swedish by F. H. Lyon)

Alfred A. Knopf, $2.75

BARON VON BLIXEN-FINECKE has written a story of African hunt and travel which has its bright spots but on the whole does not display much to lift it out of the category of "just another book on Africa." The author wrote in Swedish and perhaps translation into English has lost something of the original; at any rate, the text is not likely to be read for its literary qualities. These comments are not to be construed as entirely derogatory, however, as there is a straightforward workmanlike imprint to the book which is welcome if one has been reading some of the recent flowery, fanciful accounts of African adventure. The Baron is a hunter and writes simply.

Coming of a well-to-do Swedish family, the author had the means to buy lands in Africa where he indulged in various commercial enterprises over a period of years. He has been guide and hunting companion for many men of prominence, among them the Prince of Wales, and his field experience has brought him into intimate contact with both the wild and human life of the dark continent. There can be little doubt that the Baron has "gone places and done things."

There are significant comments on the numbers of different species of big game, observations on the effects of the intensive shooting of elephants as a control measure in certain regions, and other items likely to be of interest to sportsmen. The Baron once went out hunting with a license for twenty-five elephants in Uganda. There may have been a good reason why he should shoot so many, but he does not state it and consequently the reader may wonder just a little regarding the conservation sentiments of the Baron. The men who were killing our bison in such great numbers thought there would always be plenty left. And the Baron's defense of African conditions has much the same sound.

H. E. ANTHONY.

PAVLOV AND HIS SCHOOL. THE THEORY OF CONDITIONED REFLEXES

- - - - - - by Y. P. Flolov, M.D.

Oxford University Press, $4.00

THE Oxford University Press performed a great service to biology when in 1927 it published an English translation of Pavlov's monumental work on the *Conditioned Reflexes.* This work, however, was so rich in detail that few laymen have attempted to grasp thoroughly its contents. Now there has appeared from the pen of one of Pavlov's co-workers a very readable volume on the nature of conditioned reflexes and the important role they play in human and animal behavior. The description is enlivened by accounts of actual experiments and the circumstances which led up to their performance. In this way the reader is given insight into the methods of investigation which have made the study of conditioned reflexes one of the most important fields of physiological research.

While the study of conditioned reflexes is primarily an examination of the mechanisms of learning and forgetting, these mechanisms explain a wide variety of phenomena, including the nature of sleep, the means of telling time while asleep, and the cause of neuroses. The chief appeal of the book is the broad application of the conclusions to all phases of human and animal behavior. Pavlov and his associates and their work have had tremendous influence on contemporary physiological thought and now this work has been placed by Flolov in a historical setting which makes it a great human story as well as a biological document.

G. K. N.

WHERE WINTER AND SUMMER MEET

Continued from page 65

terminal band, make a perfect letter T.

Finding the nest, a lovely structure of dry grasses, lined with the white feathers of the ptarmigan, built in a crevice of the rock about eight to ten feet high, was most fortunate. Eleven birds in all were observed about the region. I should say that the wheatear's solitary habits, its wary nature and the type of country where it nests, have made it seem more rare than it is. It was not until my fourth day on shore that I discovered the wheatear, and many of us had passed through and around the region where these birds were found. During our observations these birds were seen in a small area and once beyond this region there was no sign of them. Their wary nature and solitary habits, plus the type of habitat where they nest, make this bird a prize to locate. In that Baffin Island is geographically ideal for its nesting, I feel it may very well be a more common nesting bird in Baffinland than we have heretofore believed.

While on field trips about the Point, we came across the Arctic hare which we had seen on several other occasions. A pair of them were flushed from among the rocks and they went off at a great pace for a short distance, suddenly stopped, and were literally swallowed up among the surrounding boulders. They are of good size, slate gray in color, and with their long ears and white cotton-like tail, add a great deal to the picturesque life we found throughout Baffin Island. Their coloring blended perfectly with the slate-gray boulders where we found them, and as long as they were motionless, it was impossible to see them, even if very near. In winter their coat would have been snow white.

Not far distant from the locality where we had seen the hares, we came across another inhabitant of the island, the little Arctic weasel. It was moving along beside a small stream, coming about among two rocks, its very attentive face and beady eyes keenly on the alert, and its large ears erect to catch the slightest sound. It was a beautiful, agile little creature with reddish brown upperparts and white underparts, being slightly smaller than our common weasel. As we returned to our vessel, the majestic duck hawk swept overhead perching atop a boulder nearby. This magnificent bird, accredited with a speed of 180 miles an hour, is one of the most perfected flying mechanisms that Nature has produced. As we rowed for the *Thebaud* we watched this graceful bird on its perch against the dying sun, a fitting end for our glorious visit to Brewster Point.

As we moved northward far from land, we were privileged to witness one of the most majestic sights the North has to offer—a polar bear on top of an iceberg. He was a most impressive picture as he stood on the berg, his white coat blending into his frozen perch, a true king of the North. As we neared him, he plunged into the icy waters and swam off among the ice-floes. He had reminded us once more that this was the North in spite of the mild and colorful landscape of Baffin Island.

Finally there came a time when to remain longer might mean spending a winter frozen into this interesting country, which I am sure most of us would have enjoyed. We had found Baffin Island one of the most interesting places imaginable, with its abundance of bird and animal life, colorful alpine flowers, delicate butterflies and insects, and moderate temperatures; and at the same time in sharp contrast its giant Grinnell Glacier covering many miles of rugged hills and mountains, its severe storms, its great ice fields and its snow fields providing excellent skiing. We had seen and enjoyed it all. Our only wish was to return once more in the not-too-distant future to this land where winter and summer exist simultaneously.

ANIMALS OF THE SARGASSO MERRY-GO-ROUND

Continued from page 20

gassumfish, only three to four inches long, liberates a gelatinous string in which thousands of eggs are imbedded. The egg mass absorbs water and swells ten times in volume and becomes jelly-like, quivering when touched. This is similar to the egg-laying habits of the anglerfish *(Lophius)*, its close relative, which lays an egg mass called a "purple veil" that becomes forty feet in length, although the fish itself is only about four feet.

But not one of the thousands of Pterophryne eggs laid under aquarium conditions has ever developed, because all the eggs were infertile. In fact, no one, with definiteness, has ever seen a male Pterophryne.

Are the Sargassumfish a race of Amazons? Pterophryne's northern, cold-water relatives, the anglerfishes, lead normal family fish lives. But their deep-sea relatives, the sea-devils, are the black sheep of their Fraternal Order of Pediculate Fishes. For a long time only the female members of the sea-devil families were known. Then the males were discovered, not as the free, dominant sex, but as tiny, insignificant, degenerate organisms that lived as parasites, permanently fastened to the bodies of their spouses. Personally, I believe that Pterophryne, with all its peculiarities, has not sunk to the low level of the sea-devils' marital relationship, but is an exemplary family member of the Pediculati.

Who • When • Where

JUNE CALENDAR OF ENTERTAINMENT

On these pages will be found a calendar of museum events in metropolitan New York for June. It is hoped that this list will enable those at a distance who contemplate a visit to New York to plan more efficiently, and that those who live in or near the city may be able to choose lectures and other activities that fit their needs or interests.

CHARLES RUSSELL
Curator of the Department of Education, American Museum of Natural History

General Information

***AMERICAN MUSEUM OF NATURAL HISTORY**
Central Park West at 79th Street, New York City
Hours: Daily 9:00 a. m. to 5:00 p. m. Sunday 1:00 p. m. to 5:00 p. m. Open holidays 9:00 a. m. to 5:00 p. m. Admission Free.
Exhibitions of gems, human and animal habitat groups, prehistoric creatures, and fossil arrangements showing evolution.

AQUARIUM
Battery Park, New York City
Hours: Daily 9:00 a. m. to 5:00 p. m. Admission Free.
Collections of living aquatic animals; fresh-water and marine, principally fishes but including other groups.

BROOKLYN BOTANIC GARDEN
1000 Washington Avenue, Brooklyn
Hours: Daily from 9:00 a. m. until dark, Sundays from 10:00 a. m. Conservatories open from 10:00 a. m. until 4:00 p. m. Admission Free.
Rose garden; wild flower, Japanese rock, and wall gardens; horticultural displays; conservatories.

BROOKLYN MUSEUM
Eastern Parkway and Washington Avenue, Brooklyn
Hours: Daily 10:00 a. m. to 5:00 p. m. Saturdays and holidays 10:00 a. m. to 6:00 p. m. Sundays 2:00 p. m. to 6:00 p. m.
Admission Free, except Mondays and Fridays, when charge is 25¢ for adults and 10¢ for children.
Arts of the world arranged in chronological and geographical order to illustrate the history of cultures.

THE CLOISTERS
Fort Tryon Park (190th Street Subway Station) New York City
Hours: Daily 10:00 a. m. to 5:00 p. m. Saturdays and holidays 10:00 a. m. to 5:00 p. m. Sundays 1:00 p. m. to 5:00 p. m.
Admission Free, except Mondays and Fridays when charge is 25¢.
Branch of the Metropolitan Museum of Art devoted to European medieval art.

***FRICK COLLECTION**
1 East 70th Street, New York City
Hours: Weekdays 10:00 a. m. to 5:00 p. m. Admission Free.
14th-19th century paintings, Renaissance bronzes, Limoges enamels, Chinese and French porcelains, period furniture.

***METROPOLITAN MUSEUM OF ART**
Fifth Avenue and 82nd Street New York City
Hours: Daily 10:00 a. m. to 5:00 p. m. Saturdays and holidays 10:00 a. m. to 5:00 p. m. Sundays 1:00 p. m. to 5:00 p. m.
Admission Free, except Mondays and Fridays, when charge is 25¢.
Collections of Egyptian, Classical, Oriental, European, and American art—paintings, prints, sculpture, and decorative arts.

MUSEUM OF THE AMERICAN INDIAN
Broadway and 155th Street New York City
Hours: Daily 2:00 p. m. to 5:00 p. m. Sunday 1:00 p. m. to 5:00 p. m. Admission Free.
Anthropological collections from the aboriginal inhabitants of North, Central, and South Americas, and West Indies.

MUSEUM OF THE CITY OF NEW YORK
Fifth Avenue and 103rd Street New York City
Hours: Daily 10:00 a. m. to 5:00 p. m. Saturdays and holidays 10:00 a. m. to 6:00 p. m. Sundays 1:00 p. m. to 6:00 p. m. Closed Tuesdays. Admission Free, except Monday, when charge is 25¢.
Exhibits of the chronological development of New York City life from earliest times to the present.

MUSEUM OF MODERN ART
11 West 53rd Street, New York City
Hours: Daily 10:00 a. m. to 6:00 p. m. Sundays 12:00 m. to 6:00 p. m.
Admission Free on Monday, other days 25¢.
Art of today—showing American and European painting, sculpture, architecture, industrial art, photography, motion pictures.

MUSEUM OF SCIENCE AND INDUSTRY
RCA Building, Radio City, New York City
Hours: Daily 10:00 a. m. to 5:00 p. m. Sundays 2:00 p. m. to 5:00 p. m. Admission 25¢. (Free to teachers with classes.)
Exhibits in transporation, communications, power, food, housing, electro-technology and other scientific and industrial fields.

***NEW YORK BOTANICAL GARDEN**
Bronx Park, Bronx, N. Y.
Hours: Museum and Conservators open daily 10:00 a. m. to 4:30 p. m. Admission Free.
Extensive greenhouses, outdoor plantings, floral displays and museum collections of economic, drug and fossil plants.

STATEN ISLAND MUSEUM
Styvesant Place and Wall Street St. George, Staten Island
Hours: Daily 10:00 a. m. to 5:00 p. m. Sunday 2:00 p. m. to 5:00 p. m. Admission Free.
Collections in science, art and history, especially relating to Staten Island.

WHITNEY MUSEUM OF AMERICAN ART
8-12 West 8th Street, New York City
Hours: Daily 10:00 a. m. to 6:00 p. m. Sunday 2:00 p. m. to 6:00 p. m. Closed Monday. Admission Free.
Collection of sculpture, painting, watercolors, drawing and prints by American artists.
(The Museum is closed from June 1st to September 15th.)

* *Regular lectures discontinued during summer.*

JUNE 1

MUSEUM OF THE CITY OF NEW YORK
3:30 p. m.—Motion picture—"Little Dutch Tulip Girl"—Auditorium—Open to public.

JUNE 4

AMERICAN MUSEUM OF NATURAL HISTORY
2:00 p. m.—Motion picture—"New York City and the Hudson"—Auditorium—Open to public.

METROPOLITAN MUSEUM OF ART
2:30 p. m.—Motion picture—"The Etcher's Art; Drypoint—a Demonstration"—Classroom A—Open to public.

MUSEUM OF THE CITY OF NEW YORK
1:15 and 3:30 p. m.—Motion picture—"Unseen Bridges"—Auditorium—Open to public.

JUNE 5

METROPOLITAN MUSEUM OF ART
2:30 p. m.—Motion picture—"Digging into the Past; The Daily Life of the Egyptians—Ancient and Modern"—Classroom A—Open to public.

GUIDE SERVICE

(Continued through summer)

The following institutions offer free lecture tours of their collections:

AMERICAN MUSEUM OF NATURAL HISTORY
Wednesdays, Fridays and Saturdays at 11:00 a. m. and 3:00 p. m. Meeting Place: 2nd Floor, Roosevelt Memorial.

METROPOLITAN MUSEUM OF ART
Tuesday, Wednesday and Thursday at 3:30 p. m. Meeting Place: Main Hall.

MUSEUM OF MODERN ART
Daily at 11:00 a. m., 1:30 p. m., 3:00 p. m., and 4:30 p. m.

JUNE 7

METROPOLITAN MUSEUM OF ART
2:30 p. m.—Motion picture—"Firearms of Our Forefathers; Eve of the Revolution" (Yale Chronicles of America Photoplay)—Classroom A—Open to public.

JUNE 8

MUSEUM OF THE CITY OF NEW YORK
3:30 p. m.—Motion picture—"King of the Rails"—Auditorium Open to public.

JUNE 11

AMERICAN MUSEUM OF NATURAL HISTORY
2:00 p. m.—Motion picture—"Declaration of Independence"—Auditorium—Open to public.

BROOKLYN MUSEUM
3:00 p. m.—Lecture—"History of Music and Its Parallels in Visual Art (19th Century)" by David LeVita—Classroom A—Open to public.

METROPOLITAN MUSEUM OF ART
2:30 p. m.—Motion picture—"The Temples and Tombs of Ancient Egypt; The Making of a Bronze Statue"—Classroom A—Open to public.

MUSEUM OF THE CITY OF NEW YORK

1:15 and 3:30 p. m.—Motion picture—"New Frontiers"—Auditorium—Open to public.

JUNE 12

METROPOLITAN MUSEUM OF ART

2:30 p. m.—Motion picture—"The Pottery Maker; The American Wing"—Classroom A—Open to public.

JUNE 14

METROPOLITAN MUSEUM OF ART

2:30 p. m.—Motion picture—"A Visit to the Armor Galleries; Drypoint—a Demonstration"—Classroom A—Open to public.

JUNE 15

MUSEUM OF THE CITY OF NEW YORK

3:30 p. m.—Motion picture—"Queen of the Waves"—Auditorium—Open to public.

JUNE 18

METROPOLITAN MUSEUM OF ART

2:30 p. m.—Motion picture—"The Etcher's Art; Behind the Scenes in the Metropolitan Museum"—Classroom A—Open to public.

MUSEUM OF THE CITY OF NEW YORK

1:15 and 3:30 p. m.—Motion picture—"A Day witb the Sun"—Auditorium—Open to public.

JUNE 19

METROPOLITAN MUSEUM OF ART

2:30 p. m.—Motion picture—"Tapestries and How They Are Made; The Making of a Stained-Glass Window"—Classroom A—Open to public.

JUNE 21

METROPOLITAN MUSEUM OF ART

2:30 p. m.—Motion picture—"Digging into the Past; The Daily Life of the Egyptians, Ancient and Modern"—Classroom A—Open to public.

JUNE 22

MUSEUM OF THE CITY OF NEW YORK

3:30 p. m.—Motion picture—"New York World's Fair Preview"—Auditorium—Open to public.

PLANETARIUM
Schedule for June

★

"Solar Cyclones"

Weekdays—2:00, 3:30, and 8:30 P. M.

Saturdays—11:00 A. M., 1:00, 2:00, 3:00, 4:00, 5:00 and 8:30 P. M.

Sundays and Holidays—2:00, 3:00, 4:00, 5:00 and 8:30 P. M.

General Admission Afternoons	25¢
Reserved Seat "	50¢
General Admission Evenings	35¢
Reserved Seat "	60¢

General Admission for Children under 17, accompanied by adults, 15¢ at all times. (No reduced price for reserved seats occupied by children.) Children under 5 not admitted. Doors close on the hour. Special facilities for the hard of hearing.

JUNE 25

BROOKLYN MUSEUM

3:00 p. m.—Lecture—"History of Music and Its Parallels in Visual Art (Contemporary Music and Modernism)" by David LeVita—Classroom A—Open to public.

METROPOLITAN MUSEUM OF ART

2:30 p. m.—Motion picture—"Firearms of Our Forefathers; Yorktown" (Yale Chronicles of America Photoplay)—Classroom A—Open to public.

MUSEUM OF THE CITY OF NEW YORK

1:15 and 3:30 p. m.—Motion picture—"Conquest of the Hudson"—Auditorium—Open to public.

JUNE 26

BROOKLYN MUSEUM

3:30 p. m.—Concert by Brooklyn Civic Orchestra, directed by Dr. Paul Kosok—Sculpture Court—Open to public.

METROPOLITAN MUSEUM OF ART

2:30 p. m.—Motion picture—"A Visit to the Armor Galleries; The Making of a Bronze Statue"—Classroom A—Open to public.

JUNE 28

METROPOLITAN MUSEUM OF ART

2:30 p. m.—Motion picture—"The Making of Wrought Iron; The American Wing"—Classroom A—Open to public.

JUNE 29

MUSEUM OF THE CITY OF NEW YORK

3:30 p. m.—Motion picture—"George Washington"—Auditorium—Open to public.

JUNE RADIO PROGRAMS

EVERY DAY

10:00 a. m.—Organ Recital—Station WNYC BROOKLYN MUSEUM.

JUNE 1

5:45 p. m.—"Exploring Space"—Columbia Broadcasting System (coast to coast network)—HAYDEN PLANETARIUM.

JUNE 2

11:30 a. m.—"Aztec Gold" by John Saunders—Station WHN—AMERICAN MUSEUM OF NATURAL HISTORY.

JUNE 4

12:00 m.—"This Wonderful World" (Question and Answer program)—Station WOR—HAYDEN PLANETARIUM.

JUNE 6

5:45 p. m.—"New Horizons"—Columbia Broadcasting System (coast to coast network)—AMERICAN MUSEUM OF NATURAL HISTORY.

JUNE 8

5:45 p. m.—"Exploring Space"—Columbia Broadcasting System (coast to coast network)—HAYDEN PLANETARIUM.

JUNE 9

11:30 a. m.—"Mysterious Tibet" by John Saunders—Station WHN—AMERICAN MUSEUM OF NATURAL HISTORY.

JUNE 10

3:15 p. m.—"Lilacs," by Charles F. Doney—Station WNYC—BROOKLYN BOTANIC GARDEN.

JUNE 11

12:00 m.—"This Wonderful World" (Question and Answer program)—Station WOR—HAYDEN PLANETARIUM.

JUNE 13

5:45 p. m.—"New Horizons"—Columbia Broadcasting System (coast to coast network)—AMERICAN MUSEUM OF NATURAL HISTORY.

JUNE 15

5:45 p. m.—"Exploring Space"—Columbia Broadcasting System (coast to coast network)—HAYDEN PLANETARIUM.

JUNE 16

11:30 a. m.—"Flying Fish" by John Saunders—Station WHN—AMERICAN MUSEUM OF NATURAL HISTORY.

JUNE 17

12:15 p. m.—"Rampant Roses," by Montague Free—Station WOR—BROOKLYN BOTANIC GARDEN.

JUNE 18

12:00 m.—"This Wonderful World" (Question and Answer Program)—Station WOR—HAYDEN PANETARIUM.

JUNE 20

5:45 p. m.—"New Horizons"—Columbia Broadcasting System (coast to coast network)—AMERICAN MUSEUM OF NATURAL HISTORY.

JUNE 22

5:45 p. m.—"Exploring Space"—Columbia Broadcasting System (coast to coast network)—HAYDEN PLANETARIUM.

JUNE 23

11:30 a. m.—"Indian Games" by John Saunders—Station WHN—AMERICAN MUSEUM OF NATURAL HISTORY.

JUNE 24

3:15 p. m.—"Summer Plans for the Junior Gardens," by Ellen Eddy Shaw—Station WNYC—BROOKLYN BOTANIC GARDEN.

JUNE 25

12:00 m.—"This Wonderful World" (Question and Answer Program)—Station WOR—HAYDEN PLANETARIUM.

JUNE 27

5:45 p. m.—"New Horizons"—Columbia Broadcasting System (coast to coast network)—AMERICAN MUSEUM OF NATURAL HISTORY.

JUNE 29

5:45 p. m.—"Exploring Space"—Columbia Broadcasting System (coast to coast network)—HAYDEN PLANETARIUM.

JUNE 30

11:30 a. m.—"When Animals Fight" by John Saunders—Station WHN—AMERICAN MUSEUM OF NATURAL HISTORY.

NATURAL HISTORY

The Magazine of the American Museum of Natural History

FREDERICK TRUBEE DAVISON, President — ROY CHAPMAN ANDREWS, Sc.D., Director

VOLUME XLII—No. 2 ★ ★ ★ ★ ★ SEPTEMBER, 1938

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

EDITOR: Edward M. Weyer, Jr., Ph.D.

ASSOCIATE: D. R. Barton.

PRODUCTION: Frederick L. Hahn.

ART: Charles Curtis Hulling.

Manuscripts should be sent to the Editor, The American Museum of Natural History, N. Y.

SUBSCRIPTIONS. NATURAL HISTORY is sent to all members of the American Museum as one of the privileges of membership. Membership Secretary, Charles J. O'Connor.

ADVERTISING DEPARTMENT: Sherman P. Voorhees, Manager. W. Ware Lynch.

REPRESENTATIVES:
Frank S. Whitman, Chicago, Ill.
Warwick S. Carpenter, Santa Barbara, Calif.

NATURAL HISTORY is published monthly (except July and August) at New York, N. Y., by The American Museum of Natural History, Seventy-ninth Street and Central Park West. Subscription price $3 a year, single copies fifty cents. These rates also apply to Canada, Newfoundland, and all foreign countries. Entered as second class matter March 9, 1936, at the Post Office at New York, New York, under the Act of August 24, 1912.

A SIGNIFICANT RECORD

Tanked artificial atmosphere composed of helium and oxygen carried on the back of the new design Craig-Nohl Dress shown above, enabled Max Gene Nohl to descend to a depth of 420 feet on December 1, 1937, thus breaking the previous record by 114 feet. Helium greatly lessens danger of the "bends," dreaded diver's malady resulting from the accumulation of nitrogen bubbles in the body, and causing extreme pain, brain fag, paralysis, and frequently death

Divers Are Guinea Pigs—

By John D. Craig

The gripping epic of an adventure that will revolutionize deep sea diving

The personal story of what happens to a man who submits to a pressure of 42 pounds per square inch and emerges in 1/24 the time previously considered safe—with helium to breathe

"Do not foul your pipe or line;
Diver . . . are you there?"
"Diver on the bottom, Sir;
Easy with the air."

Two warnings are contained in this old sea-chantey which every man who walks on the bottom of the ocean knows, and heeds.

When a man walks on the sea-floor, his chin is out to Nature, and if Nature "takes a sock" at it, then man has no redress. Nature has no room for careless divers, and softies who lose their heads under pressure have no business diving.

Today, in an age of radios, planes and modern conveniences, man is able to skip about this old world of ours with comparative comfort and safety. Nearly every wild place has known the whir of a motion picture camera, and there remains but the bottom of the sea to explore, to tempt man's sense of adventure and to challenge his ingenuity.

God may have intended man to search the sea for food, but nothing was mentioned about plumbing its depths for knowledge, or in search of wealth. Today man is trying to change all that.

Divers of old

We have records of divers and their strange calling since the earliest records of history. Thucydides tells of divers at the siege of Syracuse who were sent down to saw away undersea barriers which had been erected as hazards for invading ships. Alexander the Great at the siege of Tyre ordered his divers to wreck the enemy's submarine defenses, and later the young conqueror explored the undersea world in a contraption called a Colimpha machine. (In fact Alexander was the first candidate for the Liars' Club, qualifying when he told of seeing a sea monster which took two days and a night to pass the window of his Colimpha machine!) Pliny tells of soldiers who were divers; Livy says that in the reign of Perseus divers recovered treasure; and in the golden age of Rhodes, divers received a percentage of the gold and jewels they recovered.

But in those days, and for many years to come, the world was itself as much a mystery as the sea, and diving was left to swimmers and natives looking for sea food and pearl oysters. Man, when he wanted to investigate something other than earth, turned to the heavens, or dug mines. Roger Bacon, who seems to have investigated everything, invented a diving apparatus in 1240, but like everything else in which he dabbled, nothing was done about it for a long time. Nothing, in fact, until 1819, when Augustus Siebe designed the open dress.

Davey Jones' treasures

Meanwhile ships had sailed the seven seas, and many of them had failed, at one time or another, to make port. The ocean floor was littered with their bodies, and with the treasures they contained.

More than half the gold and silver mined in the period that followed Columbus' discovery of the New World was lost at sea. Getting some of that treasure was intriguing enough to mother an invention, and Siebe's dress was the result. It conquered the great problem of deep-sea diving—the question of supplying the diver with air to breathe.

Siebe's helmet provided for the reception of air, pumped from above through a hose, and for the dispelling of used air, through an outlet valve.

But the rest of the body, Siebe discovered, had to be protected against pressure. Beginning at atmospheric pressure of 14.7 pounds per square inch, the diver found himself, at every foot of increased depth, saddled with an additional half-pound pressure per square inch. To take care of this Siebe invented, in 1830, the closed dress, in which a diver could live in more than ordinary depths by exerting, from all points of his canvas suit, a pressure equal to that being exerted by the water—less the normal atmospheric pressure. The diver could also, in this outfit, keep his whole body dry.

No advance in methods

That was more than one hundred years ago. Steam was just coming into its own as a means of locomotion and power. There were no automobiles, no airplanes, no submarines. The world has come a long way since then. But not diving—the standard diving dress being used today is exactly the same in appearance, in operation and in practice as the dress that Siebe designed, plus safety valves and telephones. Diving is still in the pre-steamboat days.

Undoubtedly this neglect was due to the fact that nobody cared very much. Diving was the sport of adventurers and fools. (It still is.) The sea was dangerous, even when you were on top of it. Its bottom offered no sure field of economic endeavor, no reasonable chance that an investment would bring returns. With so many things to absorb the energies of man, with new countries and new industries, the prospect of finding an uncharted wreck in the cold and dangerous depths of an uncharted sea was not to be considered.

What diving occurred was of a practical nature. Rivers and harbors were charted by divers, and dredging operations were planned with their aid. Nothing experimental was tried. The divers themselves found they had no stomach for experimentation or invention. It was hard, dangerous, exacting work that taxed their bodies and wrecked their nerves. Things happened to their minds underwater, and they suffered from the bends. Eventually it caused most of them to become mentally unreliable, a little crippled. They had to retire. Some were paralyzed partially; some completely. Many died suddenly from internal complaints that doctors couldn't understand or diagnose.

Diving used to be a game for muscle-bound weightlifters—men very shy on brains, or they wouldn't have been divers. The risks involved were pooh-poohed by these huskies, partly because of their brusque nature, partly because they had dived so recklessly and been subjected to "bends" so often as to become a little punch-drunk—like a burned-out fighter.

Today, in an age of television, air transportation and recovery programs, it is to be expected that man would seek out some of his lagging endeavors, like diving, and apply to them science, engineering, physics and chemistry. This has recently been done. The developments are already with us; the results read like a fairy tale.

On December 1, 1937, people sitting by their radio heard the voice of a diver being broadcast from the bottom of Lake Michigan. Four hundred and twenty feet of water was between him and the Coast Guard Cutter *Antietam* floating on the surface. "A world's record dive!" exclaimed the excited announcer. A deep-water record of 22 years standing had been broken. Three hundred and six feet was the old record made by Frank Crilly, a U. S. Navy diver, when he reached the sunken hull of the Submarine *F4* in Honolulu in 1915. Max Gene Nohl, the broadcasting diver, had gone 114 feet deeper than any man had ever attempted before in a rubber-canvas suit, supporting the tremendous pressure of 192 lbs. per square inch.

This dive was possible because the diver wore a new design, self-contained diving gear, known as the CRAIG-NOHL DRESS, and he breathed an artificial atmosphere composed of helium and oxygen.

Behind a record-breaking dive

In itself, this dive may have appeared as a stunt, but behind that dive there is a dream, months of experimenting and research, and many hours of preparation; a purpose, too, exists, that may startle the world, if the dream comes true.

Hollywood, which has a hand in almost everything these days, is responsible for that deep-dive, is indirectly responsible for the Navy's recent 500 foot dives, and for the use of helium in modern medical research work. By using our imagination a little, we might truthfully follow this trend of thought and say Hollywood is responsible for curing hay fever. But the facts are fantastic enough without having to revert to imagination in the least. It all goes back to a Tiger Hunting Trip I made in India. We returned to Hollywood rather fed up with excitement and requested the studios give us a tame assignment, for a change; one where we could work quietly and relax occasionally, for our nerves needed a change. The studio suggested we go to Cedros Island and film the Sargasso Farming Industry.

That assignment sounded like just what the doctor ordered. We had visions of a peaceful farm, plenty of milk and butter, pastoral scenery and the quiet life city dwellers think farmers live. Quickly we accepted. For days we lived in dreamy anticipation of the healthy rest we were to enjoy. And then harsh reality slapped us back to reason.

First we found Cedros Island was off the Mexican Coast of Lower California in the Pacific. We had to charter a yacht to reach the place as no steamers called at such a remote spot. When we reached the island we found a typical South Sea desert land . . . no evidence of any farms, but plenty of rock, sand, sagebrush and parched, mountainous scenery. At the south end of the island we put ashore near a group of tents occupied by Japanese deep-sea divers.

Undersea farmers

To our surprise we learned that these men were the Sargasso Farmers, and, to our further amazement, discovered their farms existed on the bottom of the ocean! These divers actually went down and cultivated the sea floor, growing and harvesting that sea plant known as sargasso. It is dried on the rocks, baled, and shipped to Japan, where it is used mostly for medicinal purposes. I think our best known by-product in the United States is agar-agar oil. It is used as an aid in treating chronic constipation.

To film the sargasso farming industry, we, too, had to dive. The Japanese taught us how, even loaned us equipment. I had to design special diving cameras in order to make the pictures, but this was a slight problem as I had spent my youth studying mechanical engineering.

Since that summer of 1931 we have been virtually addicted to the study of the undersea world. Every time we dive there is the old thrill of entering a new world—as if we had stepped off this planet onto another. Things are so strange, so fantastic down there—there is much motion, but no sound. It is a fairyland world. It is so quiet it almost hurts. The fish float in a void like balloons in air; clouds of silvery minnows wave by overhead; the sea grasses bend to and fro in unison like delicate dancers in a ballet. It is cold beyond words.

Occasionally giant fish nose out of the dense distance to investigate bubbles constantly streaming upward from our helmets. Some fish are harmless, others might be dangerous. But it is the uncertainty of life, the unknown dangers and hazards that make it fascinating. With each breath one marvels at the beauty of Nature, and at the remarkable power of compressed air.

For air inside the diving equipment is not only air for the diver to breathe; it is also a safety factor —the strong medium which puts its shoulder against the wall of the diving dress and pushes outward a little harder than the water is pushing in. In this artificial air-bubble the diver lives, for there is no weight to air pressure, but there is to water. In 100 feet of depth there are almost 48 tons of crushing water pressure being lifted off the diver's shoulders by the air inside his dress.

Should the air bubble suddenly escape, the weight of the water will smash in, forcing the diver's body into his helmet, killing him instantly. Technically, such accidents are called "squeezes," but Antonio, my life-line tender, refers to them as "strawberry jams."

And while it is this remarkable factor of air pressure which makes it possible for man to go undersea, it is also the same factor which has limited his depth, and possibly has been the major reason why diving has remained in the pre-Indian War days.

Danger in nitrogen bubbles

Compressed air, like ordinary air, is composed of approximately 78% nitrogen, 21% oxygen, and 1% other gases, such as neon, argon, helium, water vapor, etc. Nitrogen and oxygen have been the two major factors which have limited deep-water diving. The nitrogen one breathes on the surface is mostly exhaled. But under pressure, as in a diving dress on the sea bottom, much of it is condensed in the diver's lungs and passes into the blood stream, from where it is deposited in the various tissues and liquids throughout the body, especially in the fatty tissue, joint liquids, and nerve tissues. Seven hundred and eighty cubic centimeters of nitrogen are forced into the blood by each atmosphere of pressure to which the body is subjected. When the diver returns to the surface, this nitrogen in solution in his system, now that external pressure has been relieved, returns again to a gaseous form, causing bubbles to appear in the blood and tissues where the nitrogen has lodged.

Should the diver come up to the surface too fast, these nitrogen bubbles exert great pressure and will rupture the blood vessels, tear the tissue, and shatter the nerves. If one bursts in the brain, it will either kill the diver instantly or paralyze him for life. Divers have a great fear of compressed-air illness, which they term, "the bends."

To overcome this painful and dangerous condition, the diver is "decompressed" in the water. That is, he is brought slowly to the surface so that the nitrogen has a chance to escape from the body without causing serious injury. Luckily for the diver, nitrogen is slow in returning to that gaseous form . . . it "lags" in coming out of the tissues. In his slow ascent, the pressure of the water keeps quantities of the nitrogen remaining in liquid form in the diver's body, and at each "stage" upward more and more nitrogen is exhaled, so that by the

Bellis Photo

(*Left*) STANDARD DIVING DRESS of 1904. This now antiquated outfit differs little in appearance or operation from those used from a century ago up to recent years. (*Right*) Equipment destined to revolutionize diving methods: John D. Craig in 1936 with the first design of the Self-contained Air Supply Unit, which eliminated the dangerous, cumbersome air line and led to experiments with special breathing compounds

THE NEED for a suit that would overcome the unusual hazards of the *Luisitania* salvaging operations at a depth of 312 feet caused John D. Craig and Max Gene Nohl to experiment with the Self-contained Unit in flooded quarries in Wisconsin

(*Above*) WITH TESTS COMPLETED demonstrating the practicality of the portable air supply and the increased mobility and safety of a suit unencumbered by air pipe, it yet remained for the deep-sea inventors to design a suit incorporating all the improvements they had dreamed about

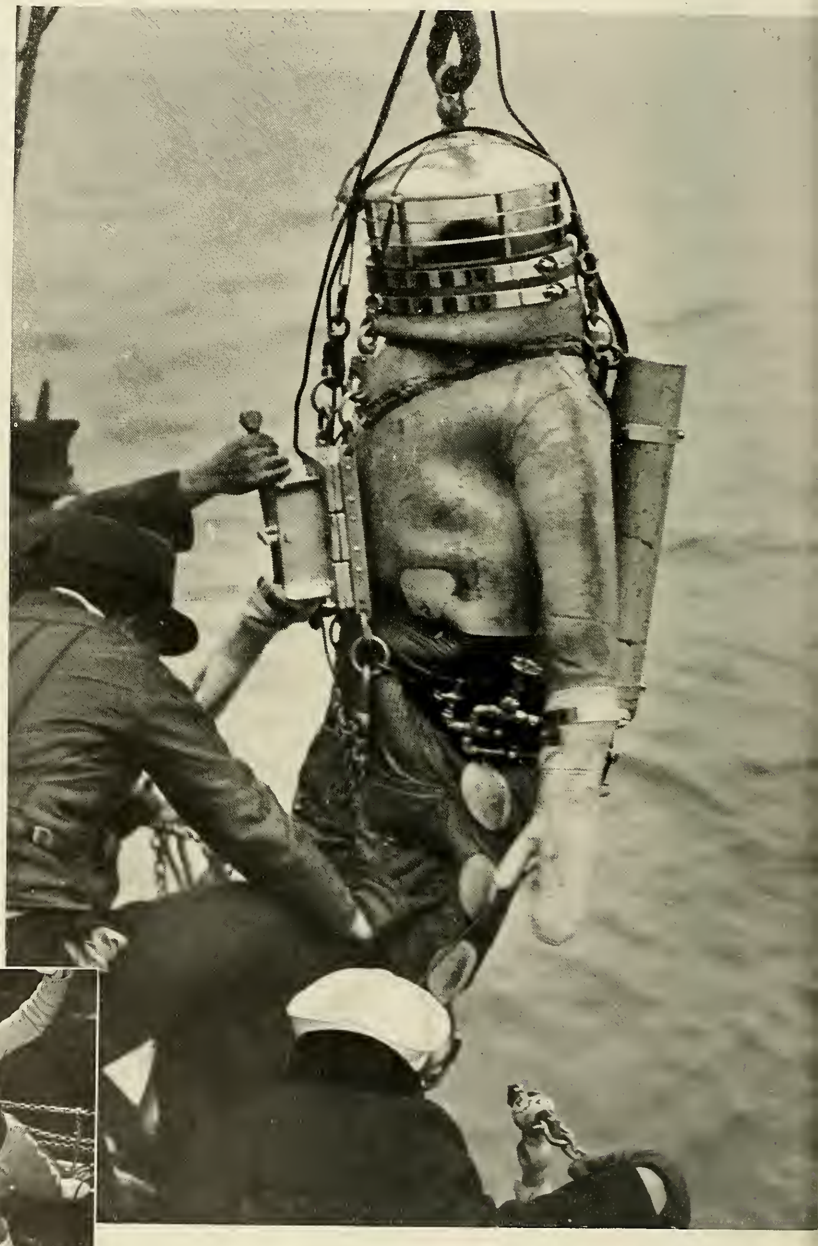
(*Left*) THE OLD SALUTES THE NEW. In contrast with the old standard Navy dress, the new Craig-Nohl Suit can be donned in 60 seconds and detached from the lowering line when the diver reaches the bottom. It allows unobstructed, unrefracted vision through 360 degrees, and carries food as well as air for the diver

(Above) THREE TANKS contain an air supply sufficient for 23 hours in shallow water, 15 hours in water 300 feet deep. Into the helmet are built a compass, a watch, a microphone, depth gauges and pressure gauges

(Right) PRELIMINARY TESTS with the Craig-Nohl Suit on the bottom of a swimming pool. It emits no exhaust bubbles to attract sharks. Another hazard—the squeezing of the diver's body up into the helmet thus bringing sudden death when the inside air pressure fails—is reduced to a minimum

A CRUCIAL DAY in the life of the newly invented "monkey suit": a trial dive in Lake Michigan made in April, 1937 from the Coast Guard Cutter *Antietam* *(at left)*, to test the practicality of a suit in which the diver, once on the bottom, can unshackle the lowering line and walk freely about

THE EXERTION of entering the old time suit with its heavy breastplate, helmet, shoes and belt has caused divers to faint before they ever got into the water. This is overcome in the Craig-Nohl suit by making the rubber-canvas dress in one piece and hanging all the weights to the helmet, which is quickly lowered and snapped in position, enabling the diver to slip into the water within one minute from the time he starts dressing



(Below) CAPTAIN CRAIG *(right)* and Max Gene Nohl waving goodby before going down. Even in hot weather, divers must dress warmly against the cold encountered at great depths

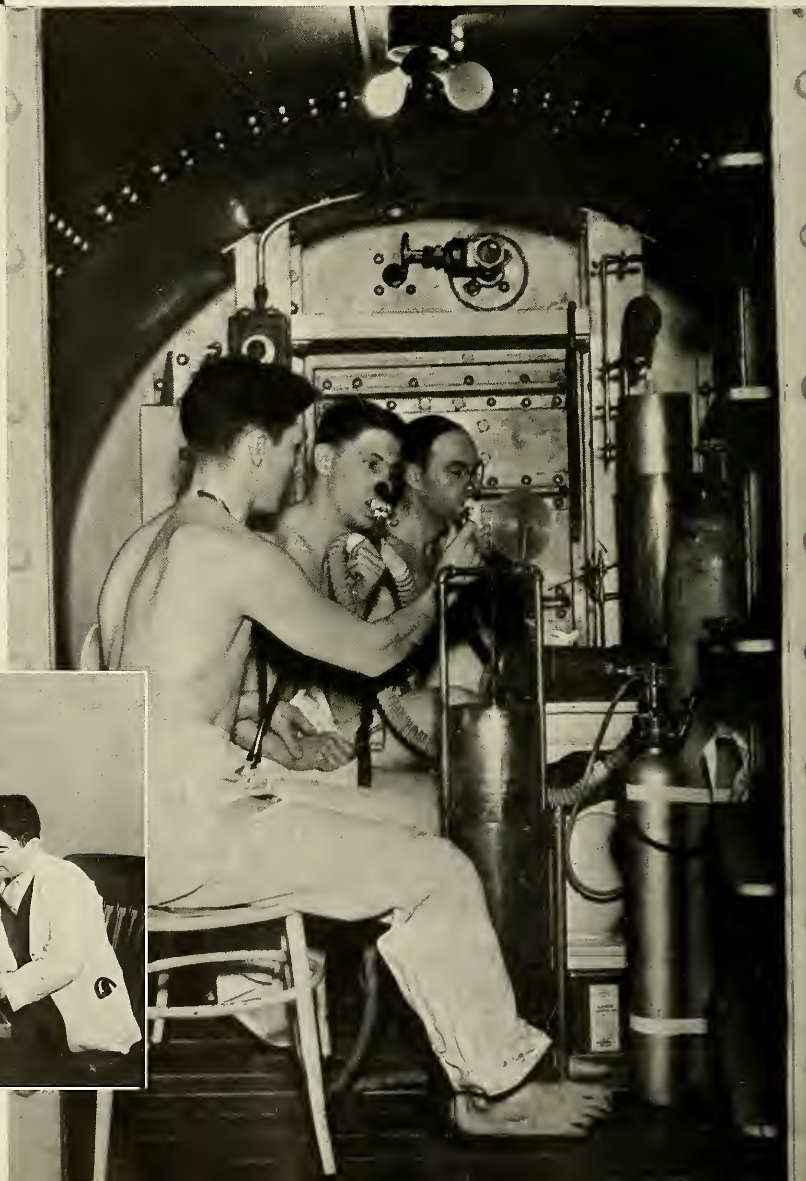
(Right) At heretofore impossible depths of over 400 feet, the diver in this suit will live and breathe in a world of his own, inhaling the same air again and again but replenishing it with oxygen and filtering out the carbon-dioxide chemically. On deck the crowd listens by telephone to his progress; far and wide the world hears him broadcast through a microphone in his helmet

(Left) Unintended excitement. Though listeners may have suspected faking, there was real danger when Craig, using the old style dress with air line to the surface, became fouled in wreckage and had to call to Nohl, who was using the new style suit, to free him. Craig's lifeline was nearly parted by the winch before he was loosened; and Nohl was brought up in a tangle of lines, air hose, and telephone cables, as shown at left

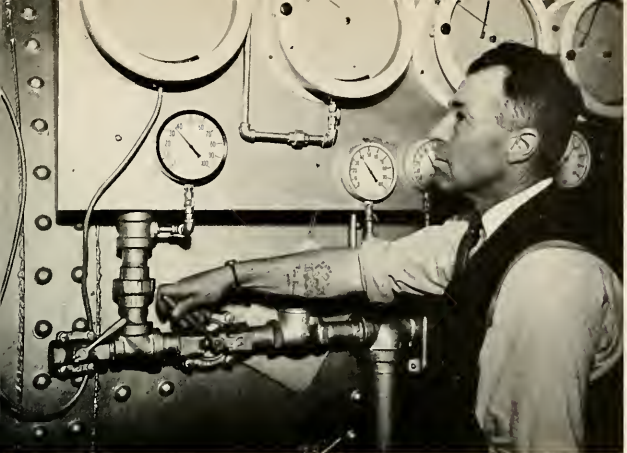
(Right) Divers "on a jag": Captain Craig and Max Nohl suffering from oxygen exhilaration after test dives. Using ordinary compressed air, the oxygen reaches a molecule richness many times normal, the body tissues are burned away more rapidly, and great fatigue results. Diving "jags" will be prevented by use of the new helium-oxygen mixture

(Left) Captain Craig and Max Nohl talking with Jack Browne after the *Antietam* test dives which convinced them that the potentialities of the helium-oxygen breathing compound should be studied thoroughly under laboratory conditions

(Below) Recompression chamber at the Milwaukee Hospital: an apparatus generally used to treat patients suffering from the dreaded bends, but here used to test the power of the new helium-oxygen breathing mixture to banish this major menace from deep-sea work. For every hour they work in deep water, divers ordinarily must spend five or six hours being slowly lifted to the surface, so that the great quantities of nitrogen in their bodies will not form bubbles and rupture vital organs. In the test, supervised by Dr. Edgar End of the Marquette University School of Medicine, the divers submitted to decompression from a pressure equivalent to a 100-foot dive in 1/24 the time previously considered safe



(Below) Before entering the chamber the human guinea pigs sign away any claim rights in case of accident or death. Stripped to the waist, they are prepared for the humid 103° F. that will accompany the 42 pounds pressure per square inch



Outside the tank, Joseph C. Fisher, engineer, tends the gauges, graphs and valves as the pressure rises. A telephone enables him to communicate with the men inside. The tank resembles a large boiler, 18 feet long and 7 feet high

With the first jolting blast, mouths open and the men swallow hard, as the air crackles into the chamber. It is painful but soon over. Through rubber mouthpieces Craig and Nohl breathe helium-oxygen, while Doctor End *(background)* breathes plain compressed air for comparison

(Below) The last two pounds of air are forced in and the chamber becomes foggy. The men's voices in the heavy air are hoarse yet piping "like Popeye the Sailor," and they cannot whistle. Finally the crucial test comes. Valves are opened with a deafening roar, and the helium-breathers feel a rapid drop in pressure

(Left) Frosty fog fills the chamber as the pressure avalanches to normal in 2 minutes. The divers emerge without ill effects from the record decompression time of 1/24 that required with ordinary air

(Right) Refreshments after a successful test which paved the way for the Navy's recent dives to the astounding depth of 500 feet: a discovery which opens new vistas toward the safe accomplishment of salvage work heretofore impossible

time he reaches the surface, if he has been sufficiently slow in rising, he will be completely decompressed and can emerge without danger of the bends.

During the years that men have been diving, a schedule of safety times on the sea floor and decompression tables for each depth and period of submersion have been worked out. By following these tables there is little chance for a diver to be hurt by the bends unless he chisels on his decompression or remains long over his safety time below.

Second most dangerous profession

The eternal small boy in man makes him disregard rules and tables. Many divers believe decompression is "Boy Scout stuff." The result is a heavy mortality among divers, and today the occupation is listed as the world's second most hazardous calling. (I believe the first is test piloting—you know, those fellows who take up new model airplanes and try to dive the wings off them!)

When I was working undersea off Mexico, small fish often struck at my hands (we cannot wear gloves when operating the intricate mechanisms on the cameras). I noticed that I did not feel pain to any great extent from these wounds. I learned that the nitrogen that had saturated my system acted as a slight narcotic . . . rather stupefying the nerves. I learned that it also affects the brain and, after a time in water deeper than 150 feet, the senses become so muddled that it is difficult for a diver to control his muscles and often he forgets the simplest things that insure his safety.

This brainfag, due to nitrogen saturation, has been one of the major limiting factors in deep-water work. It is so serious that the United States Navy Department ruled against master divers (the Navy's best, most experienced) going deeper than 300 feet on compressed air.

Oxygen, the second major limiting factor in deep-water diving, normally is the very breath of life, but under pressure it burns the tissue away so rapidly and to such an extent that divers fear it as much as they fear the bends. In shallow depths the air the diver breathes has to be compressed to enough atmosphere of pressure to support the diver. In, say, 150 feet, he is breathing air at slightly over 75 pounds per square inch (about five atmospheres pressure). The oxygen contents of this air remains in the same ratio of 21% oxygen to 78% nitrogen, but, being compressed five times, it reaches a molecule richness five times greater, or approximately equivalent to 105% pure oxygen compressed. It is the richness . . . the molecule quantity . . . that affects the diver. The result is that after a time on the bottom the diver acquires a condition known as oxygen exhilaration. You can derive a like effect by drinking five cocktails before dinner.

But the after-affects are worse than cocktails. The body tissues have been burned away more rapidly than usual, and great fatigue sometimes results. That is why young divers are preferable, and more successful, in deep water than older men. Their body tissues rebuild much more quickly.

There is a limit to the amount of oxygen a person can stand. In 300 feet of water the diver would be breathing approximately 200% partial pressures of oxygen, and his metabolic rate would be so high that should he remain down for long, there would be grave danger that he might never recover.

These compressed-air factors have been the hazards which undoubtedly have kept diving retarded, and until last summer no serious attempt was made to overcome the restrictions compressed air imposed on diving.

In the spring of 1936, I stood on the south shores of Ireland and heard an old Irish fisherman say, "The *Lusitania* sank right out there."

A baffling problem

Since that calm day in May, 1915, when the great liner went down, many salvage experts have dreamed of ways and means to salvage the wreck. But always they have been balked by its depth. In 312 feet of water, no diver could survive long enough even to reach its strong rooms, or attach lines to its jewel-stuffed safes.

To all but one company the *Lusitania* remained a baffling problem. That company, the Tritonia Corporation, of Glasgow, Scotland, designed and built an all-metal diving dress in which a diver could be lowered to greater depths than man had ever gone before. The principle used was that the metal structures of the armored suit prevented the crushing weight of water from reaching the diver's body. Inside the gear, the diver breathed air at atmospheric pressure, with no hazards of bends or oxygen poisoning to prevent him from plumbing unheard-of depths and remaining down as long as his oxygen supply lasted—a matter of 10 or 12 hours.

In October, 1935, the Tritonia Corporation located the wreck of the *Lusitania*. Their diver went down in Tritonia gear and walked on the wreck. The current sweeping past the spot was a serious handicap, as was the restricted movement on the diver's part, owing to the clumsy mobility of the heavy gear, which weighs close to 1000 pounds. No man has been down to the *Lusitania* since.

I was visiting in London when the Tritonia Corporation called me to Glasgow. They wanted to know if we could make a motion picture of their proposed *Lusitania* salvage operations. The possibilities of such a film fired my imagination. But there were serious problems to solve . . . grave ones that had to do with lost divers in the wreck, suitable motion picture lighting, cameras to withstand water pressure at over 160 pounds per square inch, and, most of all, communications and mobility. It seemed the problems were insurmountable.

And then I recalled a little experiment that Doug Campbell had once made with a pet sea bass he kept in a glass tank aboard the yacht. Every day he fed the bass a minnow. As soon as the bass saw Campbell approach, it would swim around actively and gobble the minnow the moment it hit the water. One day, for fun, Campbell separated the tank into two portions by lowering a piece of plate glass, shutting the bass in one end of the tank. That day he put the minnow in the other end. The bass flashed savagely toward the minnow, hit the glass, and was baffled. Again and again the bass struck at the minnow, and each time he hit his nose. After hours of futile effort he went to his corner and sulked. He was thoroughly sold on the fact that business was bad. Then Campbell removed the glass partition. The minnow swam all about the bass and the bass now refused to strike at it. It never occurred to him to try again.

Established methods challenged

Recalling this little incident, it occurred to me that possibly that was what was wrong with deep-sea diving: Everyone was convinced that compressed air was the only atmosphere breathable and no one had ever made a stab at overcoming the hazards. I was convinced that somewhere there *was* an answer to the problem. If we could find it, there was a world of work on the sea floor. We could open up a new field of economic endeavor. Lost wealth of ages ago could be recovered. The rewards would be far beyond our most ambitious dreams.

But in photographing the *Lusitania* salvage operations our main problem was in filming the tough time that the Tritonia divers were having. That meant a diving dress that was mobile and with which we could crawl inside the hull of the liner and get shots of the interior before they blasted her to bits with explosives in their search for the strong rooms. It had to be light, mobile, and safe. There was a current of 2½ knots sweeping past the *Lusitania's* grave. A diver with lines to him would require so much weight, just to hold him on the wreck and counteract the "bellying" of his lines, that he would be greatly handicapped and could barely move. Again, if he managed to get inside the wreck and the salvage ship above should suddenly shift, the drag on his lines might break them and the diver would be lost. Even though this hazard should be removed by the use of metal lines, the diver would be ever conscious of his danger, and the mental hazard would slow him up.

To get away from line trouble, I recalled a story we had once written about a diver who used air bottles . . . steel cylinders full of compressed air carried on his back and connected to the dress by a short hose, instead of the usual air-pipe from the surface. Max Gene Nohl and I had discussed such a diving dress supplied with air bottles during the summer of 1935 when we were working on the wreck of the *John Dwight* off Cuttyhunk. I had used such an air-bottle dress once off Mexico to enable me to cut my lines for a picture stunt and safely reach the surface without suffocating. This air-supply idea seemed our answer. It would get rid of the air line, at least.

Work on new diving dress begun

I went to Milwaukee, Wisconsin, which was Gene's home, and there we talked over designs and experimented in flooded quarries. In the fall of 1936, we set our plans, and by the spring of 1937 had constructed a self-contained diving gear which entirely eliminated the necessity of air pipe. Into this dress we built all the improvements we had dreamed about, which, in our opinion the standard diving dress lacked.

We overcame the tiring problem of dressing the diver. (Ordinarily it requires two tenders to aid the diver into his dress, and during the process the diver must support the weight of a heavy breastplate, helmet, lead shoes and finally a 100-pound belt of lead). On a hot day in the tropics, I have seen divers faint from fatigue before they ever got into the water.

In our new gear we overcame this by making the dress in one piece and hanging all the weights to the helmet. The diver slips into the rubber-canvas dress and stands under the helmet, which is suspended from a davit over his head. The helmet is lowered, the dress cuff is snapped to the helmet, and he is lifted off the deck into the water within 60 seconds from the time he starts dressing. On the bottom he can unshackle the lowering line, and walk anywhere he chooses.

We improved the visibility by making the helmet with a 360-degree faceplate. Our heads are enclosed in a helmet with a circular window. There is no refraction of light and no "blind spot." Into the helmet we built depth gauges, pressure gauges, a compass, watch, microphone, and even a container for liquid food—in case a diver remains down so long he feels fatigued. The air supply is contained in three air bottles attached to the diver's back and is sufficient for 23 hours in shallow water and 15 hours in 300 feet of water, provided an occasion should arise forcing him to stay down in that depth that long. The diver breathes the same air again and again, oxygen being added as needed and the carbon-dioxide gas being removed by his exhaling through a soda lime compound. Thus there are no exhaust bubbles to attract sharks, and no danger of blowing up. The chances of "squeezing" are eliminated to a minimum.

Since we were using air compressed in these steel bottles at 2500 pounds per square inch, we thought, "Why not eliminate oxygen poisoning by reducing oxygen contents?"

It was a new idea. But we found it difficult to get compressed air with reduced oxygen pressure.

Helium

It was then we began experimenting with other gases and adding the small quantity of oxygen we needed. Thus we stumbled upon helium.

Helium is a strange and non-inflammable gas, controlled by the United States Government. It comes from a limited number of natural gas wells near Amarillo, Texas. This relatively rare gas came into prominence recently in the dirigible *Hindenburg* disaster, the loss of life being blamed on the use of hydrogen rather than the non-explosive helium. More recently the Government of the United States refused sale of quantities of helium to Germany because no guarantee was forthcoming that the helium would not be used for war purposes.

A few years ago the U. S. Bureau of Mines made some breathing experiments with helium, but no use was then found for the gas, and the experiments were abandoned.

Helium is an inert gas and can be breathed without ill effects. We mixed the helium with oxygen and discovered we had an excellent artificial atmosphere. We tried some of it in the air bottles on the dress. Breathing it there on the surface seemed to work. We apparently had a dress, we calculated, which could be used in depths up to 400 feet. We tested it in the rock quarries of Wisconsin, where the water is sometimes 300 feet deep. It worked—but we shied away from the temptation of 300-foot dives. We know only too well we were not prepared to risk our necks at such depths until the dress had been fully tested and we knew a little more about helium. I won't forget going down in one quarry and seeing a barn on the bottom. From under its rotting wall a pair of red rubber boots extended. Horrified, I pulled at them, expecting to haul out a corpse. But they were just rubber boots.

Lifeline nearly parted

On April 12, 1937, we made a test dive in Lake Michigan from the Coast Guard Cutter *Antietam.* It was an important event in the development of the new "monkey suit," as we called it, but I somehow got myself fouled up in wreckage on the bottom, and Gene, who was wearing the new gear, had to free me. We were broadcasting at the time and I'll never forget what a sap I felt when I realized that here I was, heralded as an expert diver, and then getting my lines all fouled up until I had to ask Gene for help. I tried to keep it quiet by making casual remarks about the darkness down there, hoping that Gene would come over and aid me without the listening radio audience thinking I was faking. The pictures the newsreels made showed we were not faking, in fact the line tenders took a turn around the winch and nearly parted my lifeline before they pulled us free. We both came up in a fine tangle of lines, air hose and telephone cables.

That dive was such a mess we both felt we had better be amply prepared before we tried any deep diving with the new helium mixture. To this end we enlisted the co-operation of the Marquette University School of Medicine at Milwaukee. Dr. Edgar End, a young professor with a bent for adventure, took us under his wing. With him we entered upon a series of tests that have made diving history. We became his human "guinea pigs" and loved every minute of it.

The Haldane tables of compressed air decompression were more than 100 years being compiled. We were seeking to make a like set of decompression tables for helium-oxygen atmospheres in time for our *Lusitania* diving program. There were no such tables for helium in existence, so we had to make them ourselves by means of the trial and error route. No one knew how fast helium saturated the blood, nor how fast it would come out of the tissues once it got in. We knew that nitrogen was about seven times heavier than helium, and that by comparison nitrogen moved slowly. In theory helium should, therefore, saturate the tissues seven times faster than nitrogen did. Also, if it obeyed the laws of most gases it should come out of solution at the same rate of speed as it saturated, or in one-seventh the time nitrogen required. Doc End explained all this to us in his best scientific manner; but in our minds there was the big question: "There is no *proof* that helium will follow these theories."

We tried it first on guinea pigs in the lab. After 30 days of being subjected to helium-oxygen atmosphere under pressures equivalent to 350 feet of water, and being decompressed in one-seventh of the time required for ordinary compressed air (nitrogen-oxygen), we found that the pigs were healthier, more robust, larger and freer from petty illnesses like colds and nervousness, than were the pigs which had not been subjected to the helium-oxygen tests. It was most gratifying.

Human guinea pigs

Then one day Doc End approached Nohl and me with that peculiar gleam in his eyes that most medical men have when about to saw off your leg. "How about you fellows playing guinea pig for a change," he said.

The terror of deep diving is adjusting the blood and body to changing pressures while coming up. For every hour of exhausting work on the bottom in deep water, we have had to spend five to six hours being lifted to the surface—hoisted away a few feet at a time to sway in the freezing cold water for our bodies to become adjusted to the different pressure. These decompression schedules (Haldane tables) have been carefully worked out by the Navy, and their use is a matter of law in states where there is diving or pressure construction work. There have been so many fatal cases (during the building of the Hudson Tubes the mortality was a fraction over 24%, and on occasions they had as high as 76% cases of "bends") that some county hospitals had installed "re-compression chambers." In these, persons suffering from caisson illness (bends) could be again compressed until the nitrogen bubbles were actually squeezed back into solution in the blood, then by following the decompression schedules the patient was properly decompressed and nearly always left the chamber hale and hearty and none the worse for his experience.

At the country hospital, Milwaukee, a far-sighted engineer, Mr. Joseph C. Fisher, had built such a re-compression chamber. It was to this chamber that Doc End guided us.

Before making the tests we had to sign away claim rights, to release the county of responsibility in case things did not turn out as Doc End expected. "It's your funeral if anything happens," was the comment of skeptics. Nohl and I felt there was just one way to find out—try it. We were both quite sold on the theory that helium was safe and preferable to compressed air, and we had utter confidence in Doc End; nevertheless we were not at all calm when we visualized what might happen if the stuff had tricks in it. I've seen men's eyes pop out of their sockets from the internal pressure created when they accidentally came up too fast. The Navy decompression time for one hour exposure in 100 feet of water calls for 47 minutes decompression. We were going to come out in 1/7th of that time.

Our plan consisted of first trying a mixture of 1/3 helium and 2/3 air. We breathed the mixture from a cannister called a "spirometer" and had to wear breathing masks, like those used to administer anaesthetics.

The county re-compression chamber looks like a big boiler. It is 18 feet long and 7 feet in diameter. There are two compartments inside, a chamber and a lock. An intricate system of valves varies the pressure, if desired, in the two sealed compartments. Gauges and graphs keep accurate check on the temperature and pressure.

Forty-two pounds per square inch

Telephones enable us inside to communicate orders. There is an automatic door between the two compartments which opens when a certain equalized pressure is reached. No one, not even Hercules, could open that door when the pressure is high. Airtight gaskets prevent leakage. The trick was to hold the pressure of 42 pounds to the square inch for one hour, and at a given signal evenly reduce or decompress the air to zero. For the 1/3 helium mixture this was done in eight minutes. Nohl's breathing apparatus went on the fritz the first few minutes of the test so he and Doc End were locked in the inner chamber to take their proper 47 minutes decompression, while I played first guinea pig and came out in the eight minutes in the outer lock, I felt fine.

The next test was likewise a percentage helium test. All went well again. Then came the pure helium test with enough oxygen added to sustain life. This was the one which would prove our theory—or friends could send flowers next day.

Stand by and look at the test.

Breathing tubes are taped and masks are given final adjustments. Water is used in the face-ring since air would be collapsed by the heavy pressure.

"In we go," nods Doc End, and Nohl and I follow.

"If anything happens we'll hammer three times," is my last message to Fisher, mindful of the possibility of something going wrong with the telephone.

"Don't hammer unless there is danger," says Fisher. He's a hard man.

We three are stripped to shorts, pants and shoes. It is going to be hot and muggy inside. June in Milwaukee gets pretty sticky. You can look through a thick glass window in the door at the end. Fresh ink is put in the small cups of the graph needles.

The pressure soars

The first jolting blast of air is shot into the sealed chamber. Mouths open and we swallow hard as the air crackles into the lock. It hurts, but it's soon over.

Nohl and I wear clips over our noses. We apply the rubber mouthpieces, and from now on until the end of the test it's pure helium-oxygen atmosphere, without nitrogen. Doc End breathes the compressed air that fills the chamber. Higher goes the pressure. Sweat beads begin to appear on our naked backs. Doc, not hampered with breathing circuits, methodically takes notes. Tests are run on a basal metabolism machine. Heart beats and blood pressures are checked. Periodically Doc sticks a needle into our arm and draws a sample of blood. Its coagulation time drops noticeably.

Higher goes the pressure—30 pounds now. A swirling mist appears and fills the chamber. It is very warm. Doc gives us salt tablets to compensate for the loss of perspiration.

A faint tint of red appears on the cotton sticking out of Nohl's nose, mild bleeding from pressure. Nothing to worry about.

Up goes the gauge.

"All O.K., give her the full jolt," are the telephoned orders, and Doc End checks again.

Fisher opens valves and watches the gauges intently. Up and up, bit by bit, climbs the gauge needle as the compressor pumps more air into our chamber. Fisher is a good man to have around in a pinch. He reaches for exactly the right valve at the right time.

"She's forty pounds and going up," he telephones. "Are you all right?"

"Swell," is Doc's response—without consulting us. He was not using the helium mixture.

When you breathe helium under pressure you cannot whistle to save your life. Something happens to the voice organs making your speech sound hoarse yet piping, like Popeye the Sailor Man, in falsetto. Doc End nearly had hysterics every time we tried to talk to him. We laughed often—a high strung hysterical laugh that was not at all natural. Our brains were keenly alert, and we could think of things clearly and with a vividness not experienced before. Doc reduced the oxygen contents of the cannisters—claimed we were getting an oxygen jag.

The last two pounds of pressure are forced in. It looks like a fog inside. Sweat streaks down our backs and streams from our faces. Towels are used often. Nohl and I do not smile or laugh or motion to each other as much now. We drink much water. A pitcher of milk has been placed inside but we are too busy observing reactions to bother.

There is a noisy hiss outside. The newspaper men wonder a bit.

"Just the safety valve ready to pop," explains Fisher.

"How's the air?" queries the engineer over the phone.

"Fine—much better than Saturday," is End's answer in a squeaky voice. If lives were not at stake the press boys would almost laugh at the sound.

The period of breathing the helium is up.

The crucial period

Now comes the risky test . . . coming out in two minutes instead of the prescribed 47 minutes.

"Everything all right?" asks Fisher.

"Fine, let's go," comes Doc's anxious voice. The strain is beginning to tell.

Pausing for a second for the last look at the gauges, Fisher and his aids open valves. Doc End hands me the wrench, with which to knock in case things go wrong, and steps inside the inner lock, closing the door behind him. Nohl and I are alone. His bloody nose has streaked down his chest with the sweat. I catch a faint grin through the haze.

"Well, we asked for it . . . here we go."

You've heard the sound when a railroad brakeman uncouples the air brakes on a train? The first rush of air from the compression chamber sounds 50 times as loud. The press boys hold their ears.

Down drops the gauge from 42 pounds pressure. Faster and faster the air is pouring out. More valves are opened to add to the deafening hiss.

Lightning fast is the temperature change as the pressure drops. Before, it was hot—103 degrees, exaggerated by the humidity and tension. Now it gets cold quickly. Frosty fog fills the chamber until I can't see Nohl sitting arm's length from me. Anxious faces peer in at the window—a nurse—a doctor—the press. We slap our legs and chests to keep warm. Everything's fine. The last ebbing outburst of air . . . crackling sound fills our ears . . .

bubbling, snapping. The temperature inside the lock dropped from 103 to 45 degrees in the two minutes. The door swings open. A burst of hot air warms our chilled and goose-fleshed bodies.

"Right on the dot," says Fisher.

"Take it easy, boys," warns the physician in attendance outside.

We must wait at least 30 minutes before we are certain the dreaded bends will not develop. Everyone is most concerned over how we feel. We look at each other and grin. Perhaps we are thinking, for a moment, we are a step nearer the *Lusitania's* gold.

Doctor End, still breathing nitrogen and oxygen air, remains in the inside chamber for the more gradual step down of pressure for comparison against the results obtained with helium.

"Well, how is the guinea pig?" I kid him over the telephone.

An "open sesame" to the deep

Nohl wants a shower bath. "Wait," pleads Fisher, an old hand in caisson work and engineering. Half an hour passes. Medical inspection reveals no ill effects from breathing the helium under pressure or the record time decompression of 1/24th of that required for ordinary air.

Forty-seven minutes after Nohl and I emerged, Doctor End comes out with his notes, graphs and charts to check and submit them to the Navy Department and the Bureau of Mines, who were interested in the tests.

The tests we made do not mean that the ticklish job of making complete decompression tables for helium has been mastered, nor does it mean divers will in the future use the rare gas exclusively. Since that test, Nohl has reached a depth of 420 feet in Lake Michigan. The Navy Department is making record dives to obtain more information about human reaction to the gas. It undoubtedly has been a contribution to diving and will make the lot of the diver much safer.

I am often asked, "Don't you ever get scared? How many accidents have you had?"

Undoubtedly these thoughts are in the minds of most people who have heard of our work making adventure motion pictures. I have noticed that people seem to hang on my answers to those questions. Sometimes they appear a trifle disappointed that I haven't lost a leg to a tiger, or had an arm torn off by a shark. Always they are amazed that we can continue working amidst what they consider tremendous hazards. I feel they expect me to tell how brave I was when the wings of death were beating about me. There I fear I am very disappointing.

It is much easier to remember the times when I *wasn't* scared. They are much fewer than the times when I *was* scared stiff, and stand out as deep valleys of serenity amid towering ranges of jagged peaks of fright.

And then I realize that most people think very little about comparative dangers. It is always the strange, the unusual and the unknown that creates the greatest fear. The fear of a slow suffocation in crushing pressures deep in the cold, dark depths of the sea is enough to cause a city dweller shudders of horror. But I have seen auto accidents that mangled the victims in a much more frightful manner.

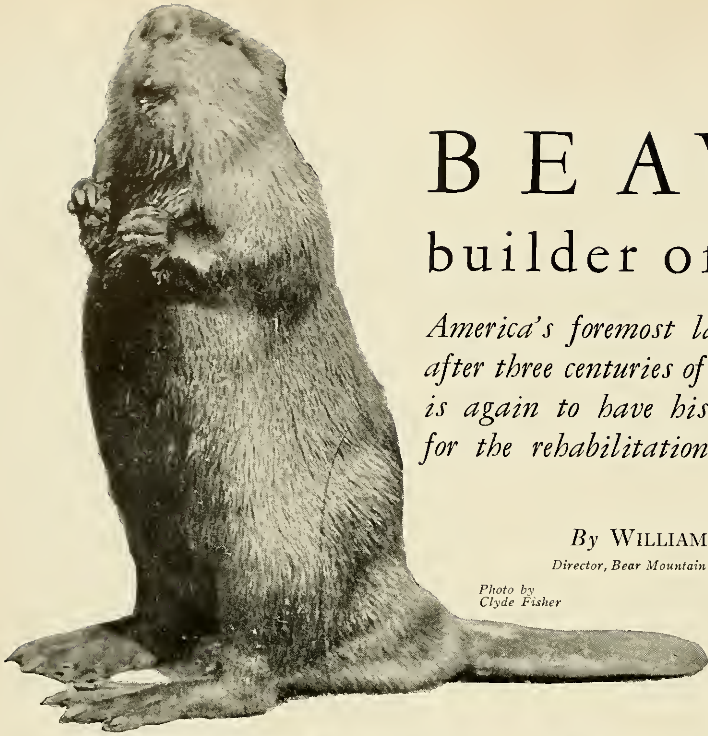
I believe all explorers, all adventurers, all delvers-into-unfrequented-places sooner or later pass through that period in their lives when they feel that they are frauds, deceivers and phoneys. That is because they are honest with themselves. If they are truly courageous men they will continue to be self-examining. Humility is the hardest virtue they have to achieve.

Since his cave-dwelling days, man has been an adventurer. His advance has been painful. Slowly, necessity has pushed him forward; curiosity has caused him to reach out; his need to satisfy his ego has made him strut.

Today, in every branch of man's activity you will find the pioneer—the adventurer. If the ground he treads is unknown and fraught with possible dangers to his person or to his estate, we applaud his courage. Many of us, following what we consider a more mundane occupation, like to fancy ourselves in his shoes. In looking at these adventurers' apparently more colorful lives, we lose sight of the fact that our own adventure in living might be just as colorful from his point of view. We forget that there is a share of danger in every man's life.

I know that greater suffering was experienced by Antonio, my life-line tender, when I was fouled up undersea on one occasion; and by Doc End when Nohl developed bends one night six hours after an apparently successful decompression, than we who were actually in the danger have ever suffered. Our thought is: advancement costs a price. Somewhere along the line that price must be paid in knowledge, experiment, invention or in suffering. We hope knowledge and invention, science and engineering will be able always to pay for our advances.

Still, it's interesting, and sometimes fun to be the guinea pigs.



BEAVER
builder of Empire

America's foremost landscape authority, after three centuries of heartless slaughter, is again to have his place in the sun, for the rehabilitation of our woodlands

By William H. Carr
Director, Bear Mountain Trailside Museums

Photo by Clyde Fisher

Centuries ago, from the Rio Grande to the Arctic and from coast to coast, the energetic, intelligent, flat-tailed beaver was America's foremost landscape authority. He was the original director of regional planning. Today the Department of the Interior and many state agencies are endeavoring to replace this animal engineer in numerous sections, particularly in the Northwest, to recapture some of the benefits lost through the near extermination of an animal that was once a true builder of empire. The beaver not only stores water, preventing droughts and floods; he is a master forester as well.

Deputizing the beaver

The value of beaver as conservation agents has long been recognized; but today the animals are front-page news. In Idaho the State Game Department, the U. S. Forest Service, and the Federal Biological Survey are all coöperating with the Interior Department's Division of Grazing in the transplanting of beaver along various water courses. Already the animals are constructing dams that will prevent erosion and increase the water facilities of the entire region.

A field report from this area relates that: "One planting of beaver has constructed seventeen dams on a small stream which a few years ago ran barely enough water for a horse or cow to drink. The construction work made a continuous water supply for this district, with ponds deep enough to form meadows along the formerly eroded stream. These same ponds are also making excellent duck-breeding grounds and are now sufficiently developed to warrant stocking with trout. In a few years the beavers will have built up a water reserve that once was destroyed."

A testing ground

An outstanding earlier example of the beaver's ability to "bring back the land" concerns the release, in 1920, of three pairs of beaver in the Palisades Interstate Park at Bear Mountain, forty miles north of New York City. Since then, and for 18 years, this 42,000-acre preserve has been a testing ground, with the animals becoming the park's most valued citizens. Their numbers have increased an hundredfold under complete protection. More than sixty colonies have been established and the animals have spread over a 30-mile radius. Some actually swam across the Hudson River, at a point where the tidewater was more than a mile wide.

The Bear Mountain beaver breed regularly each year and raise from three to five young. Kittens appear in April or early May, and when a year old they wander off to find mates in other colonies, build new ponds and lodges, and raise their young. The father often disappears when a litter is born, to keep bachelor quarters elsewhere for a time. Thus it is estimated that more than 2000 have sprung from the original park stock. Individuals have been shipped to ten states to carry on woodland rehabilitation wherever their clever front feet find suitable material to work with.

One pair of the original woodland builders released in Bear Mountain Park was carefully watched for a number of years. They walked forth from their cage, seemed to take their bearings, and then journeyed down a small brook in search of a home-site. Eventually they selected a region in a spreading rocky gorge, where the brook trickled through wastelands of poplar brush, the beaver's favorite food. The original forest had been destroyed long before the turn of the century, and recurrent fires had discouraged the second growth and scorched the soil until the park came into being in 1909, to place the area under its protective wing.

With sod, poplar branches, and small stones, the beaver dammed the stream, at first almost as any small boy would have performed the task and with similar materials. Near the center of the spreading pond a mound of sticks, the beaver lodge, made its appearance. With additional work upon the dam, the pond gradually deepened; yet the house continued to grow in circumference and height. Commenced in late summer, the waters covered several acres by snowfall, and the dam was laced with weathering poplar logs, mud, and many small branches, all denuded of bark.

The principal food of beaver is bark. Thus not a thing is wasted. They consume the outward covering of their own building material, in addition to lily bulbs, grasses, various root stalks and leaves. The beaver is a strict vegetarian and does not eat fish, fowl or insect. The bark of alder, aspen and poplar forms his preferred diet, although he will sample other trees if the situation demands. Oak, maple, even the hard-wooded ash, have been felled. He prefers tender saplings, but we have seen 18-inch trees cut down. Two beavers seldom tackle the same tree at the same time.

Food stores under ice

When winter came in earnest, ice formed an eight-inch barrier and the beaver were well-established in a world of their own. The water surrounding their house was four feet deep, and the lodge extended above the surface for about an equal distance. Beaver are not able to breathe under water, nor to hold their breath for any length of time. Eleven minutes seems to be a record submergence. Therefore, the living-room of their lodge must be above water and ventilated. The sleeping and feeding room is a foot or so above the pond surface, with underwater entrances leading upward through the stick-and-mud walls and foundations to the inside landing platform.

Since beaver are not hibernating animals, it is necessary for them in northern latitudes to store food beneath the ice. Consequently, in the fall, many small trees are felled, transported over land and on water, and submerged near the lodge entrance. Thus the surface ice does not interfere with the hungry animal when he swims to his food pile, quickly chews off a branch, and carries it into the house for a meal. Freshly peeled sticks often may be seen floating beneath clear ice where beaver have cast them forth. The white stick floats away, but the bark remains in the beaver's stomach.

The coming of spring released those first beaver in the park colony, and they took advantage of their freedom to repair the dam and increase its height and length. This structure was now some four feet high and six feet wide at the center. A secondary dam was constructed below the large one, thus backing up the water and relieving pressure upon the main embankment.

As green leaves appeared and mountain-laurel blossoms transformed the hillside, thousands of human visitors traveled past the pond upon a nearby state highway. Comments received by park officials concerned the spindling dead trees that were revealed straggling upward from their watery graves. Many thought it a pity that beaver should be permitted to kill so many trees, not only through actual cutting but through flooding their roots.

"Wait and see," they were told; "the beaver may be doing damage now, but later on you are going to get a surprise. Not this year, nor the next; maybe 20 years from now; but wait."

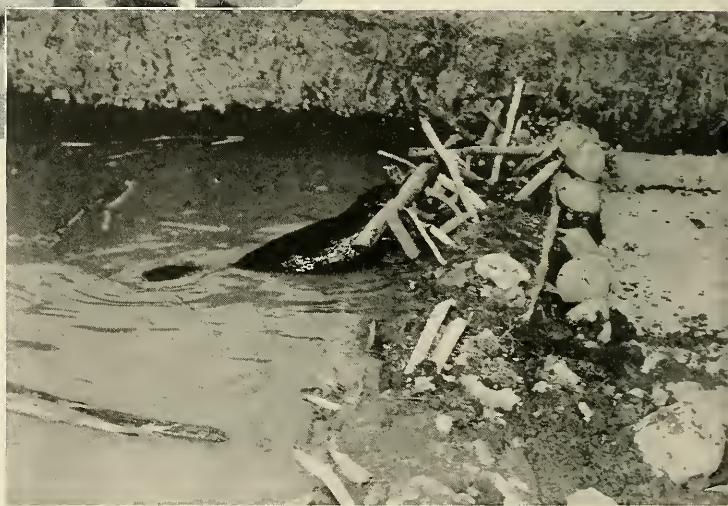
Wild life attracted

For five years the beaver labored in the little valley, as others were doing elsewhere in the park. Then, after at least three litters of beaver kittens had been sent upon their way, the food near the edge of the pond became exhausted. The beaver left, in search of greener pastures. Though the dam curved upstream and was built solidly and well, it soon commenced to disintegrate. Without the ever-present vigilance of the woodland engineers, no beaver dam can long exist. Receding waters revealed a residue of rich, black soil stored upon the pond bottom and spread fan-wise over the rocks and upon the previously starved forest floor. While the stor-

ANIMAL ENGINEER, master forester and conservation agent are only a few of the names which can be applied to the beaver. After being slaughtered nearly to extermination, this animal rewards its present-day protectors by proceeding, with traditional diligence, to rehabilitate our woodlands

AMNH Photo

Province of Quebec Tourist Bureau Photo



PLACING a four-inch log on his dam: a candid photograph of a beaver at work in the medium where he is master. Ashore he may be likened to a "duck out of water," because he is clumsy and can be overtaken and killed without trouble. In the water the otter is one of the few animals that can destroy him

LIKE A MEDIEVAL CASTLE, the beaver's lodge is generally surrounded by water, but it has additional protection in the submerged entrance. Because beaver cannot stay underwater for many minutes, the living room is above water and well ventilated. Before ice covers this pond, small trees will be stored underwater near the entrance, on whose bark the beaver will feed comfortably in his lodge

N. Y. Herald Tribune

Before and after—a six-year interval. Within 40 miles of the greatest population center in America, the dam in the background of the upper picture caused a small stream in the Bear Mountain Park region to be converted into a sizable pond, giving nourishment to the soil and to the ever-increasing animal and plant life attracted to it. This year the beaver moved on and the dam disintegrated, leaving a lush meadow *(left below)*, tenanted by raccoon, skunk, muskrat and many varieties of birds

Photo by Samuel Stein

(Below) Transplanting Nature's landscape authority. Reluctant to leave their chosen site except for reasons of their own, beaver are transported to regions where their work is needed more, in large traps in which they are captured unharmed. Here several beaver are about to be released on the Federal range in Idaho, where they have recently been used effectively to "bring back the land"

(Below) Seventeen dams, like the one shown, were made by one planting of beaver in a small creek in Idaho which previously barely afforded a drink for a horse. These dams provided stock-watering facilities and a water-course excellent for duck-breeding and for stocking with trout. Once again the beaver silently raises his wise little head above the figures of his conquerors, to assist in the reparation of a land spoiled by careless man

Photos from Division of Grazing, Department of the Interior

age of water had permitted a steady flow below the dam, even in dry seasons, it had nevertheless withheld sediment, top soil, and humus which otherwise would have been washed downstream during flood periods.

Later that same summer a luxurious crop of grasses, sedges, and other small plants covered every inch of the moist pond bed. Gradually the stream regained its former course and flowed slowly along beneath bending reeds. The raccoon, finding excellent feeding grounds, returned to leave his plodding tracks upon the brook sides. So did the skunk and the muskrat. Deer came to feed upon the newly provided meadow.

Several years later cattails appeared, furnishing nesting sites for redwinged blackbirds which called to each other above the green tangle that grew ever higher. Eventually the oak, the black birch, and the beech would join foothold upon the re-created ground. Networks of roots would bind the soil together and hold its life-giving treasure against spring freshet and summer sun. Trees killed by beaver would long since have turned to soil and thus have added their bit toward the growth of a vital woodland that would rival the forests of old, long after the beaver had been forgotten.

Abundance of birds

When the beaver pond was in existence, many forms of animal life had come to take advantage of it, as others of their kind now benefited from the meadow. In one remote section of the park, black, mallard, and wood ducks all nested beside the same beaver pond. Rare warblers, not reported in the Hudson highlands in any numbers for many years, returned to take up their duties. Among these were the Canadian, Blackburnian, hooded, and black-throated green warblers. The great pileated woodpecker returned to nest in dead trees provided by beaver flooding. Flickers, hairy and downy woodpeckers, chickadees, tree swallows, and the crested flycatcher also took advantage of dead-tree nesting places. Many of these birds, formerly absent or nearly so, reappeared and increased to such an extent that the wood duck, for example, rated "very scarce" in 1920, could be called "common throughout the region" in 1938.

The altruistic beaver provides food, moisture and shelter for countless forms of life, both plant and animal. Water stored in the pond aids the growth of surrounding trees, through a rise in water-table level, or ground water, and through increased air moisture. Rarely are fine trees killed.

Fishermen complain at times that beaver ponds spoil their sport. As a matter of fact, they serve as breeding places not only for fish but for fish food, both amphibian and insect. One of the best trout experts in the land secured several animals, released them, and reported that the beaver made dams and created pools which raised numerous trout "which have greatly added to my fishing."

The very trappers and hunters who complain most bitterly about the beaver ponds have benefited through increased numbers of mink and muskrat, to say nothing of beaver pelts. In some sections otter are reported on the increase.

Of course, there are instances where beaver become real nuisances, flooding roads, destroying fruit trees, or otherwise interfering with man's property and routine. Last spring, for example, a beaver dam was blamed for a washout and freight-train derailment in Ontario. But it is a simple matter to trap beaver alive and uninjured and transport them elsewhere. State conservation departments will issue permits to do away with particularly troublesome individuals. It is wrong to malign all beaver for the depredations of a few.

John Burroughs, one of our foremost interpretive naturalists, discovered traces of an ancient beaver dam beneath his extensive celery garden in New York's Catskill Mountains. He realized at once that the celery owed a great debt to the industry of long-vanished animal tenants of his farm. No man will ever know how many fertile fields were created by beaver in eras gone by. Given a fighting chance, it is reasonable to suppose that the beaver will once more work for the forest, for the prevention of floods and the restoration of healthy, natural conditions in sections not too far gone for the persistent worker to perform his miracles as of old.

What of the beaver himself, the creature that trappers nearly exterminated during three hundred years of relentless slaughter throughout all of his range? He was spared from complete annihilation only through the discovery and use of silk velour, which replaced beaver fur in the manufacture of hats during the middle of the last century. His tribe was circumpolar in distribution, although few remain alive today in Norway and other European countries.

His moated castle

Visitors to beaver colonies marvel at the ponds, dams, and houses, and wonder why the animal works so hard. Why does he build dams and ponds? Observation soon reveals that a beaver ashore is a clumsy animal, overtaken and killed without trouble. In the water, however, he is master of the situation. The otter is one of the few animals which may destroy him there. So the beaver lodge may be likened to a castle, and the surrounding water to a moat which protects that castle. It is true that beaver sometimes also build bank houses, half on shore and half in the water. Even here, however, there is always an underwater exit which enables the lodge-dweller to seek watery escape.

The pond is an essential part of the beaver colony, not alone for protection. It also permits the beaver to float food and construction material from source of supply to point of use. Not the least value of a beaver pond is its use as a firebreak and source of water to combat forest fires.

In appearance the beaver reminds one somewhat of an overgrown woodchuck, with black, hairless, paddle-shaped tail. He has small front paws, but his hind feet are large, with webbed toes. Ears and eyes are small. His hair is coarse at the ends until plucked and treated by the furrier.

Equipment

Tools employed by the beaver are as efficient as they are simple. Four curved front teeth are the principal instruments, with the clever forepaws playing second part. These front teeth are some two and one-half inches long, from base to tip, including the part within the jaw. They grow constantly and the cutting edge is replaced as wear occurs, an ideal arrangement for an animal that will bite through a four-inch tree in 20 minutes. Grinding teeth, farther back, complete the dental equipment and are employed to crush the bark before it is swallowed.

But teeth and toes are by no means all the beaver's tools. His tail, that emblem of beaverdom celebrated in song, story, and art, serves as a prop when its owner is cutting down trees, as a rudder when swimming, and as a warning device when danger threatens. The pistol-like report of this tail, brought down smartly upon the water, may be heard for half a mile in the still woodland, serving to inform any unwary beaver that the time has come to seek the protection of the pond and, if need be, the house.

The large hind feet, with expanding webs between the toes, are marvelous propelling devices that enable the beaver to swim with precision and speed though they greatly hinder his movements ashore.

The beaver's importance in the human history of all the North American continent, as a trade staple in early days, cannot be overemphasized. Indians regarded the animal as godlike, and were well aware of the similarity of his ways to their own. Innumerable legends sprang up. Small wonder that white settlers should concoct stories of their own, often colored by tales of the Indians. These stories have come down to the present day, and have lost little in the telling.

As late as 1937 the Federal Theatre Project produced a play called, "The Revolt of the Beavers." Humanized beaver were represented as struggling, downtrodden creatures under the command of a Beaver Chief. This idea of a beaver chief originated in Indian legends. There never was a boss beaver and never will be; beaver are too independent and too willing to perform their just share of colony activities to need a boss. Indeed, a colony rarely consists of more than three pairs; and it is this wandering quality, this aversion to a crowd, that causes beavers to spread so rapidly.

Other fables of equal antiquity concern the employment of the beaver's tail to plaster mud or to ferry material across the pond. Both ideas are false. So, too, is the belief that the beaver can cause a tree to fall in a given direction. Beaver have been killed by falling trees, so that if they determine the direction of fall they must have committed suicide.

Truth about the beaver is remarkable enough to need no embroidering. Perhaps the best way to discover the facts is to live near a colony. Thanks to the accessibility of Bear Mountain Park, within forty miles of the greatest population center in America, it is probable that the park's beaver are better known to a larger public than any other group in the world. Hundreds of thousands of campers, motorists, hikers, and general visitors have observed their ways. A Beaver Museum, complete with living animals, has been established in the park.

Nocturnal workers

Innumerable adventures with beaver have been the result of this unique situation. Park police have been known to stand guard while beaver moved felled trees across main highways, unmolested by passing automobiles. On one such occasion a uniformed officer gave an impromptu lecture to motorists who watched while a particularly tame beaver pulled branches of a tree across the road, down a bank, and into the water. Usually they work after dark, though they may begin in the early evening.

Many campers have spent evening hours beside a beaver dam, the better to become acquainted with beaver habits. A group of Camp Fire Girls voted to allow a beaver family to stay beneath their boat dock, despite the friendly animals' distressing tendency not only to clutter the surroundings with branches but also to chew upon the dock supports in a more than experimental way. Evening canoe rides are often enlivened by the tail splashes of the animals, approached unexpectedly.

Efforts to cause the beaver to move from various locations often result in amusing experiences. A favorite method once was to destroy a large section of the dam; but the indefatigable beaver were likely to return in the night and repair the damage. A scheme to place a scarecrow in the break of the dam once resulted in the actual use, by the beaver, of the scarecrow's supporting stick to aid in repair work. Large wire mesh traps are now used to catch the beaver alive and unhurt. These traps operate after the manner of a woman's purse, the animal walking into the center, stepping upon a trigger, the trap then closing upon him.

Perhaps the most unusual experience this writer has had with beaver occurred one August night in a pond beside a state highway. Three men from the American Museum of Natural History in New York were seeking specimens of frogs and toads in the glare of flashlights. Being the only one with rubber boots, I waded a short distance and then climbed upon a rock and stood quietly surveying the pond. While my companions were searching among tall grasses on the shore, a large beaver made its way across the pond and circled my rock. All flashlights had been trained upon the exploring animal in the meantime. Standing perfectly still I watched the animal climb up and, rearing on his hindquarters, actually place his forepaws upon my rubber boots. Visions of his ability as a hewer of wood flashed across my mind; so I shouted and moved backward, causing the beaver to plunge into the water, splash his tail, and disappear.

What the animal had in mind, or why he approached, I never shall know. Only the presence of witnesses makes it seem advisable to tell the story. Beaver, as a rule, most certainly do not approach as closely.

Friendly

On one occasion a beaver weighing 68 pounds (30 is the average) was brought to the Bear Mountain Trailside Museums for exhibition during the summer months. Within several hours after release in an enclosure, it was possible to encourage him to feed upon a branch held in my right hand while my left scratched his head. The beaver had been living in a wild state a few hours before.

Such an experience demonstrates that the beaver is not a ferocious animal. Occasionally one will exhibit aggressiveness and make short rushes toward his captor, but in the main the animal is docile, gentle, inoffensive, a perfect example of a gentleman who not only minds his own business but knows it thoroughly.

For a number of years we have lived near the homes of the beaver and have observed their goings and comings. We have known the inspiration that is to be found in the reflected golden light of an evening sun upon the still waters of an inland beaver pond. We have crouched for quiet hours watching beaver-made ripples roll and spread across the mirror-like surface, and have listened to the crash of severed tree trunks in the moonlight, enjoying to the full that intimate and priceless experience that is the heritage of any patient observer of nature.

Many animals have had their place in the development of new lands, but none has ever played a more important part than the beaver. The story of its nearly complete destruction over two continents is replete with the romance that accompanies the heroic urge of conquest and settlement. It is a tale of sturdy advance, of bloodshed, of daring perseverance, and of endless seekings for fortunes in strange wildernesses. As the ivory led adventurers into the heart of Africa, so did the beaver lure trappers across frontiers of a new world.

His place in the sun

Back, and ever back, into the stirring annals of our American, human history, we can see the beaver's wise little head appear silently above the figures of its conquerors. It rises to claim membership in the foremost ranks of the tokens of wealth that filled the hearts of white men with the desire of possession. Its furry coat was the means to an end, and that end had to do with gold in men's pockets and with the beginnings of a lasting commerce between the New World and the Old. It also was concerned with the passing of an era of animal prosperity that never will be known again.

It is heartening to learn that the beaver is to have his place in the sun once more, not alone to build small empires for himself, but literally to knit ours more closely together.

A NEW "LOST WORLD"—*In one of the least known sections of South America, the Phelps Venezuela Expedition ascends a sheer 8000-foot tableland to search for evolutionary changes in a biological "isolation zone"*

By G. H. H. TATE*

Assistant Curator of South American Mammals, American Museum

For forty minutes the Lockheed flew over the low rolling country of southern Venezuela, past savannas, past forests. Then through the pilot's window the goal of our expedition, Mt. Auyan-tepui and its outliers, loomed gigantic in the distant haze. So rapid was the plane's speed on its course of 155° E that a few minutes later the northeast cliffs of this biologically unexplored tableland spread across the entire view from our right-hand window. Making a brain-spinning bank our pilot slipped down through a hole in the cloud field a thousand feet over the runway (earlier inspected and flagged), and brought the shining ship smoothly to earth. A little group of Indians clad in loin-cloths of red calico or vari-colored cloths hurried across the savanna grass to meet us.

It was a romantic setting, and stepping out we felt a tingle of excitement as the red and white cliffs of Mt. Auyan-tepui filled our northern horizon. At the base, rock walls hundreds of feet in height alternated with steep stopes of talus matted with the trunks of burned forests. Above towered nearly a quarter of a mile of vertical sandstone walls. But if we felt any apprehension as we gauged the ascent which appeared by no means easy, it was quickly subordinated to the realization that for the first time we were visibly within reach of the sum mit of this romantic tableland. And what new light this interesting region might throw on biological and geological history was naturally the one question that filled all our minds.

A hundred and fifty miles to the east lay Mt. Roraima, the supposed setting of "The Lost World," Conan Doyle's celebrated romance of book and screen, and 300 miles away, Mt. Duida formed the extreme southwest outpost of the Guiana highlands, to both of which mountains the American Museum has earlier sponsored expeditions. Like those two mountains when they were first being explored, Auyan-tepui now promised to yield the unusual animals and plants which generally characterize elevated areas where contact with the surrounding country has long been interrupted. All clues tending to illuminate the dark places in the evolutionary picture are avidly seized upon by scientific "detectives." Rarely, however, does such an opportunity occur as the discovery of the 300 square miles of Auyan-tepui with its attendant fauna and flora. The discovery of Roraima and Duida (though not their zoological exploration) dates from the days of the Schomburgk and from early Spanish colonization. But the vast plateau of Auyan-tepui stands in a region which even on modern maps is shown as having only rolling hills a few thousand feet above sea-level.

After the expedition had settled down a grand display of trade goods was staged. Colored calico, thread, needles, machetes, fish-hooks, gun-powder, shot, salt, hats, belts, shirts, cigarettes also a series of trinkets brought from America: rings, necklaces, earrings, mirrors, colored combs, lipstick, harmonicas—all these and many other items were put on

---

*Despite his youth Dr. G. H. H. Tate has long been one of the more active field workers among American Museum mammalogists, and reports of his expeditionary exploits have appeared over a number of years in these pages as well as those of the more technical journals. Professionally most interested in South America, and in particular the biologically isolated highlands of Guiana, he has told in his article above the story of his third scientific investigation of that region. His first collecting work in Guiana was conducted in 1927 on the famed eminence of Mt. Roraima, believed to be the locale of Conan Doyle's "Lost World." The following year he scaled nearby Mt. Duida and now, ten years later, the exploration of Auyan-tepui, most recently discovered of these tablelands, is added to his list. Prior to the work in Guiana, he collected in Venezuela, Bolivia, Equador, and last year was mammalogist for the Archbold Expedition to Fly River, New Guinea. —The Editor.

show. The use of many of the articles had to be demonstrated: earrings and necklaces and bracelets actually put on, and lipstick tastefully applied to faces with delightfully appalling results. Then came the council board to determine prices, a matter requiring much discussion and deliberation, for quite a number of the Arecuna Indians know the value of the Bolivar. At length, however, the cash value of each article was agreed upon and almost all the Indians down to quite small children undertook to carry on the morrow.

A horrid chattering from the alarm clock of our Chinese cook brought reality at 5:30 each morning —the reality of a world of cold gray mist with the daylight only beginning to grow. Our cook who gloried in the name Napoleon Ramon Wong—Nap for short—got his Primus stove to work on early coffee (he was allowed the luxury of kerosene for cooking only at that hour), and presently, too, the smell of frying bacon assured us that the real breakfast was in course of preparation.

Radio communication

As soon as possible we moved the entire party westward to an upper base 3700 feet above sea-level (2200 feet higher than Urullen, the native village on the savanna), whence the way led directly to the huge slanting crevice in the 1000-foot cliffs that gave on the plateau. The camp functioned as principal base from early December until the end of February; and there a field radio set, built by our transport man, Cardona, and sold to us by him when he was unfortunately forced to leave, served to maintain communication with few interruptions every other day with Ciudad Bolivar, the expedition's main base.

Each afternoon a long line of Indian carriers, male and female, could be distinguished by their bright colored clothes winding along a gently inclined ridge, as they brought a relay of equipment from the old base eight miles away. When they arrived our camp boys assisted them by raising their loads while the Indians twisted themselves free of the shoulder straps. They showed little sign of fatigue and a few minutes later were chatting happily together in groups. The women, though given lighter burdens than the men, often carried more weight; for in addition to the actual cargo, they strapped on a hammock, some bananas and cassave, and often gave the youngest member of the family a ride on top of all.

Toward evening cumulus clouds welled up over the southeast shoulder of Auyan-tepui and drifted across the face of the towering cliffs, blotting them out in a few moments. No rain fell that day however. And as daylight faded food for the carriers was given out, fires were lighted, and our incandescent lamps spread their radiance widely. From here and there on the savanna where the Arecunas rested in their palm leaf shelters, voices reached us faintly. In another hour the heavy clouds had melted away leaving Auyan-tepui mistily outlined under a moon-lit sky.

Outside the store-tent, members of a little group of Indians, tempted to labor by the attractiveness of the trade goods brought from New York, were tying loads securely into their carrying baskets, the latter fitted with shoulder straps and head loops; for today we would make our initial attack on the giant mountain.

Minutes later the last of the carriers vanished into the forests. Steep, slippery climbing became the order of the day. And at one bad spot—a cliff nearly 30 feet high—a rope hung loose for one to help himself up. Five hours' climbing brought us to the base of the cliffs which at that spot remained dust-dry on account of the overhang of the rocks. From there we entered a giant cleft in the sandstone—a weathered joint in the quartzite, littered with huge boulders, half burned trees and rotting timber—while the white mist gathered like a warm wet wrap around us. The tiny track ambled crazily among huge rocks; and we heard between our rapid heart beats the slow drip of water from hanging mosses and the drooping fronds of tree ferns. At length the fissure ahead became closed to the very top with debris and we scrambled up onto a world of gigantic rocks, scores of feet in height and thousands of tons in weight, composed of a stone so hard that the fragments through which we walked chinked and clattered like broken chinaware. Over all, great puffs of mist surged and billowed.

The summit

After a well-earned rest our Arecunas, keeping closely to the scarcely visible trail, led us clear of rocks and mist to a view of a vast rocky interior basin sloping gently away—the top of Auyan-tepui. We beheld a surface edged to right and left several miles apart by vast and fantastically eroded blocks of rock and cliff. Between us and the more level portion, however, a series of stone ridges stood directly across the path, separated one from another by troughs the size of the Panama Canal locks, filled with an indescribable tangle of partly recumbent trees. In the open at last, we passed mats of pitcher plants, broad-leaved Xyrids and occasionally beautiful yellow, white or pink orchids

By Plane to a New "Lost World"

By G. H. H. Tate

Assistant Curator of South American Mammals, American Museum

Bound for a zoologically unexplored tableland similar in structure and animal life to nearby Mt. Roraima (scene of Conan Doyle's "Lost World"), G. H. H. Tate, leader of the Phelps Venezuela Expedition landed at the airfield *(above)* of the city of Caracas. After a 300-mile motor trip the entire expedition boarded a second plane at Ciudad Bolivar. From this base three and a half months of thorough investigation was conducted by Museum scientists into the birds, mammals, reptiles and plants of a southern Venezuelan mountain still uncharted on most modern maps

En Route, the big Lockheed plane drones over the meandering Carao River *(below)* that threads its way through the rough forested country surrounding precipitous Mt. Auyan-tepui, goal of the expedition. The northern outliers of this sheer 8000-foot mountain, long cut off from the encircling country, are visible beyond the Lockheed's tail-rudder

(Left) The "Promised Land" of the Camarata valley is brought into focus by taxidermist Dillon's field glasses from the edge of Auyan-tepui's 8000-foot cliffs. It took two weeks to move the entire party to a base camp 3700 feet up the mountain. From this point small parties climbed higher, scouring the summit and adjacent peaks for significant data on the newly discovered biological isolation zone

(Above) Flanked by Auyan-tepui's lower cliffs the Indian-inhabited Camarata valley *(above)* has its river source in the mountain; thus its grassy savannas are developed out of sandstone deposits carried down to the valley by cascading streams

(Left) Staff pictures are secured with difficulty. Some member is always off in the bush or too busy with specimens to be photographed. However, just after lunch they are more compliant. From left to right, front row: W. H. Phelps, Jr., J. A. Dillon, W. H. Phelps, Sr., G. H. H. Tate, W. F. Coultas, E. T. Gilliard

INDIAN CARRIERS of the Arecuna tribe became friends of the Chinese cook Napoleon who wanted a kitchen commensurate with his talents. The pictures along right border show the spacious Indian-built structure at various stages in its development

DETAILS in the kitchen's construction: posts were set deeply in the soil, holes having been gouged out with machetes; cross pieces meeting at the apex were tapered and grooved, while horizontal poles were notched, spliced and lashed securely with "bush ropes." *(Below)* One of the base camps in the Camarata valley showing a finished Arecuna building thatched with palm leaves

(Above) Taxidermy in a tent: perhaps the least attractive but most necessary side of expeditioning. Author Tate is shown sewing up a carefully stuffed specimen of one of the mammals collected on a mountain whose creatures have been isolated from the evolutionary process for centuries. Though no dinosaurs were found on Auyan-tepui, the collections were of great interest to South American mammal specialists

(Above) Ideal arrangement of an expeditionary camp. Living and working quarters set in long clear rows give the triple assurance of equipment accessibility, ventilation and cleanliness

(Above) Expedition sponsor W. H. Phelps takes the hide off a red and blue macaw. These huge raucous-voiced birds are among the wiliest forest denizens. And tough? After six hours boiling, their flesh retains the consistency of an automobile tire

(Right) Taxidermist Dillon stayed his professional hand while befriending the expedition pets. The two birds, hatched from wild eggs by a domestic hen, lived peacefully with the young fawn "Pepe"

(*Right*) His real name was Maica-Bima but the expedition called him Joe. He is shown staggering into camp under the weight of a wild pig that had just been shot for scientific purposes

(*Left*) Young girls also carried burdens. Almost an entire Arecuna tribe was pressed into general transport service although only the men made the dangerous climb to Mt. Auyan-tepui's upper regions

(*Left*) Junior gets a ride. Children are carried mile after mile in this manner without ill effect from the scorching sun. But even tots like this one are perfectly capable of walking several miles by themselves, and when they are only a little older are given light loads to carry in tiny *guayares* of their own. A hardy, resilient people, these Indians tirelessly lugged their packs over brittle, tortuous trails in return for an allotment of trade goods that included gun powder, salt, cigarettes, harmonicas and lipstick

(*Below*) Native workers chat during a breathing spell. Though lured by novelties, the Indians had some sound economic values. Their chief has regimented the population to pan gold for him in mountain streams, and judged by the yellow glitter in his teeth the return is considerable

(*Below*) Fording one of the lowland rivers which are fringed with forests having all the apparent density of impenetrable jungles. But they are only a few yards wide, the trees soon giving place to the tall grass of broad savannas which were often found burned over by Indian-lit fires

FIRST CAMP of the expedition was thrown up hurriedly on the savanna as soon as the airship *(right)* landed. A line of Indian carriers are shown toting supplies from plane to tent

(Right below) THE SAME VIEW but snapped from the Haicha cliffs, 1500 feet higher than the first picture

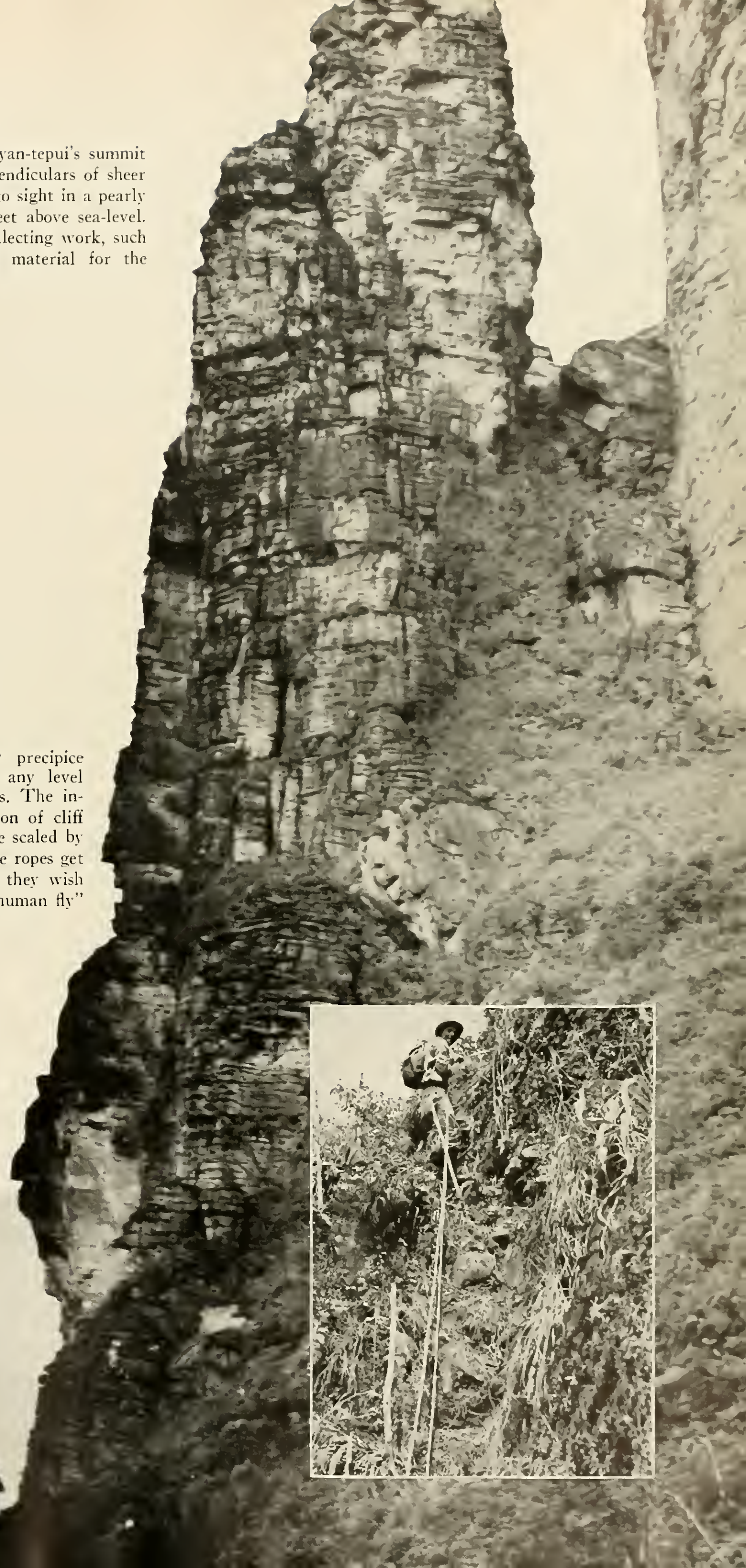
(Below) EXPEDITION MASCOT: the fawn "Pepe" was cared for by the Indians after the death of his mother. He became civilized to the extent of developing a taste for condensed milk

(Above) A TRUE CORAL SNAKE. These reptiles like all other poisonous snakes were relatively rare in the valley. Readers should note that there are also "false" coral snakes, distinguishable to the eye by a somewhat different arrangement of the colored pattern and to the feelings by being completely harmless. (See cover and more detailed explanation on page 155)

(Below) JABIRU STORK with wings spread by ornithologist Gilliard. Though not extremely rare, this stork is difficult to approach because of its height and consequent vision, since it chooses to stand knee deep in swamps where it can have an uninterrupted view of 1000 yards

(Below) GIANT SPIDERS abound in the forests about Auyan-tepui where they live in holes among roots of trees, emerging at night to creep slowly through the undergrowth in search of prey

(*Right*) The only way to Auyan-tepui's summit is shown between these two perpendiculars of sheer laminated sandstone. Often lost to sight in a pearly mist, the summit towers 8000 feet above sea-level. Although defiant of extensive collecting work, such rugged cliffs offered interesting material for the geologist



(*Right*) Bands of sheerest precipice occur intermittently at almost any level of Auyan-tepui's approach slopes. The inserted photograph shows a section of cliff 30 feet high which could only be scaled by the use of ropes. But how did the ropes get there? Arecuna Indian boys, if they wish to, can outclimb any ordinary "human fly"

(Above) THIS PANORAMA shows the spread and ruggedness of what the expedition called the "first wall." An irregular line of huge quartzite blocks, this barrier proved impassable because of the broken nature of the ground

(Below) A SECTION of the first wall with the second wall, an even more formidable barrier, showing three miles away in the right quarter of the picture. Base camp for collecting parties stands in foreground, 2200 meters above sea level

(Above) THE "SANJON" or big gully, whose mist-shrouded path offered the only access to the plateau, gives on a scene of unimaginable desolation. Everywhere huge rifts, through which the white mist works its way, cut the weather-fretted sandstone. And an almost total lack of soil precludes growth of all but the tiniest shrubs on the exposed surfaces

(Left) River action on the plateau. Due to the unfolded though slightly tilted position of the strata and their extreme hardness, the rivers cut chiefly against their sides and along lines of vertical jointing. In that way blocks of rock are loosened, broken down into smaller pieces and gradually conveyed along the course of the stream

(Right) As the departing plane roared across the savanna three and a half months after its arrival, the Phelps Venezuela Expedition gazed back on the forbidding terrain of this new "lost world." Etched and sculptured to a thousand shapes by all weathers, the isolated table-land whose treasures and secrets they had rifled, looked down indifferently upon the leave-taking of its conquerors

(Left) A WATER RUNNEL trickles over the sandstone surface while building up its own banks with deposits of silica which it carries in solution. The shot-gun bridge shows the smallness of this errant stream, but don't think it insignificant, for the Grand Canyon was probably started by a stream of similar size

(Above) SOLUTION ACTION along joint lines in the rocks followed by collapse of part of the beds. No one knows the rate of disintegration of sandstone mountains in the tropics, but it seems to be rapid and some day the majestic height of Auyan-tepui will be washed away to a minor hillock in a vast sweep of savanna grass

THE FLOWERS OF AUYAN-TEPUI and indeed of the Guiana uplands as a whole are strikingly beautiful. Few of them are known to horticulturists and new species are still plentiful in every collection brought out

on our way to the little forest of bronze-tipped *Bonnetia* trees beside which camp was placed.

How resilient is the temperament of the Indians! After two days of most arduous labor and five minutes after slipping off their heavy packs (they carried 35 pounds each), they squatted on the tops of nearby rocks laughing and talking as though the matter were an everyday occurrence.

These sturdily built Arecunas of Carib stock are likable, intelligent and tractable. Lately, however, the advent of civilization in its various forms has had its effect. The present chief of the clan, Alejo, whose teeth gleam with gold fillings acquired during a visit to Ciudad Bolivar, exercises an unusual degree of influence among his comrades and has regimented the whole population to wash gold for him. "Colors" occur in many stream beds, so Alejo is able to accumulate ounces of the metal by working his Indians for the three dry months of the year from January to March.

Though the supply of dry fuel within a few yards of our summit camp was almost unlimited, the cook boy exhibited the frugality customary among natives in regard to firewood. After a good though simple meal and before climbing into our blankets, we looked about us once more. Cliffs faced us to east and west. Southward were the rock walls past which we came that day; to the north apparently nothing but vast chasms into which all the water of Auyan-tepui falls. Overhead the half moon picked out here and there a weird figure sculptured by Nature, and a chill breeze crept over the plateau.

Collecting

Some weeks were spent on the plateau trapping animals, collecting birds and plants, lizards and insects. Fifty acres of forest whose dominant kind of tree is *Bonnetia* contained peculiarly specialized plants and creatures but proved to be relatively poor in species. Meanwhile, exploration had been actively pursued elsewhere on the summit, especially away from the rim of cliffs. It became clear very soon that owing to the development of long lines of rifts and cracks running southeast and northwest much time was lost in attempting to journey in other directions. Efforts were, therefore, made to penetrate the plateau to the north-northwest and to reach the highest cliffs to southeast, from which both lowland camps (the base at 3700 feet and the level savannas on which the Lockheed had landed us) could be observed.

In one part we had to burrow like moles beneath unimaginable quantities of tumbled rocks—rocks of such gigantic size that travel over their surface was utterly impossible—and sometimes we crawled beneath smaller blocks on which 1000-ton pieces rested. Another trip induced us to cut track through what looked like acres but in practice proved to be miles of burned forest overgrown with new vegetation—a hideous tangle in which we sweated in vain for hours. Again, an attempt to cross the great rocky wall just west of camp led to ultimate defeat: hours spent scrambling among huge sharp-edged boulders and rotting logs and stumps were rendered fruitless when we came finally to some impassable chasm or cliff.

Two exploring trips, however, proved highly successful. One, made in several stages, resulted in the establishment of a second camp beside a good-sized stream flowing through a tall forest three or four miles in from the margin of the cliffs, and a comparatively good trail leading to it was discovered. The other trip brought us with unexpected ease to a giant split in the cliffs from which the bearing of our 3700-foot camp could be taken, and farther along to the southern promontory of the mountain. From here a magnificient view was had not only of the air field and the 3700-foot camp, but also of the vast panorama of huge flat-topped sandstone mountains and plateaus so characteristic of this region.

Comparisons

Compared with Mts. Roraima and Duida, Auyan-tepui shows characteristics of its own. In its geological structure it most nearly matches Roraima, as it does in its animal life, but the latter as well as the plant life is several times richer on Auyan-tepui, corresponding to its much greater size. The most striking geological difference between Roraima and Auyan-tepui, apart from size, is that the sandstone cap is much thicker on Auyan-tepui, resting on intrusive rocks which reach an altitude of only 1500 to 3000 feet, as against 6000-7000 feet in the case of Roraima. On both mountains, the sandstone layers are scarcely disturbed from the horizontal, and there is an accompanying paucity of soil, with huge areas of bare rocks on which little vegetation grows.

The sandstone of Duida, on the contrary, is thrown into strong folds, some of which are sheared and partly overturned, and this sharply undulating surface carries a deep cover of nearly pure humus upon which the strange and specialized forests of that mountain grow.

Auyan-tepui displays a further difference from Roraima in the consistent slight dip of its sandstone beds amounting to four degrees toward the north-northwest and resulting in increased erosional effects.

Both Auyan-tepui and Duida on account of their great size (both approach 300 square miles in area) have developed extensive river systems. Caño Negro on Duida varied from 15 to 20 feet in width; and the stream flowing past our interior camp on Auyan-tepui was about 30 feet across. Roraima, with only 20 to 25 square miles, had no large stream on its surface.

The slight dip of the strata of Auyan-tepui has resulted in dissection of the northern parts of the plateau on an enormous scale, as shown on a recently published map*. Falling into the largest of the gorges, cutting back nearly to the center of the mountain, is the waterfall photographed from the air by James Angel and shown recently in many newspapers.

The three mountains just discussed, which have all been visited by American Museum expeditions, are but a sampling of literally scores of giant mesas dotting this little known section of Venezuelan Guiana. The height of land is so disposed that a ridge carrying other huge masses of sandstone and nowhere less than 3000 feet above sea-level connects Auyan-tepui with Roraima. From Roraima the water parting trends south and then westward for about 350 miles, to terminate in the huge mountains of the upper Caura River and the Duida area. In the lowlands enclosed by this great divide, whose shape is more or less that of a great question mark lying on its back, the Rivers Caroni, Paragua, and Caura are born, all flowing northward into the Orinoco. The first of these flows within a short distance of the west side of Auyan-tepui, where it has attained a width of nearly an eighth of a mile.

Lower zones

While several of the members of our party worked on the plateau, the remainder, more than half a mile below, devoted their efforts to securing a complete representation of the birds and mammals of that level. That station proved to be by far the richest faunal area tapped by the collectors of the expedition. It included three chief types of environment: savanna, rain forest, and relatively bare, gently sloping rocky plain. Each type contributed substantially to the total of the collections made.

Meanwhile, the Arecunas, though they showed marked disinclination to carry supplies to the party above, quite got over what little mistrust (if any) they may have had at the beginning. Some, particularly little boys, collected birds for us with their blow-guns and split-palm darts, with which they are marvelously expert; the men shot deer and wild pigs, women brought quantities of yams, sweet potatoes, platanos, bananas, and even wild honey in their *guayares* for sale; and one Indian with his wife took service in the kitchen with Napoleon the cook. Nap it may be said, though unfaltering in his determination to have nothing to do with mountain climbing, never failed to provide bountifully and richly for the table.

Nicely settled here, and with the expeditionary work going smoothly, it was hard to realize that the very existence of a mountain such as Auyan-tepui was unknown at the American Museum a few months before our arrival at its foot. The discovery of its potentialities must be credited to Mr. W. H. Phelps of Caracas, a keen student of Venezuelan ornithology and sponsor of our expedition. He learned many particulars of Auyan-tepui from Mr. Gustavo Heny, Capt. Felix Cardona and Mr. and Mrs. James Angel, who for many months had been exploring thereabouts with a small plane and who underwent a very arduous experience on the plateau. The descriptions and photographs they brought out so fired Mr. Phelps' imagination that he at once wrote a series of letters to the American Museum offering to support an expedition to ascend the plateau for the purpose of studying and collecting its bird, animal and plant life.

Personnel

Mr. Phelps' suggestion, made in June, was promptly acted upon. Four members of the American Museum staff were selected for the work; W. F. Coultas, ornithologist, formerly in charge of the Whitney South Sea Expedition; E. T. Gilliard, ornithologist; J. A. Dillon, taxidermist; and the author as mammalogist, in charge. Quantities of stores and food supplies were assembled; moreover every possible consideration was given the expedition by the State Department in Washington and by the Government of Venezuela.

In that country Mr. Phelps actively prepared for the expedition's arrival. At Cuidad Bolivar, the main base of operations, he assembled quantities of additional stores and made arrangements with the Venezuelan Government to fly the entire expedition with all its supplies to the large savanna at the base of Auyan-tepui and from that point back to Cuidad Bolivar when the expeditionary work had been completed.

A supplementary plane-load of stores was arranged for the middle of January. The ship, though delayed for a few days by bad weather, brought every item ordered. A few weeks later, our work at an end, the orderly retreat from the plateau began—first down to the 1100 meter base, and after-

Continued on page 153

Geographical Review, July, 1938.

THE INDIAN AND THE SUPERNATURAL—*While the reservation Indian tried to fit strange mechanisms into his scheme of life, his conquerors felt the eerie beauty of the aboriginal world and half-believed in its magic*

By CLARK WISSLER
Curator, Department of Anthropology, American Museum

I RECALL an interesting journey with a party of Indians traveling on one of their customary visits to another reservation. As soon as the necessary travel permit was received from the Reservation Agent our Chief ordered everything made ready to break camp the next morning. Each family had a wagon on which were piled tipi poles, bedding and other necessary equipment, women and children riding on top. The men and boys usually rode horseback and there were a few pack-horses trailing behind, accompanied by two or three colts who got into an occasional panic, alarming their mothers by their loud cries.

By invitation, I rode ahead with the Chief. It was a fine clear summer day, and our trail ahead extended almost the full length of the reservation lands. The Chief was so silent and subdued in mien that I ventured to sound out his hopes or fears as to the journey before us. The import of his reply was that from neither man nor beast had we anything to fear, but that we should not ignore the unseen powers whose acts were for the most part unpredictable. His own feeling was that these powers were now hovering over our trail, whether for good or ill remained to be seen. The Chief then lapsed into silence, as was the Indian custom, assuming that I was silently reflecting upon these utterances.

An omen

Glancing at the face of the Chief from time to time, I thought his expression was one of awe rather than apprehension. Presently, looking ahead, I saw lying on the ground a large Indian pipe. The bowl was of redstone, the long stem decorated with feathers, and the mouth-piece pointed toward us. An exclamation from me called the pipe to the attention of the Chief who instantly gave the command to halt. He then harangued the party, explaining that something mysterious was happening; that their white guest was about to receive something from the unseen powers; that as a symbol of this, a pipe was to be given; and that he would now instruct this white man as to the manner in which he was to take up the pipe.

At his request, I dismounted and stood by his side facing the pipe, while the Chief recited a prayer too ritualistic for me to understand. We then advanced a few steps, pausing for another prayer. Once again we did this, after which I was told to advance and take up the pipe.

To avert anger

An old woman now came forward with a piece of calico, took the pipe, and wrapped it up with trembling hands, muttering a prayer that the pipe be not angry with her. The Chief explained to me that the rule was that a woman must care for such objects, so she would carry it. I was impressed by the solemnity of the party. Clearly they were all deeply moved, and the remainder of the day's journey was accompanied by unusual silence.

The next morning we took up the trail, and again I rode ahead with the Chief. Later in the day an exclamation from several Indians caused me to look behind and, guided by the pointing Indians, I saw that a dog was closely following me. It looked sleek and friendly, not like an Indian dog. When we stopped, it sat upon its haunches and waited. No one seemed to have seen this dog arrive and none of the camp dogs paid the least attention to it. All this struck the Indians as queer, but I gave no thought to it at the time.

When we camped at noon to rest the horses and to lunch, the new dog kept close to me. In fact whenever I moved, he rose to follow. I offered him a handout as I ate, but either he was not hungry or possessed finicky tastes. All that afternoon he followed and kept close to me as camp was pitched. The woman caring for the pipe found on the previous day, brought it to my tent and hung it on the back wall where, according to Indian custom, a medicine bundle should be. The dog watched the woman closely and after she had gone sniffed at the bundle, then lay down in the door of the tent where he stayed during the night. I suspected that the dog was lost and belonged to the people who had dropped the pipe, but eventually I learned that the Indians had a different explanation. They, as all of their kind, had been born into a society which sanctioned a totally different point of view from that entertained by the white man. All happenings in the least out of the ordinary were to them signs of the supernatural.

The next day's journey was uneventful, though the dog was still close at my heels and at night lay on guard at my tent door. However, the following day, the Chief told me of a curious dream he had during the night, in which he saw a strange Indian sitting in my tent door smoking the pipe.

Later as we rode along, heavy clouds appeared to our left, and as we descended into a narrow valley, it appeared that the storm would soon be upon us. So the Chief ordered the tipis to be pitched. Everybody began to work as fast as they could, the storm approaching nearer and nearer, with repeated crashes of thunder. While struggling with my tent, I noticed a bird hopping around at my feet; several times I with difficulty avoided stepping on it. At last the tent was up and I crept under it to rest and await the rain. Then for the first time I noted that though the storm was near and the thunder terrifying, its direction had changed, for instead of heading our way it was now passing over the opposite terrace of the valley. All at once I thought of the dog and the bird, but neither was in sight. After so many strange happenings I began to feel that maybe the Indian did live in a different world, as pipe, dog, dream, bird, escape from the thunder storm followed one another in a sequence of mystery.

In due time we reached the other reserve, joining a camp of friendly Indians who gave us a hearty welcome. There was a grand old medicine man there, called Yellow Spot, now all but blind, yet dignified, intelligent, and credited with unusual powers. One evening he invited me to his tipi where I found a few head men assembled, among them our Chief. I was surprised to be offered the seat of honor next to Yellow Spot. For a time nothing was said, as was the custom, the pipe passing back and forth. Finally the old medicine man began to speak.

Proof of supernatural understanding

In substance his rather long monologue, as interpreted to me, recited first his satisfaction that I had honored him by this visit, that I came as a friend of Indians that he held in high esteem, but especially because the same unseen powers that looked after his people held me in high regard. He had been told that the Indians in our party had seen mysterious happenings, which the wise medicine men of old were able to understand and the wisdom of which had been passed on even unto the present generation. Indians who experience such communications from the unseen do not speak of them for a time and he noted that I had been silent upon the subject. To his mind this was further proof that I understood the importance of the events of the past few days. No doubt these powers had and would again appear to me in my dreams and promise me long life and prosperity. This was why he felt honored by my presence, I who had received great power and would soon receive even greater powers.

I was somewhat mystified by all this but knew enough about Indian thought and belief to recognize the point of view and to appreciate the sincerity and faith of this aboriginal philosopher. So far he seemed to have addressed his remarks to me, but now by his manner indicated that he spoke to the Indians present. In outline he followed the events of our journey, showing that the Chief and other members of our party had lost no time in circulating the news. The rapidity with which Indians could disseminate information always amazed me. The old medicine man told accurately enough about the pipe, which he considered no ordinary pipe though possibly made by human hands; yet the dream of our Chief he interpreted as the truth back of the event, the pipe being but the symbol of the power transmitted to me by this new-found guardian spirit.

Agents of the unseen

The dog was to his mind a manifestation of guardianship, not so much for the pipe as for me who was venturing into a strange country. But the important happening was the demonstration of power over the thunder. Almost every year some of his people were killed by lightning, so the thunder was to be feared—it was a great power. Yet they had it from their ancestors that from time to time the thunder gave the Indians a pipe as a sign that he would hear their prayers and take pity on them. So the power of the pipe had unquestionably turned away the storm. The bird fluttering at my feet was according to tradition in touch with the unseen powers and so there could be no doubt as to the reason for its presence. Neither the dog nor the bird were to Yellow Spot's mind real animals, but the form in which the unseen chose to be made manifest.

After returning to my tent, I reflected upon these experiences and the reactions of the Indians, so different from my own. To me, it was merely a matter of chance that an Indian lost a pipe, that my trail crossed that of a lost dog, that I happened to pitch my tent too near a nest or a brood to suit a parent bird and that we misjudged the direction of a thunderstorm. The Chief's dream could be explained by a psychologist as a trick of his nervous system. Yet was there any particular virtue in my explanations other than to say that the customs and habits of my people demanded them so? And were not the Indians entitled to enjoy whatever values they could read into the aforesaid sequence of events since they felt that a ritual and a few songs belonged therein.

I suspected that sooner or later our Chief or old Yellow Spot would dream something of even deeper significance. And, sure enough, some days later our Chief hinted that he had in fact learned a song when he first dreamed of the man sitting in my tent. Realizing that I should never acquire a song in this way I decided to put the pipe and all it stood for in the keeping of the Chief. The only injunction I laid upon him was to keep it and take it with him when he died. He seemed deeply moved by this unexpected generosity. For my part, I was happy to have been in on the making of a new ritual.

Medicine men were not always such impressive characters as Yellow Spot. In fact, judged by our own standards, they were often far from impressive, being rather unkempt, their faces smeared with paint, and accompanied by a peculiar odor—the result of much ceremonial smoking and burning of sage, sweet grass and other forms of incense. Yet time and again I was surprised to note that many white people about the agencies came to believe in the powers of certain medicine men. Perhaps this was due to the summation of stimuli, as the psychologists say; but in any case, a white man venerates success. And so when from day to day he saw a reputed medicine man going about his calling, commanding more and more respect from his fellows, he came to feel that after all, there might be something in it.

Contest between rain makers

This was first brought to my attention by a contest of powers between two medicine men, Bull Shield and He-crow. The former was well on in years, long famous for his varied powers, the latter still young, ambitious and rising. The occasion for the contest was a tribal festival at which time, according to custom, a medicine man or two was expected to see to it that good weather was maintained, particularly that there should be no rain and that the sun should shine. For many years this obligation had been assumed by Bull Shield, without failure, but long before the appointed time, in the year of my visit, He-crow had boasted that he was a great rain maker and would use his powers to humble his rival.

I arrived at the ceremonial grounds early. It was cloudy and misty. He-crow was strutting about declaring that his incantations had brought up the clouds and that he would produce rain to prevent the ceremony. Now and then when an audience would assemble, He-crow would dance, jumping high into the air, pointing toward the clouds with the stem of a small pipe and occasionally crying out in tones which he fancied sounded like those of an eagle on the wing. Obviously this was meant as an appeal to the Thunder Birds. Altogether it was not an inspiring scene, partly because He-crow was a small unimpressive person. Anyway he had few sympathizers.

Bull Shield, busy in his tipi, was by far the more picturesque, stripped to his breech cloth, his body painted yellow, with many symbols in blue, so distributed as to emphasize the symmetry of his figure. His ritual for fair weather consisted in songs and prayers to the Sun, whom he regarded as the one great supreme power in the universe. Some of his friends and understudies had gathered in to help with the singing, and to fill the ceremonial pipe.

An anxious bout

Every now and then, there would be a rift in the clouds through which the clear blue of the sky could be seen; then He-crow would come forth to dance frantically, crying out to the Thunder Birds and after an interval the clouds would unite and threaten rain. Then He-crow would walk about smiling and boasting about how he offset the power of his rival. Soon the deep tones of Bull Shield's drum would be heard and the low but tense singing of his followers, continuing until another rift in the clouds materialized. In the afternoon, the sun broke through for brief intervals causing He-crow to engage in violent dance contortions and strain his hoarse voice still more. The white people standing about now felt that Bull Shield was winning, it was plain that their sympathies were with him anyway. Finally the western sky cleared, the sun cast a glow over the whole landscape. We saw no more of He-crow, but Bull Shield in his glorious paint came out, offered a pipe to the Sun and prayed for all the people. It was a great triumph for him, he obviously enjoyed it to the full.

My white friends were impressed. They shook their heads mystified, saying they knew not how it was done but that everyone could see that these old

Indians had some control over Nature and that a medicine man could do what no white man could do. I offered another explanation, but it fell upon deaf ears. And even the Catholic priest of the reservation, who pronounced it the work of the devil, received not so much as an encouraging look. Perhaps after all civilization has little resistance when faced by first class magic.

Bull Shield was inclined to be friendly with me and once when camped with his band, he asked if I would consent to receive an Indian name. He explained that most white personal names could not be translated into Indian, thus making it difficult for Indians to speak of their white friends. I was pleased with the idea and suggested that he confer such a name. He was willing but remarked that the customs of his people required that the recipient of the new name furnish a steer and several boxes of crackers, so that a feast could be served. In other words Bull Shield would give a real party if I paid the charges. After all this seemed fair enough and Bull Shield looked as if he needed a good meal. So a crier was sent out to ride around shouting out invitations to those considered worthy of participation. Imagine what a furor there would be in a white town if Mrs. Jones decided to give a party and sent out a man with a megaphone voice to ride through the streets telling all about it and giving the names of those invited to be present! Well, the Indian way is not the white man's way and, come to think of it, there is considerable merit in the Indian method; all the mystery and suspicion are thereby foregone when one gives a party.

Named after a chief

Upon the appointed day everyone was so radiant with happy expectation and so enjoyed the aroma of boiling beef which filled the outdoor air, that I felt amply repaid for the expense involved. The leading men sat in a great circle passing a big pipe back and forth amid dignified silence broken only occasionally by subdued conversation. I remarked the contrast here, for if one brought an equal number of white men together there would have been such a chatter that even the magpies would have retired discouraged. After the feast, Bull Shield made a speech explaining why the Indians had been called together, as if they had not already known it for a long time. Several other old men made long speeches, the tenor of which I dimly understood to be that they approved of the idea. In due time Bull Shield announced that he was ready to give out my name, that of a distinguished chief long dead, meaning in English, "He-who-gets-what-he-goes-after." So far as I could see, it was a good enough name, though just how it applied to me, I could not understand.

As soon as the name was announced, the crier mounted his horse and rode about shouting out my new name. The women cheered and that was the end of it. Many times I visited that reserve always to be greeted by that name. Even the children knew it. Some people fancy that when a name is conferred upon a white man he thereby becomes a member of the tribe, but that is nonsense. I asked old Bull Shield how one became a tribe member; at first he said a white man could not do it, but afterward qualified the pronouncement somewhat by saying that if one would take an Indian woman, settle down there, learn the language, etc., he might finally be tolerated; yet even after all this, he would still be a white man.

The spirit in the phonograph

I had another interesting experience with a medicine man named Day Star which brought out the peculiar attitude of the old-time Indian toward the white man's machines. It is difficult for a white man to understand what an Indian sees in a machine; such a contrivance does not fit into his scheme of things. To him, if something is accomplished, there must be a living agent. I had come to know this but every now and then would be taken off my guard. Day Star was such a hard-headed and sensible fellow that I thought him a good bet for securing information as to certain rituals and, since songs were an important part of the affair, I persuaded him to sing them into a phonograph. He claimed to have heard such a machine in a trader's store. However, when I brought out the apparatus, to explain its operation, he remained silent and apprehensive. I played a record, sang into the machine, and let him hear the reproduction. He was obviously uneasy. Had a spring broken or something unusual happened, I suspect he would have rushed out in a panic. The only thing he would say was: "Wait, wait!"

For a long time he sat facing the machine, occasionally moving his lips as if in prayer. Then he began a monologue addressed to the machine, telling who he was, reciting his autobiography in some detail, explaining what he had promised to do and why. Finally, he pleaded with this new mysterious presence not to misunderstand him, that since his motives in singing these songs were pure and worthy he hoped it would exercise due care to see that no harm came to him or to his family. It was an impressive scene and I began to have serious doubts that he would so much as speak a word into the machine, especially when he arose to take his leave. However, he promised to return the next day after he had consulted his spiritual guardian about it.

My hopes fell. Past experiences with Indians gave little ground to expect Day Star to face the machine again. But he did. He came next day, ready and anxious to begin. At the outset he expressed doubts that the machine knew Indian well enough but the first trial convinced him that it could speak Indian just as well as he could. He was now more firmly convinced than ever that he was dealing with something far superior to a material contrivance. However, he quickly warmed up to the task and would have continued for hours had I been willing but I suggested that he take a rest and return the next day.

This time Day Star failed me, nor did I see him for a long time, but finally he came in, obviously ill at ease. Without waiting he announced that he would have nothing more to do with that machine. By persistence I got from him the story of what had happened. While Day Star was singing into the machine, his wife was taken with a hemorrhage of the nose, something she had never experienced before. Eventually the family, becoming alarmed, dispatched a rider to recall Day Star, meeting him on the way home. Now, Day Star was a famous medicine man, one of his specialties being to stop bleeding. Always he was sent for in such emergencies. According to his story he labored long and hard, praying, singing, drumming, before the bleeding stopped. This, he said, was a warning. He had offended the spirits that guarded him by tampering with the spirit in that machine. No more would he speak or sing to it.

New power for Day Star

Naturally, I agreed that logic was on his side and hoped he would take no chances with his wife's health. Incidentally, I remarked that I had some skill in stopping such bleeding and, noting that he was interested, explained the procedure. Taking up some cotton, I showed him how to pack a nostril. He asked many keen questions about it, seeming to grasp the rationality of the various steps. Finally I packed his own nostril to let him know how the patient would feel under the treatment. At the end, he asked where that stuff was to be had; the soft pure cotton impressing him as a remarkable substance. My answer was to present him with a package of surgical cotton. He was surprised and tremendously pleased. His eyes sparkled and he made a long speech, the substance of which was that I had given him a great new power, that his usual fee for a treatment was a horse and that this package of cotton should bring in at least twenty.

Afterward I learned that according to the customs of his people, when one medicine man gives a secret to another, the recipient is thereby obligated to do in return whatever may be requested. So, inadvertently, I had put Day Star into a tight place. He was now duty bound to keep his promise. After some hesitation he requested me to get out the machine, that he was ready to sing. From that time on his interest in the machine grew, though he occasionally made long speeches to it. My chief difficulty was to prevent him from using up all the blank records and to overcome his opposition to letting other Indians use it.

One day I casually remarked that the man who made the first phonograph was still living, that all the white people thought him an unusually brilliant man. Day Star was not especially impressed and looking affectionately at the machine said that the inventor was no better than other men, that he did not invent the machine because he possessed special virtues, but that he was merely a lucky man, not a great man. This was strange philosophy to white ears, so I inquired as to what was meant by luck. Day Star said that Edison was undoubtedly sleeping one time when some of the powers appeared to him, telling him to put wood and iron together, thus and so, and the voice could be reproduced. He did nothing himself, but he was very lucky in being chosen as the person to introduce this machine into the world. So, he said, it is with everything, man himself creates nothing.

I have often pondered upon these words and met other Indians who had much the same view, though I would not claim such a belief common to all members of that race. Maybe there is some truth in it, for after all, why ideas come to some people and not to others has never been adequately explained.

The camera and the Sun Spirit

According to my experience, most medicine men were individualists, some of them very eccentric. Old Spotted Horse was in the latter class. I could make little headway with him, as he was always opposed to anything I wanted to do. There was nothing invidious about this since he treated his fellow tribe members the same way. As to getting information from him, I had little success, his attitude being that it was none of my business anyway. One of his pet hobbies was denouncing photography. At every gathering where white people appeared, he stalked about haranguing the Indians upon the dangers to be incurred in facing a camera. Ill luck, disease, and even death, were the penalties. One day, with a camera in hand, I called upon him, hoping that this would lead to an argument. It succeeded admirably. After a long exchange of words, I asked if he understood how photographs were made, and upon his stating that no one had ever explained the thing to him, I offered to demonstrate the process. He became interested and asked keen intelligent questions about every point. I had the feeling that he was grasping the gross mechanical, chemical and optical principles in photography. Finally he wanted to know what really put the picture on the film, to which I answered "It was the sun."

Old Spotted Horse then lapsed into silence. I had hoped that when he discovered there was nothing mysterious about the camera he would cease to oppose its use, but there is where I was wrong. Presently he began to speak. He said he was grateful to me for explaining the process so clearly, that he had always felt there was something wrong in taking pictures, but he did not know what it was. Now he knew, for I had set him right. It was the power of the Sun which did it. The Sun was the supreme power ruling over his people; to be photographed was trifling with that sacred being; in short it was sacrilege! Henceforth, he intended to oppose photography with all his might.

I should have known better than to try it. I have never seen a white person with a firmly fixed idea who could be swerved by facts. He could always interpret them his way. Nor have I found Indians any the less skillful in such manipulations.

The making of a medicine man

Reflective thought, the formulation of explanations, was what distinguished medicine men from their fellows. They were relatively speaking not men of action, their attitude being one of detachment rather than participation, though when professionally engaged they could proceed swiftly and continuously. I heard many narratives about the mythical heroes of the profession, to which there was usually a biographical introduction. In most cases, the medicine man as a boy did not play about with other children but sat upon the hills or walked about alone. Often he had some slight deformity or some disgusting habit, which tended to isolate him; in short the idea seemed to be that a medicine man must begin his preparations early in life. Yet no one ever suggested that one must be born with a special talent; those childish peculiarities were worked into these stories as predictive signs that a medicine man was in the making. I supposed these rationalizations were a kind of reading backward, because most medicine men, like our own scholars, seemed more or less queer; and conversely, if not queer, one could not be a medicine man. However, I observed that most of them went through a long period of training. Even as late as my days on the reservation, each medicine man had one or more understudies. Some of these apprentices had entered into such service while still boys and many graduated only upon the death of their teachers. The duties of such a student were various, he took care of the pipe and the ceremonial equipment, helped with the singing, thus gradually learning all that his superior knew. From time to time his teacher delivered long monologues or lectures on the mysteries and the technique of handling the sick. I came to know some of these understudies, their hopes and disappointments. There was one called Willy Bear, a moron if ever there was one. He had learned to speak English in school, was moderately successful in stock-raising, but longed to be a medicine man. Hours and hours he attended his teacher, shook the rattles and beat the drums vigorously, felt that the finest things in the world were to be found in the rituals and teachings of the great medicine men, but with tears of disappointment he would confess to me that though he tried and tried, he could not master the subject. He was then nearing fifty, and went on trying harder and harder, even to the last day of his life.

The medicine man always occupied an unenviable position on the Reservation. To the churchman, he was the symbol of pagan iniquity, to the reformer he stood as the greatest obstacle, to the official he expressed the determined conservatism of pagan life, the self-appointed leader of the opposition. Even the trader had little use for him because he bought sparingly and set his influence against credit, debt, and changes in the standard of living. About the only person taking a neutral attitude was the agency doctor, perhaps because he understood humanity better and knew more of Indian life than any other white man, not overlooking the recognition that in spite of all that could be said to the contrary, the medicine man was a physician.

A power

Within his domicile, the medicine man relaxed, spent much of his time in thought, meditating upon nature, man and the heavens. Often he was not politically minded, was not the leader the Reservation Agent supposed him to be, but was still a mighty power in defending the old views of life, and in one brief monologue, he could nullify 50 sermons by the missionary.

The young educated Indians, many of whom had been converted to Christianity, would vie with each other to tell me how foolish and silly they believed the medicine man to be, but not within his hearing, for in reality they respected and feared what he stood for. Should one of them be really ill, this same

Continued on page 154

MUMMY CAVE—*A story of bloodshed and the obliteration of cultures, of long-forgotten cataclysms and daring engineering feats, unfolds when an archaeologist repairs the watch tower of the oldest consecutively occupied cliff dwelling in North America*

By EARL H. MORRIS*

OCTOBER NIGHT spread a shroud of silence over the Canyon of the Dead as I gazed toward the twin recesses of Mummy Cave on the opposite side of the gorge. Their dark shadows peered like brooding eyes at the deeper blackness of the canyon wall behind me. Through a rift in the rimrock the full moon poured a splash of silver upon the gaunt ledge between the grottoes, to illumine in full magnificence Tower House, Citadel of the Cliff Dwellers.

The ancient builders, ignorant of the brief tenure they were to enjoy, had shaped and laid each stone with the greatest skill they could command. Through centuries of abandonment this masterpiece of native Southwestern architecture had resisted all efforts of the elements to drag it down, but during the last few decades inexorable Nature had begun to have her way. The high front wall of the tower had parted from the others and begun to settle outward to its fall.

A 650-year-old tower

We found the great leaf of masonry held upright as if only by long habit, and ready, if a grain of sand were to give beneath it, to transform itself into an avalanche of wreckage. To forestall such an event we had spent the best of our strength and ingenuity. Sundown of that October day had seen the task completed. Again the tower stood as firm and secure as it did nearly 650 years before when the aboriginal masons wiped mortar from the tough hands they had used as trowels and stepped back to evaluate their handiwork.

The great red del Muerto gorge, beautiful and baleful, majestic and mysterious, lies hidden in the mesa country of northeastern Arizona. Because it is a well-watered valley furrowing a barren upland, it has been a favorite haunt of every people which frequented the region. The Basket Makers, oldest of the known colonizers of the northern Southwest, a semi-nomadic tribe but recently introduced to agriculture, came to grow beside the stream the one plant they had learned to cultivate, maize. As time went on, care of the growing crops and guarding of the garnered grain imposed upon the Basket Makers the necessity of sedentary existence. They brought their keen intelligence to bear upon the possibilities afforded by a different pattern of life, and soon were on their way toward proficiency in such material arts as home building and pottery making.

Eventually, to judge from skull form, there came among the descendants of the first settlers a new and virile stock which amalgamated with the old and in the end supplanted it. From the fusion of the two arose the Cliff-Dweller-Pueblo tribes, who were to make the farthest advance toward civilization attained by native Americans north of what is now Mexico.

Present inhabitants

Throughout the centuries Canyon del Muerto continued to be a teeming and important center,

*An addict to archaeology since he dug up his first prehistoric vessel at the age of three and a half, Morris spent much of his boyhood among the cliff dwellings of northwestern New Mexico. Before graduation from the University of Colorado, he had been on two expeditions to the Maya city of Quirigua, Guatemala. In 1916 he began exploration of what is now the Aztec Ruin National Monument in northwestern New Mexico for the American Museum of Natural History, which, together with several side expeditions to the caves of Canyon del Muerto, Arizona, continued until 1923. In 1924 he went to Yucatan as Director of Excavation for the Chichen Itza Project of Carnegie Institution of Washington, excavating and repairing the celebrated Temple of the Warriors. Completing a popular book and a technical report on the great Maya architectural complex of that name, he turned again to research in the Basket Maker-Pueblo field of the Southwest, with which he is still engaged.—THE EDITOR.

until, after the Golden Age of the Pueblo had passed, some conspiracy of forces brought about a complete exodus from thousands of square miles of territory of which the del Muerto drainage is a part. For a considerable interval the fertile trough among the hills remained untenanted. But finally there was drawn to its shelter a new and different group, the Navajo Indians, who are its present-day inhabitants. Their herds of sheep and goats graze upon the talus slopes, their peach orchards thrive in sheltered pockets among the cliffs, and fields tilled when there were Pharaohs in Egypt still make them a return of corn and squash and melons.

In the faces of the mottled cliffs there are scores of ledges and shallow caves to which no drop of moisture has penetrated since the last geologic change. For superstitious reasons these places are shunned by the Navajo, but they were eagerly sought by the earlier tribes because of the protection they afforded against both elements and enemies. In such havens the old people hid their valuable possessions, stored their corn and grass seed, buried their dead, and, in the more favorable ones, built their habitations.

They overlooked no ledge or cranny to which it was at all possible to climb. As evidence of this there are many tiny rooms and long lines of rock paintings in spots so inaccessible that the Navajo aver the men who made them were possessed of wings. Due to absolute dryness of many of the shelters, their bulky content of man-made articles is often perfectly preserved. Feather ornaments, baskets, sandals, jewelry, weapons, utensils, and the bodies of those who made them are to be exhumed little changed during the hundreds of decades since they were laid away. Such conditions make of the canyon a treasure house and source book to the archaeologists.

A strategic site

Of all the del Muerto cliff shelters, Mummy Cave is the finest and most spectacular. It is as if Nature had labored with avowed intention to provide one perfect dwelling place for the ephemeral creatures who would strive to wring warmth and sustenance from her reluctant breast. Here the canyon is some 600 feet in depth. The twin recesses lie in a rounded angle in the sheer wall formed where a huge fin of rock juts out. Below them there is a sharp descent of native stone, then a green talus which reaches to the valley floor about 200 feet beneath. Above, the rimrock leans far out to form a roof more massive and enduring than was ever made by man. From its eaves in times of rain, there falls a misty curtain to splash upon the talus a long stone's throw in front of the cliff dwellings. Facing south and west, the recesses catch the warmth of the low winter sun and look downstream upon a three-mile stretch of canyon which constitutes a view magnificent beyond the power of pen to describe.

When the Basket Makers moved into Mummy Cave they camped upon the bare rock floor, spread their beds of bark and grass upon the more level spots and laid their fires in the cracks and crevices. Being an untidy folk, they disposed of their rubbish in the easiest way, by throwing it down the slope in front. Through the years a vast amount of it accumulated. Sweepings, ashes, broken stones from the fireplaces, bones of the animals brought home for food, corn cobs and husks, bits of stone chipped from knives and dart heads, worn out hand mills, footgear, shreds of blankets and all sorts of discarded objects rolled down the slope to form a bulky talus at its foot. In time the people of the cave turned this to their advantage. Having grown in numbers until the cave would not give comfortable quarters to more, some genius devised the plan of building retaining walls of logs and brush and stone across the refuse slopes and filling in behind them. Thus the rubbish slide was changed to a series of terraces, each broad enough to give footing to the crude dwelling rooms that by this time the Basket Makers had learned to construct.

The larger the population, the more rubbish there was to shove down the hill, and when the dwelling quarters became nearly buried by the growing mass of it, it cost less effort to move out and build new terraces on top than to keep the area clear. This process was repeated time after time right up to the level of the deep recesses, and the top of the deposit was smoothed out to add several thousand square feet of level area to the cave floor. It was upon this plane that during the later periods the Pueblo people built their houses of coursed masonry.

An ancient catastrophe

Between the two grottoes a massive natural pillar stands as if purposely sculptured to support the enormous vault of the roof. Even though the ledge skirting the foot of it was meager, the Basket Makers, in their need for expansion, built an arc of chambers which crowded passersby to the very brink. Then a huge leaf split away from the forward side of the pillar and crashed down upon the flimsy habitations, burying the shelf under hundreds of tons of stone. Could that old ledge be cleared there is no telling what evidence of tragedy might be found.

In order again to have a pathway between the two grottoes, those residing in them built a retaining wall and created a promenade of much greater width than the one originally provided by nature. But probably because the catastrophe was remembered, long years sped before anyone dared to build upon this spot again.

In the latter half of the thirteenth century, however, there was trouble in the north land, and a small Pueblo group abandoned its cliff home in Mesa Verde and moved southwestward. Across river, plain and mountain the little band journeyed until finally it paused beneath the canyon metropolis. The great shelter had for them a powerful attraction because it offered all the features considered ideal for a dwelling site in their old homeland. These Mesa Verde people were good fighters and they would add materially to the protective strength of the cliff village, but there was no room for more dwellings except upon the terrace in front of the mighty pillar.

Among the Mesa Verde group there was one, more engineer than the rest. He scanned the face of the pillar and saw that all loosened stone had fallen from the one area and that there an expanse of roof had been left more solid than all the rest. He viewed the proportions of the terrace and laid out the plan of a dwelling amply large to house his kinsmen. It would be so arranged that it would be an effective fortress and at the same time leave a pathway in front for communication between the grottoes.

Before many months had passed hearth fires glowed within the Tower House. Its only entrance was a doorway near the western end. Completely to cut off the structure from view and reach of the main grotto, the eastern end was raised into a tower three stories in height, handsomely built, and provided with a parapet from which a watchman could discern for miles down-canyon the approach of an enemy or smoke signals relayed from long distances.

Silence falls on Mummy Cave

For a time all went well within the snug retreat, but before the first of those born in the Tower House had grown old, gone were the Pueblo from the whole of the canyon, and Mummy Cave became retenanted by rats and owls.

Recent history of Mummy Cave is indeed meagre. No one knows who was the first European to lay eyes upon it, but there can be no doubt that he was a member of a Spanish raiding party such as the one responsible for the massacre of Navajo which took place less than a mile farther upstream.

In the great roundup of the Navajo in 1863, preparatory to their exile to Bosque Redondo on the Pecos, some of Kit Carson's forces must have marched down del Muerto, but they were in search of live Indians, and not much interested in ruins left by those long dead.

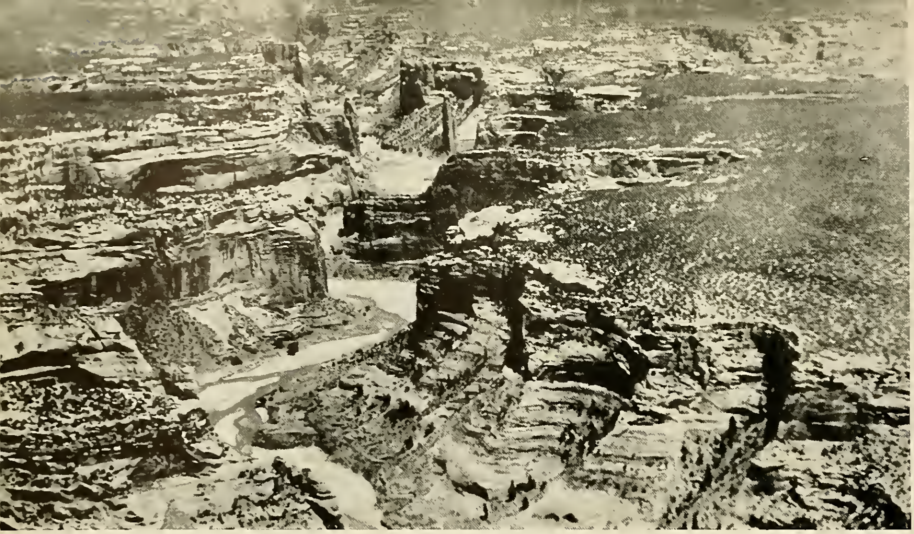
In 1882 Colonel James Stevenson made the first detailed report on Mummy Cave. And the following year Cosmos Mindeleff spent some time at the great shelter, mapped it, took photographs and subsequently published his findings.*

During the 1890's the Days, father and sons, were proprietors of a Trading Post at Chinlee, situated near the mouth of Canyon de Chelly. They dug extensively in the caves of both de Chelly and del Muerto and amassed an extremely large and important collection of relics which eventually was purchased for the Brooklyn Museum of Natural History. For years thereafter the caves lay fallow because the younger generation of Southwestern archaeologists believed everything of importance had been removed. To my personal good fortune nothing happened to dispel this illusion until 1922. In June of that year I was riding with Mr. Charles L. Bernheimer on one of his extensive exploring expeditions. One day we brought our pack train down a difficult trail that scales the north wall of del Muerto, and turned up-canyon toward Mummy Cave. For days John Wetherill, our veteran guide, had told me of the rich archaeological promise the canyon still contained, but I was in no wise prepared for what I saw. Before night I was literally wild over the wealth of specimens and of information that lay snugly tucked away in the dry ledge shelters. I resolved to begin their exploration at the earliest possible date.

Collapse imminent

Funds were not too easy to obtain, but in the fall of 1923, I began a long campaign of research for the American Museum of Natural History. Our first season's work was done mostly in the refuse slope of Mummy Cave where buried dwellings and storage cists yielded a vast wealth of archaeological treasure. Often during that first season, I climbed to view the Tower House at close range. Knowing the Tower as Mindeleff had described it some forty years before, I was shocked by the degree to which the danger of collapse had since increased. Unless protective measures were soon carried out, this magnificent example of ancient Southwestern architecture would be but a mass of wreckage at the foot of the cliff. To restrengthen the old walls would be a

* "The Cliff Ruins of Canon de Chelly, Arizona," Sixteenth Annual Report of the Bureau of American Ethnology, pp. 73-198. Washington, 1897.



Courtesy of Carnegie Institute of Washington

(Above) SUNK DEEP in the mesa country of northeastern Arizona, Canyon de Chelly (shown in an aerial view by Col. Charles A. Lindbergh) and Canyon del Muerto hide the secrets of centuries. Here Earl Morris and his companions labored for years to restore the watch tower wrought by Indian inhabitants of America's oldest consecutively occupied cliff dwelling

(Below) LOOKING UP de Chelly, the mother canyon. The Expedition's truck strikes a strange note of modernity among these immense perpendicular walls where ancient Cliff-Dweller Pueblo tribes succeeded even earlier cultures, as the most civilized natives north of Mexico

E. H. Morris

(Below) LOOKING DOWN del Muerto from the watch tower's roof. The scene is approximately that viewed by the early American architects who dwelt in Mummy Cave in the time of Pharoahs and Crusades. Note the autos and tents of explorers grouped within the hairpin turn of the stream

E. H. Morris

The twin recesses of Mummy Cave appear from the valley floor like two black inscrutable eyes set deep into the cliff's face; but to the Indians of long ago they seemed a gift of Providence, scooped out to give them shelter, and they built their Tower House between them

The tower still stands as a monument to their culture. Sheltered in the rounded angle where the huge fin of stone merges with the canyon wall, it has survived for seven centuries and, thanks to reparations by the author and his companions, bids fair to continue for many more

(Below) Failure of the old retaining wall brought on the threatened collapse of the Tower. When reconstruction started, an enormous five-foot-deep ragged hole lay open to the center of the Tower's base, and the front wall, pulled out from the sides, teetered dangerously forward. Here the base stones are shown, poised delicately upon one another. The jarring of one rock beneath them could send 50 tons of wall crashing down upon the workers

E. H. Morris Photos

(*Above*) CONTEMPLATING the task ahead, the archaeologists discuss ways in which modern architectural science can save the remarkable work of some of America's earliest builders

(*Above*) RESPLENDENT in a velvet blouse, with jewelry of silver, turquoise and coral: a comely Navajo and her solemn-eyed baby by the colorful name of Young Eagle visited the explorers' camp

(*Below*) MORTAR CARRIERS by day, these Indians gathered around the expedition's campfire by night to practice their ceremonial dances. Tough as their desert ponies, they proved friendly and hard working

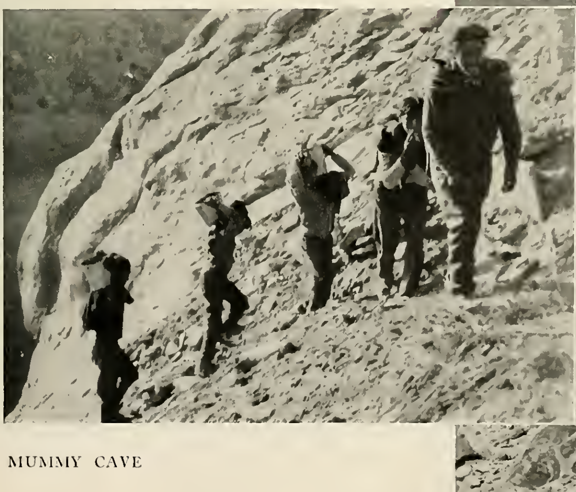
(*Below*) EAGER TO VARY the monotony of corn and mutton, Navajos flocked into camp at meal time, seeking left-overs from the white man's table. Canned peaches were offered as workers' bonuses. All the Navajo men within several miles were hired to carry adobe

(*Left*) CLINGING LIKE FLIES to the steep cliff with its 60-foot sheer drop, the expedition workers start operations on the leaning tower. This view, taken from the talus of the eastern grotto, shows clearly the gap left between the front wall and the rest of the building

E. H. Morris Photos

(*Below*) RUDE SCAFFOLDING erected against the Tower walls provided a more secure footing for the masons. The Tower and its neighboring caves proved to be archaeological treasure houses, replete with cultural relics of the ancient inhabitants. Protected from destroying moisture, their arts and tools as well as their mummies have remained perfectly preserved

(*Below*) BUCKET BRIGADE of mortar carriers. The same stones which the ancients had hewn were gathered from nearby fallen walls to patch up the Tower, but the adobe mud which held them together had to be carried up from stream banks 200 feet below



(Left) PRAYER STICKS fixed in the heart of the Tower wall. Roughly carved to look like serpents by the sandstone tools of the Pueblos, they served as a propitiatory offering to the gods. But they did not succeed in preserving peace in the valley of del Muerto. Grim evidence of strife and bloodshed is afforded by human remains clubbed to bits, found among the debris on the Tower floor

E. H. Morris Photos

(Right) STICKS TIED TO STICKS raised the scaffold ever higher until the final stone was laid in the new corner binding the front wall back in its place. Without the anchorage provided by the jutting ceiling poles left protruding by the aboriginals for ornamental effect, the erection of the scaffold 700 years later would have been much more difficult

(Below) MUMMY CAVE TOWER as it stands today. With the scaffolding removed, the Cliff Dweller citadel resumes the silent vigil it has maintained since long before Columbus. And now the white man after all his destruction of Indian culture has to his credit the preservation of a deathless tribute to the aboriginal

(Below) IN THIS BEAUTIFUL CEILING with its slender peeled willow mats, lay the clue to Mummy Cave's antiquity. From the circular holes at upper left, sections containing the growth rings were removed, and from their evidence Doctor Douglass, famous wood expert, was able to place the construction of the Tower House at 1284 A. D.

demanding task, but I pledged myself to its accomplishment. The opportunity for a beginning came in 1924, when the late Dr. J. Walter Fewkes, the Chief of the Bureau of American Ethnology, made a small grant to be expended upon the most urgent features of repair.

The failure of the old retaining wall was responsible for the threatened collapse of the Tower. Gravity had gradually dragged the top of this foundation wall forward, and as soon as the movement reached to the base it had slithered down the incline to the talus 70 feet below. Pack rats delved in the crannies between the stones, pawing out the sand which filled them, and the gales which for a few days every year howl past the face of Mummy Cave whipped out the powdery refuse earth. Thus stones became loosened to roll over the cliff, until finally there was an enormous ragged hole that reached five feet inward beneath the very center of the Tower. The front wall of the Tower settled, broke away from the sides and began to lean outward at the top. Fortunately large stones beneath each end of it supported the tottering leaf of masonry long after it would otherwise have collapsed.

When Oley and Oscar and I stood ready to begin a new foundation for the Tower, the prospect was not wholly pleasing. From the mouth of the ragged foundation hole that we must fill there was a ten-foot slope so steep that we could not stand upon it, and beneath the brink a sheer drop of sixty feet to jagged rocks below. One of us went down on a rope to set a short timber in a crevice just back of the brink. Behind it he wedged others, laid horizontally side by side, until at the proper height there was a semblance of a scaffold from which we could work in comparative safety. In the steep incline where our foundation was to rest we chiseled steps, so that each stone of our masonry should be bedded flat upon clean, living rock. Very slowly this preparatory phase went forward, because 50 tons of wall loomed 35 feet above us, and if one stone beneath it were to be jarred loose by our hammering we would be crushed like cockroaches upon our flimsy scaffold.

Local materials used

Building stone could be obtained in sufficient quantity from fallen walls in the main grotto near at hand. Adobe mud was to serve as mortar. Once thoroughly dried, it would be nearly as hard and fully as strong under downward pressure as the building stones themselves, and no moisture would ever reach the ledge to soften it again. But this mud could be obtained only at the price of bitter labor. We hired all the men of the Navajo families living within a radius of several miles to carry it up from the stream banks 300 yards distant and 200 feet below, but there were not enough of them to keep us supplied. The clay was tough and stubborn to mix, and the long climb, especially the last end of it up the loose and sliding refuse slope, was hard enough to wind a white man empty-handed. Humanly enough, the Indians could see no reason for hurry, so that for days, no matter how urgently we clamored for mud, a good half of our time was spent waiting for it. Finally I proposed a contract basis for the job—twenty cents a pailful, with a box of crackers and a can of peaches for the one who had made the greatest number of trips by the end of the day. It was amusing to see the transformation. The leather-lunged rascals scaled the slope without a pause for breath, and ran on the down trip. A veritable stream of adobe poured up the cliff and we plied our trowels till our wrists ached in order to use it as fast as it came. It was not long then until the cracks between the stones were filled, and the last wedge was driven between the top of our buttress and the foot of the Tower.

Tethered to the cliff

The front wall had been made secure at its base, but still it was not proof against collapse. A balanced leaf it stood, ten feet broad and thirty high, thus presenting a surface of 300 square feet to occasional gales exerting a pressure of more than 100 pounds to the square foot. These hammer-like gusts tend to set up a swaying motion, which sooner or later would cause the stone-work to crumple at its weakest point. There was a way of lessening the possibility of this. Halfway to the top and equally spaced we pierced the leaf with two transverse bores, and opposite these we drilled holes deeply at a downward slant into the face of the cliff behind. In each drill-hole was set a rod of iron with expanded tip, and the cavity around it filled with melted sulphur, which, when cool, became as hard as the native cliff. These rods were connected by turn-buckles to companion rods passed through the wall. Getting the S-irons in place on the outside of the wall was the only bothersome part of this venture. It was not really dangerous, but by the time one had dangled in space on a rope end long enough to install the plates and turn down the threaded nuts against them, it seemed that a winter wind had been blowing in the August afternoon. Inside the chamber the turnbuckles were tightened until the rods lay straight and rigid as bars of solid steel, and emitted a clear, high-pitched resonance when tapped with the wrench. Now the tower had not only a firm, broad foot in front to stand upon, but was so firmly tethered to the canyon wall that, barring an actual crushing of masonry, it could not sway outward.

Eight years were to pass before our return to fill the great vertical cracks in the side walls and to tie these walls to the front one that already had been strengthened. Meanwhile the scenic splendor of the canyons and their singular richness in archaeological remains had become more widely known. As a result, after permission of the Navajo Tribal Council had been obtained, the de Chelly Canyon system was set aside by presidential proclamation as a National Monument, thus falling under jurisdiction of the National Parks Service. In 1932 Mr. Frank Pinkley, Superintendent of Southwestern Monuments, could spare a small allotment to complete the repair of the Tower, and Carnegie Institution granted me time for the work. So by mid-September Oley, Oscar and I were back on the job to begin where we had left off in 1924.

As we examined the structure minutely to lay our final plans, we could find no good reason why the Tower had not fallen long ago. Each of its three man-made walls stood practically as a free unit, like a tall, thin book set on end. True, the front wall was somewhat braced by our draw bolts, and the supporting timbers of the second and third ceilings provided a flimsy cross tie between the side walls. However, these devices were not enough to impart rigidity to the various elements, as we learned one day when a strong gale blew. Above the roar of the wind, creaking was audible in the cross timbers, and a spread hand held against either side wall plainly felt the tremor that resulted from each terrific gust. Would the weakened masonry sustain the tugging of the necessary scaffolds and withstand the vibrations of our hammering? Only time could give the answer.

The east corner had broken free from both the side wall and the front, and had leaned outward and hurtled down the cliff. We dug as deeply as we dared into the loose mass of rock fall upon which it had rested, then filled the pit to floor level with long stones laid in rich cement. Upon this relatively substantial foundation we began to rebuild the corner, binding the new masonry firmly to the old. Thus, by the time it had been raised as high as we could reach, the structure was to some extent consolidated and better able to sustain the scaffold that must now be raised.

Scarcity of wood

Sawed timbers freighted all the way to Mummy Cave would have cost more than the total of our small appropriation. Nature must supply our needs. The Indians have scoured the slopes for trees straight enough and long enough to be of use in the building of their *hogans*. But in a cove just beneath the rimrock a mile downstream we found two dead firs that had fallen in a thicket and been overlooked. They were seasoned, light in weight, and nearly 30 feet in length—just what we needed for uprights. With long ropes the Navajo hitched them down the ledges to the canyon floor, then carried them to their destination. From oak trunks left by strong freshets in the stream bed, we split rude planks for floor boards and cross pieces to support them.

Unknowingly the builders had done us a good turn. Presumably for ornamental effect they had allowed the round pine joists of the second ceiling and the roof to protrude nearly a yard beyond the walls, leaving us purchase for a scaffold. Placing of the scaffold fell to the lot of Gustav, the Norwegian, whose ability I knew from the many problems we had met and solved while rebuilding the Temple of the Warriors in Yucatan. Agile as a fly, fearless as the tides of his Arctic homeland and intelligent to a rare degree, he was several men rolled into one. Aloft he went on a rope end and in a few hours, to the astonishment of the Indians who had lugged our unpromising assortment of sticks and tree trunks up the slope, he had lashed them together skillfully as a spider weaves its web, forming a structure that was crazy looking but as firm and solid as the Tower itself. How solid that might be was the only disturbing question.

On the scaffold there was room for but one mason and a helper to draw up stone and mortar for him. I chose the scaffold. Oley set to work sealing the breaches in the western wall, and Oscar remained below to select for me stones of the shape and size needed for each particular unit.

Painstaking work

The task before me was an exacting one. To the last detail the new corner must duplicate in appearance the old masonry and it must be in effect a rigid monolith, not only supporting itself but binding together the ancient walls like an angle iron at the corner of a packing case. To make each stone contribute its share required constant attention to technique and made the work aggravatingly slow. For the face we would use only stones cut by the ancients. Picked up elsewhere in the cave, most of these had been chipped and broken at the corners in falling. Hence the ends of nearly every one had to be spalled off in order to permit a close fit. Moreover, the blocks were dry as sponges, hence had to be soaked before being laid. Otherwise they would have sucked all moisture from the cement mortar before it set. And the ends of each new course must be securely tied to the ragged stubs of the ancient walls. This was fortunately facilitated by a habit of the ancient builders of laying their face courses with never a "header" or cross tie to bind the two shells together. The faces had sagged apart enough partially to loosen the filling of small stones and mud which had been poured in between. This material I worked out as far back between the face courses as my arm would reach. Because I dared not pound or pry, their removal was as tedious as picking meats from the shell of a black walnut. Tiny rock squirrels had filled all cracks with cactus spines, acorn shells and the fuzz of their nests. This prickly material had to be clawed out, usually with the fingers. Then when stones had been moistened and the cavities crammed full of rich cement and small stones, the new elements became inseparably welded to the old walls by much the same process that a dentist uses when anchoring a filling in a tooth.

Day by day the Navajo toiled up the trail from the creek bed with sand and water, and day by day the new corner rose nearer to the top. Each nightfall the Tower was stronger than at the previous sunset, and finally there came the time when I knew that danger of collapse had passed. Surprises were in store for us, but not of an unpleasant nature.

One afternoon Oley brought me a slip of age-yellowed note paper and a curiously carved stick which he had found in a crevice in the western wall. On the paper was written:

> *Jer: Sullivan M.D.*
> *Alex M. Stepen. A.M.*
> *September 2" 1885*
> *Sketch, etc.*
> *I. K. Westbrook Aug. 29, 1915*

(The last line in a different hand.) While Sullivan and Stepen were not the first white visitors, no earlier names or dates have thus far been found written in Mummy Cave.

Prayer sticks

The piece of carved wood, about a foot in length and brown from age, was far more ancient. Its surfaces showed plainly the marks of the rasping implement of rough sandstone with which the Pueblo had shaped it. One end of the cylinder thinned abruptly to a blunt point, while the other was graven into a rough semblance of a serpent's head. It was a *paho* or prayer stick of a type common in Mesa Verde, former home of the builders of the Tower.

Later we discovered that prayer sticks of this sort had been set in the outer faces of both side walls at the level of the second and third ceilings, and a whole series of them had extended from the top of the front wall no telling how far toward the base, in definite, overlapping sets. Each set was composed of two of the serpent-like sticks to the heads of which were bound pairs of twigs shaped like miniature bows. Parallelling each serpent was a slender withe bent at the tip to the form of a shepherd's crook. Two years later, my keen-eyed helper, Al Lancaster, spied a vertical alignment of prayer sticks identical in shape and grouping, in a crack in the front wall of Balcony House, Mesa Verde. This fact would strongly suggest that Balcony House had been the previous home of the immigrants who built the Tower House in del Muerto.

After the last stone had been laid in the coping of the Tower, we began to clear out the débris inside the structure. Strewn about on the floor were the dismembered skeletons of several persons, the skulls and long bones clubbed to shreds. Such evidence of frenzied savagery dispelled all possibility that the Pueblo exodus from Mummy Cave had been a peaceful one. While the time of that exodus can be fixed only approximately at about 1300 A.D., the exact year of construction of the Tower House is known—1284 A.D.

The tree-ring calendar

In many the question will arise, "How is it possible definitely to date the works of a people who left no written records or even traditions that have survived?" Thus far it cannot be done for any other archaeological area than the northern Southwest, but for that district there exists a time record reaching far back into the centuries, more exact than any kept by man in comparatively early times. Nature laid down this record in the annual growth rings of coniferous trees, and at last there came a scientist who deciphered the code. In so doing, Dr. Andrew Ellicott Douglass accomplished one of the outstanding intellectual feats of the century.

Searching originally for rainfall records more ancient than had been registered by man, Doctor Douglass turned to the growth rings of trees in the marginal forest area where they could be expected to show a very sensitive response to relative precipitation. After years of study it was confirmed that over the entire sweep of the Southwest normal growth had been identical, and the ring pattern was carried back more than 600 years. Beyond this the span of living trees did not reach. In quest of still more ancient timbers, Doctor Douglass turned to beams in the ruins which abounded in the region and were no one knew how old.

The first archaeological timbers to fall beneath his glass were provided by the American Museum of Natural History from its excavations in Pueblo Bonito and the Aztec Ruin, New Mexico. Soon Doctor Douglass announced that beams from the Aztec Ruin had been cut on the average 25 years later than those from Pueblo Bonito. While it was known from materials exhumed that the two great structures were culturally contemporaneous, here was a degree of exactness previously undreamed of.

Spurred by these findings, Doctor Douglass, by 1929, pieced together a ring record for a 500-year period that fell somewhere beyond the nether limit of his historic series. In that year were found the timbers which joined the two, and then came a letter from Doctor Douglass stating that the sections which Gustav and I had taken in 1926 with a tubular saw driven from periphery to heart of every ceiling support in the Tower, were all from trees felled in 1284 A.D.

That was the most recent construction date for Mummy Cave, but our hope reached forward to the day when the ring record would be extended far enough into the past to reach some of the Basket Maker habitations that underlie the masonry houses in the eastern grotto. That hope has been realized. Doctor Douglass has pieced together by shingle-like overlap the growth pattern back to the year 11 A.D. That does not mean proof of the presence of man in the canyon shelters that long ago but that the oldest timber so far recovered began its growth in that year.

The earliest positive cultural association is at 477 A.D., at a time when house building and pottery making already were well under way. There is an older cutting date, 348, from a loose pole found high in the talus in front of Mummy Cave. Since it was not incorporated in any sort of structure, there is no check as to the culture stage to which it pertains. Nevertheless, it leaves no doubt that someone was living in the cave at that time, and its position in the refuse dump gives strong evidence of much earlier occupation. It seems safe to postulate, indeed, that 300 or 400 years would have been necessary for such a volume of sweepings and ashes to accumulate.

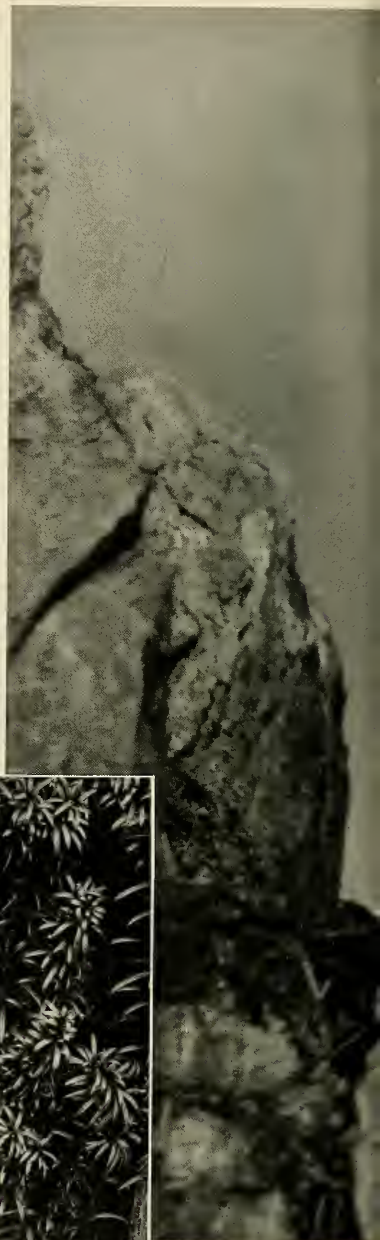
Thus it seems very probable that some group of aborigines had established themselves in the canyon retreat by 1 A.D. Be that as it may, discounting the debatable first three centuries, the span from 348 to 1284 places Mummy Cave as the longest consecutively occupied dwelling place yet known in North America. Naturally we hope that it will remain intact a long time to come.

SALON PHOTOGRAPHS

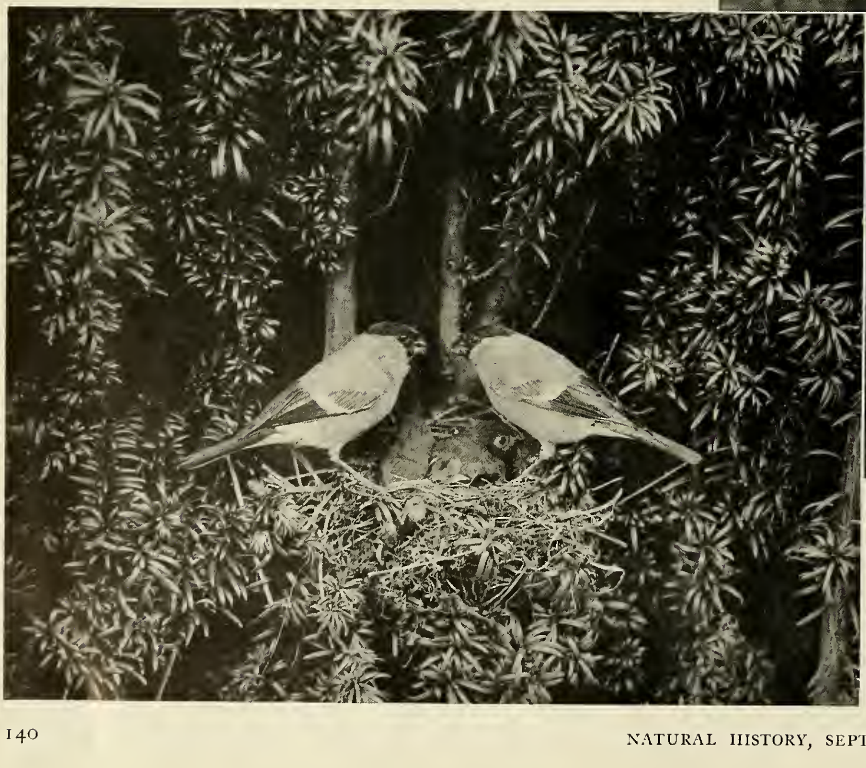
The following camera studies of wild life were recently exhibited among others under the auspices of NATURAL HISTORY MAGAZINE at the American Museum, to illustrate the extraordinary advances that have been made in the technique of animal photography. They are part of the International Exhibition of Nature Photography held at the Museum of Natural History, London, and organized by the British periodical COUNTRY LIFE. The collection was brought to America by the American Federation of Arts.

CORMORANT—A RESTING ATTITUDE RALPH CHISLETT

GANNET PUTTING ON THE BRAKES



COCK AND HEN BULLFINCHES IAN M. THOMSON



Niall Rankin

Penguins • A. Saunders

Lions • Frank Anderson

TIGER • F. W. CHAMPION

GREY SEAL • FRANCES PITT

THE INDOOR EXPLORER

Master Miniature Builder

Some years ago a small boy wandered into the dinosaur hall of the American Museum. Many boys have done that before and since this particular time and many of them have had their imaginations fired as his was by the weird titans of the earth's past that are gathered in that place. This boy had a talent for drawing and modeling and when he returned to his Minnesota home, he began to make sketches and sculptures of the things he remembered seeing in the dinosaur hall. Doubtless other boys with similar talents have done likewise. But most of them eventually drifted into other things and in time the dinosaur hall and what it inspired them to do became only distant memories. But this boy kept on with his hobby. In the local library he found books on the animals of prehistoric times. Some of these books supplied him with the actual dimensions of extinct creatures, but others, in the fictional genre, stimulated him to imagine monsters far more staggering in size and far more terrible of mien than those the palaeontologists have been able to reconstruct. The boy developed a fetish for bigness. His models grew ever larger and, though the scientific aspects of his work suffered, his modeler's fingers became nimbler and his sketching pencil always more articulate.

Come of age

Today that boy is back in the American Museum. He is still making things bigger, but there is a difference. His name is George Henshaw Childs, and his modeler's skill is supplemented now by a sound zoological training, as evidenced by a Ph. D. from the University of Minnesota, where he also taught, and by fourteen years' experience in the invertebrate laboratory of the American Museum. Now instead of fabulously expanding the already enviable size of dinosaurs, his talents have found a more mature and far more valuable outlet in constructing enlarged models of, oddly enough, worms. This he does with absolute fidelity to the tiny original and with the scientist's nerve-straining insistence on detailed authenticity.

In his boyhood days, worms would have served him for little else than to bait fish. But to the boy become zoologist they have quite another significance. At this writing, for instance, Doctor Childs, under the direction of Dr. Roy W. Miner, is modeling from a very small and, to the uninitiated, very unimpressive proboscis worm which rejoices in a longish "nose" and the somber scientific name of *Dolichoglossus*. Like his previous and now zoologically famous enlargements of *Amphioxus*, this model is the result of exhaustive research on the Protochordates, a section of the animal kingdom which, structurally, seems to occupy a twilight zone between the lower invertebrates and the dawn of creatures with spines.

The small, crawling proboscis worm and its allies have inhabited the salt water mud flats of most of the earth, endlessly reproducing their unchanging kind, for millions of years. For although no fossils of this soft-bodied animal have been found, it is probable that they have remained comparatively unchanged since early Paleozoic times.

Here is perhaps a subtler phase of prehistoric investigation. Proboscis worms have little immediate appeal to the imagination, and there are no rare expeditionary finds, since countless living specimens are today available in nearly every bay and harbor. Yet that ancient zoological secrets may be locked within the confines of their innocent-appearing tissues, is seldom questioned by those who have investigated their flacid anatomy under the microscope. Like Doctor Childs they know that by prying relentlessly into the exact process by which these creatures contrived to merge the characteristics of both spined and spineless animals, a significant beam of light may be thrown along one of the darker paths of evolutionary development.

Art and Science

The nature of such investigations is curiously indicative of the personality of the investigator. For Doctor Childs himself represents a merging of characteristics. The free-flowing imagination of the artist grown to maturity has been stemmed and parceled into the ordered channels of science. And the zoological discipline is an exacting one. It takes him an entire year to complete a single model as complex as the proboscis worm.

First, he must cover thoroughly all available literature on the subject, jotting down notes on everything that he can possibly incorporate into the model, next many specimens of the

---

(Left) Circling Heron
By
Hugo Adolph Bernatizik

worm are submitted to the powerful lenses of the microscope under which the meticulous hair splitting dissections are made. Once this stage is finished the artist's materials are assembled and work begun on the elaborately colored, tenuous-lined drawings which will serve as a sort of blueprint for the finished model. Then impressionable plastiline takes shape under his sculptor's hands and a plaster mold is cast. Into this mold pure beeswax is poured and allowed to harden until the ingeniously fashioned plain model is formed—accurately scaled up to a dozen or more times the creature's natural size and ready for the color finish. Working from the drawings Doctor Childs then carefully paints onto the wax the colors used to designate each section of the proboscis worm's anatomy. These colors are not, the writer learned to his surprise, the true colors of the living animal's organs. Doctor Childs acknowledged that it was strange to find a scientist attempting to improve on Nature, but hastily denied any suggestion that he was perhaps returning to the imaginative creations of his boyhood. It seems that Nature simply doesn't arrange her color scheme for the convenience of those studying animal anatomy. It was, therefore, found advisable in constructing students' models to provide a sharply distinguishable but wholly arbitrary color key—black for nerves, chrome yellow for digestive tracts, etc. This color key was compiled long ago by Dr. Roy Waldo Miner, Museum Curator of Living Invertebrates, in whose departmental work Doctor Childs is engaged.

For the fit though few

It is a red letter day for all zoology classes in nearby schools and colleges when one of Doctor Childs' completed wax models is at last unveiled to the public. The disinterested observer without knowledge of the creature's significance derives small benefit from the model, but it is a perfect method of teaching the student and, in making the models, Doctor Childs draws heavily on his experiences with student difficulties during his teaching days at Minnesota.

Asked if the proboscis worm was like a leech, or possessed of any other habits obnoxious to man, Doctor Childs pronounced it perfectly harmless.

"The only objectionable thing about it is a rather irritating smell," he explained, "which is due to the fact that it secretes a surprising amount of iodic acid—that's the stuff iodoform is made out of, you know."

"Then it might be of commercial value?"

"It might, at that," Doctor Childs replied, "and there's a good idea for

someone to look into. As far as I know, no one has done anything about it yet."

Staring at the nearly finished wax model, with one eye on the color chart, the writer remarked that judging from the size and appearance of the digestive tract, the proboscis worm must be a pretty heavy eater.

"That's right," Doctor Childs said, "most worms are."

It developed that Doctor Childs had spent a great deal of time on these necessary food organs. His doctor's thesis was on the digestive tracts of thousand-legged worm-like millepeds, and later in his Museum modeling exploits, he has had the task of working in the very impressive equipment of the proboscis and other worms in considerable detail. He emphasized, however, that the parts he is particularly stressing in his *Dolichoglossus* model are the fish-like pharyngeal gill openings and, of course, the evolutionarily important rudimentary forerunners of a vertebrate dorsal nerve cord and backbone.

A home career

Yet the boy who loved to draw fantastic dinosaurs has not been entirely engulfed by the sober requirements of science. He still has the urge to create things for his own amusement, and he does this now on his spare time in his Brooklyn home. But here the artistic problem is curiously reversed, and he departs from the exacting job of making things bigger, to the perhaps even more delicate process of making things a great deal littler.

It all started when a museum colleague of Doctor Childs' who had made a temporary hobby of building small but highly detailed replicas of his New York apartment, requested him to model miniature reproductions of the moose heads that decorated his fireplace. Doctor Childs obliged and was so pleased with the result that it was no time before he was experimenting with tiny miniature animals of his own. So the boy who had sketched the bones of mounted dinosaurs on such an enormous scale that he had droves of curious little humans climbing steep staircases into the imaginary animal's chest cavity and even making their way along precarious cat-walks to the tremendous brain chamber, now turned to the more sophisticated hobby of reducing actual animals to their smallest recognizable size.

In making these intricate miniature models, Doctor Childs' artistic talent still shows the effect of its merger with the scientist. The little models do not duplicate in microcosm the grotesque caricatures of his childhood but are orthodox animals accurately scaled down with the most restrained precision.

Inspired by the majestic sweep of the many large museum habitat exhibits, Doctor Childs broadened his field to include whole groups. He fashioned his own idea of an African water-hole group similar to the one in Akeley Hall and equipped with an interior electric light bulb, but like all his creations, by no means a direct copy.

Humble materials

In time his increasing skill with diverse materials became little short of miraculous. Ground glass was magically transformed into a carpet of powdery snow on which caribou, bears, lynxes and other North American animals stood among sharply etched paper evergreens against a background of frosty hills. Strips of celluloid became still, transparent, pond water for a pair of grave blue herons only an inch tall peering into the clearly detailed crystal depths intent on tiny fish. Tom Thumb lions sprang out upon startled, rearing, zebras from amazingly realistic veldt grass which began as a wisp of yarn in Mrs. Childs' skillful fingers; for she helps, too, knotting bits of grocers' string into tiny bushes to be passed on for her husband's coloring treatment. Ordinary paper is snipped out into shining green leaves, then fixed on slender limbs while, an iridescent kind of glue gives the effect of recent rain not yet absorbed by a field of tall grass, where pea-sized quail and their ultra-diminutive chicks are hiding.

All his animals are begun by twisting an armature of wire into the required shape, then small tools and brushes are put to work dabbing on gobs of liquid plaster which are molded slowly into the form of the creature desired. Oil paint brings out the details, and when the wonderful little backgrounds are wrought out of their humble materials the finished animal is ready to assume his place in the group.

The artist's problems

Doctor Childs finds that he can finish a bird either in flight or in a perching position in much less time than is necessary for mammals. The latter, whenever they are shown in action and particularly in those cases where members of the cat family are depicted, demand much patience and a very definite skill in order to suggest on so small a scale the subtle play of their muscles. But of all the artistic problems to which he has set his hand, Doctor Childs feels that capturing the true essence of the human form in miniature is by far the most difficult. That he can do this, successfully however, is evidenced by

his figurine of a dancing girl, for which Mrs. Childs, a former Morgan dancer, posed. This was done purely for his personal amusement, and, delighted by the results, Doctor Childs pressed on to even more difficult conquests. A very elaborate figure of Shan-Kar was next attempted. This involved scaling down to the restrictions of a bare two inches all the poetry of motion implicit in the gestures of that great oriental dancer. Not only is the graceful attitude perfectly reproduced in miniature, but Doctor Childs has completely duplicated the exotic costume. The skirt is of tissue paper stiffened by shellac, in which multicolored threads were pressed while it was still damp. Delicately Doctor Childs manipulated these almost invisible threads until the Hindu mosaic of the design was completed.

Of all the models which Doctor Childs has produced, those in the game bird series—ornate little things, with the male and female bird and often their young surrounded by a rich natural background—have been among the most attractive from a popular standpoint. These and other models that he has exhibited or sold from time to time have won him considerable fame. He has been approached by various committees with ideas for placing his work on widely distributed public exhibition and some are already on display in the Chicago Historical Society. Such exhibits enable people to see at a glance what it would take them days to cover in a regular museum. And those who have an eye for perfection on a small scale, can find nothing short of marvelous the work of this master miniature builder.

—D. R. Barton.

Intelligence Test for This Issue

A few informational highspots that may be gleaned from this month's NATURAL HISTORY

Score 10 points for each correct answer. Correct answers on page 153

1. For what has helium been used as a substitute in deep sea diving?

2. Are the "bends" caused by: *lack of vitamin A, an excess of nitrogen, insufficient oxygen,* or *lead poisoning?*

3. Where does agar-agar come from?

4. Which is the poisonous snake on the cover?

5. Can a beaver cause a tree to fall in a given direction?

6. Does the beaver use his flat tail to plaster mud on his dam?

7. For what novel by Conan Doyle is Mt. Roraima the supposed setting?

8. Mt. Auyan-tepui is important as: *an active volcano, a primitive counterpart of Mt. Olympus, a biologic isolation zone,* or *a burial place for Indian chiefs?*

9. The Basket Makers were: *the Aztec slave caste, the oldest known colonizers of the northern Southwest, modern Indians of any tribe who make wares for sale, the last tribe to come under governmental protection?*

10. Beaver can remain under water for *5 minutes, 11 minutes,* or *indefinitely?*

YOUR NEW BOOKS

NEWTON, PHYSICIST & METAPHYSICIST • BIRDS IN LIFE AND LETTERS • THE COMPLETE GEM CRAFTSMAN • MASTER BUILDERS OF SIXTY CENTURIES • SNOW ON THE EQUATOR

ISAAC NEWTON, 1642-1727. With a memoir of the author.

------- by J. W. N. Sullivan

The Macmillan Company, $2.50

TO paint an adequate picture of the great Newton in a volume of 275 pages is an achievement, especially as it has been done in a most readable, non-technical style. One can well believe that the author spent ten years and more in the preparation of the book, as stated by Dr. Charles Singer in the introductory memoir. J. W. N. Sullivan died just after the completion of the biography.

It is evident that the author in his research became thoroughly familiar with everything that Newton wrote and with all of importance that has been written about him. After assimilating this mass of formidable material, he has told his story as only a student with great understanding of mathematics, physics and astronomy could tell it, and, at the same time, only as one with fine literary ability and rare skill in popularization could present it. It is a fascinating story, and we are told that it owes a good deal to the inspiration and encouragement of the author's friend, Sir Arthur Eddington.

Newton, probably the greatest mental giant of all time, wrote to Hooke, "If I have seen farther, it is by standing on the shoulders of giants," and this modesty was characteristic and genuine. He was quiet, a good deal of a recluse, apparently with no capacity for deep friendships, with little tact, and with not much of social grace. He never married, or had any love affairs. He lived to be eighty-five and was in excellent health generally, except for one brief period when his intense mathematical work drove him to the verge of a mental break.

Nearly all of Newton's scientific work was accomplished during the first half of his life, and this work includes what the author designates as "three of the greatest discoveries in the history of scientific thought, the Differential Calculus, the Composition of Light, and the Law of Gravitation," as well as the writing of his monumental *Principia*. The surprising characteristic of Newton is that he never appreciated the importance of his scientific work. But he was a genius, and could not keep away from these problems at times working with great intensity. Our author states in relation to his work on the *Principia,* which Newton wrote in seventeen months, "He now enters on a period when his personal will, his own preferences and distastes, hardly seem to be concerned. He behaves like a man dominated by an irresistible force. And it did not relax its grip until it had pushed him on to the accomplishment of the greatest intellectual feat of his life, the greatest intellectual feat in the history of science."

During the last half of his life, he gave much thought to theological questions and to mystical meditations. His idea of God and the cause of gravitation and other fundamental phenomena are better understood in the light of his day. His feeling that science was relatively unimportant is indicated by the famous remark he made a little before his death, "I do not know what I may appear to the world; but to myself I seem to have been only like a boy playing on the sea-shore and diverting myself in now and then finding a smoother pebble or a prettier shell than ordinary, whilst the great ocean of Truth lay all undiscovered before me."

"The paradox of Newton's scientific career is due to the fact," as this biographer says, "probably unique in the history of scientific men, that he was a genius of the first order at something he did not consider to be of the first importance."

CLYDE FISHER.

THE SKY'S THEIR HIGHWAY

------- by Kenneth Williamson

Dodd Mead and Company, $3.50

IN a circumscribed area of limited extent, a naturalist has the opportunity to become familiar with the feathered inhabitants of his region in a way that is not feasible for one who ranges more widely. Not only may he learn to know all the species that visit or permanently reside in his bailiwick but he becomes acquainted with some of the individual birds which he often comes to know by certain special features of appearance or personality.

Mr. Williamson's book concerns a certain portion of Lancashire, not far from Manchester, in England, and of this he writes with unusual familiarity, calling it his "Selborne" in allusion to the locality made famous many years ago by Gilbert White who wrote so charmingly of the natural history of that little village in Hampshire. The author's "Selborne" is of a different sort than Gilbert White's, being set near an industrial center, blighted by the smoke of factory chimneys, and with the meandering river tainted by adjacent sewage works. That the author has made the best of these unfavorable conditions is aparent to anyone who reads his book; in fact, the reader would not realize that the region were at all unfavorable did not the author call it to his attention. The keynote to the author's success is best illustrated by quoting from his own remarks.

"Often the commonest birds are the most entrancing, offering as they do almost unlimited opportunities for close attention and a deeper association than can be achieved with the rarer species. Those who, loving Nature, find themselves in an impoverished countryside, should not despair, feeling that Nature's best is banished: there is a mood that sees much of value in very little, and in the study of the wild that mood is not at all difficult to attain." In an earlier paragraph he says: "I like to think that had White been fated to live in such a district, he would still have been the Gilbert White we know and love."

There are many descriptions of nests, eggs, and downy young; the etymology of the common names of various familiar species; experiments to determine whether certain individual Lapwings had predilections for particular arrangements of the eggs in their nests (which, it was found, they did); the observation of cygnets sometimes using but a single leg for swimming; the note on young swallows of the first brood helping to feed the nestlings of the second brood; the gathering of the birds in preparation for their fall migration. Throughout the book there runs also the story of a young Tawny Owl that was found with an injured wing and nursed back to health and eventual release to take its place in the natural world of its species.

The author is a believer in the existence of some powers of reasoning in a bird's mentality apart from its instinctive behaviorisms and presents many incidents in support of his belief. Not all biologists will agree with his conclusions but the incidents are none the less interesting on this account. There are other speculative passages relating to migration, flock-movements, and other activities that may or may not offer the correct solutions to some of the mysteries of bird-behavior, but it is not always easy to say why they may not, after all, be as correct as alternative explanations which have been presented elsewhere. There is still much to be learned of how and why birds do certain things.

As to the author's style of presentation, there can be nothing but praise. The account flows smoothly on its way with description, anecdote, and general discussion but with little of detailed statistics that might prove dry and dull to a non-ornithological reader. Anyone who is at all interested in the natural history of an English countryside may pick up the volume with the assurance that he will find full enjoyment in its perusal.

J. T. Z.

A BOOK OF BIRDS

---------- by Mary Priestley

The Macmillan Company, $2.50

FOLLOWING an awakened interest in birds, the compiler of the present anthology commenced the collection of descriptive passages and accounts of birds in prose and verse, both ancient and modern, that seemed to her of particular interest. The volume here presented is the result of this activity.

There appears to be special emphasis on the writings of a few authors like Hudson, Gilbert White, Robert Lynd, A. R. Wallace, Donald C. Peattie, G. M. Levick, and Edmund Selous but there are over ninety authors in the complete list, which thus covers a moderately wide range of literary effort going back as far as the Pentateuch of the Old Testament.

Admittedly a scrapbook, the reader may browse through selections which are all interesting, many of them being classics either by themselves or by virtue of the work from which they are extracted.

Separate indices of the authors and of the various birds make it possible to find any wanted selection with a little effort.

Eighty-two woodcuts, full page and otherwise, by C. F. Tunnicliffe, enliven the volume.

J. T. Z.

JEWELRY, GEM CUTTING AND METALCRAFT

------- by William T. Baxter

Whittlesy House, McGraw-Hill Book Co., $2.50

THIS manual of fine metal working contains detailed instructions which enable the amateur to develop his technique in the manufacture of jewelry and metal work without the benefit of class instruction. The author, William T. Baxter, is Instructor in Art Metal and Jewelry at the Woodrow Wilson High School, Washington, D. C. He has clearly drawn upon his classroom experience in writing the book, for it shows an appreciation of the difficulties of the tyro who knows nothing of the terms or technique of the trade. The first section deals with metalcraft, the manufacture of simple, and unattractive, things from copper. They are, nevertheless, useful practice pieces preparatory to more advanced work.

The second section tells in equal detail, and in the clearest possible way, the steps in the manufacture of silver jewelry. The different types of equipment are discussed and suggestions made for the right torches for use under varying conditions of work.

The third section deals with the cutting and polishing of cabochon stones. The treatment is more sketchy and requires more understanding on the part of the reader. Facetted stones are dismissed with a paragraph, though the average amateur will soon lose interest in cutting the rounded shapes. Though very helpful, especially in mentioning the names of materials, and in the glossary which gives a list of supply houses where the equipment necessary for the work described in the book may be obtained, further instruction would be necessary for the average beginner.

The same is true of the additional section by H. C. Dake on the identification of gem stones. Without discussing gem stones in general, he gives a list of the various methods of testing stones to determine whether or not they are genuine. No attempt is made to give the characteristics of the common gems, except by inference, but the chapter serves as an excellent supplement to some of the better known books on gems in which the subject of imitations is but briefly treated.

A man in Mr. Baxter's position is probably better qualified than the average jewelry maker to write such a book, and he has done it very well.

F. H. Pough.

MASTER BUILDERS OF SIXTY CENTURIES

----- by John Anderson Miller

D. Appleton-Century Co., $3.00

IN a series of clearly written, entertaining chapters the author tells the story of the great engineering triumphs of the ages: the Great Pyramid, the Hanging Gardens of Babylon, the Temple of Diana at Ephesus, the Chinese Wall, the Roman aqueducts and military roads, the medieval cathedrals, the Mayan temples, the lighthouse at Alexandria, the dykes of Holland, the Atlantic cable, the Brooklyn Bridge, the Panama Canal and many other examples of man's ingenuity; a fascinating story of these great structures of ancient times with a background of their purpose and influence on the life of their time and subsequent civilizations.

Written by a civil engineer who has delved into ancient and medieval history, the terminology is non-technical, so much so that no hint is given as to the extent to which mathematics entered into the design of the ancient structures. Some mathematics certainly were used for all the structures but it is evident that little was known of the strength of materials until recent times.

The reader is impressed by the marvel of large scale quarrying and rock excavation work carried on without explosives or hard steel by the feat of raising great masses of materials and single heavy units, such as the Egyptian obelisks, with only the inclined plane as a hoisting medium; by the difficulty of transporting vast quantities of materials with no other power than that of man and beast and, in some cases, with no knowledge of the principle of the wheel.

Most of the ancient monuments were in course of construction for many years and required great armies of workmen. It is interesting to speculate on the high degree of organization required under such circumstances. The author gives some facts on this in his account of the Great Wall of China. Construction progress was more or less subject to the labor requirements of agriculture and to the economic resources of the builders.

The purposes which inspired the building of most of the ancient structures were essentially the same as those of today, that is, religion, civic and national needs, defense, aggression, splendor, flood control, sport and entertainment.

The destruction of most of the great monuments was brought about by war, earthquakes, vandalism, removal of materials for other structures, and neglect.

The book brings into focus the relation of the modern science of engineering to the early art of construction and gives the reader a fine insight into the civilizations which preceded our own.

R. P. Johnson.

SNOW ON THE EQUATOR

---------- by H. W. Tilman

Macmillan Company, $3.00

FOR those who lament that the "pioneer fringe" has all but disappeared, a most refreshing prospect will be found in H. W. Tilman's light-hearted account of his life in Central Africa during the years which followed the World War. Tilman found himself the proud possessor of a square mile of Kenya jungle, the first view of which he obtained from the top of a tree. He climbed down and spent the next ten strenuous years of his life in hewing for himself a coffee plantation from this very jungle.

Snow on the Equator, as the name implies, is a book of great contrasts, dealing as it does with a remarkable series of adventures, whether on snow-capped peaks rising out of steaming forests, stalking bull elephants in bamboo thickets, prospecting for gold or, alone, forcing a bicycle for 4000 miles across the rutted sandy wastes of Africa.

Tilman presents a fine picture of the life of a pioneer planter in one of the most diverse and fascinating parts of Africa. The accounts of his experiences while hunting elephant and rhino verge on the incredible, and were it not for the reviewer's personal acquaintanceship with the author and his innate modesty, I might be tempted to ascribe these tales to an overly fertile imagination. The student of natural history will find much to absorb his attention in this part of the book.

For the reader who delights in the lore of the mountains, the book will have much to offer. Tilman, with one companion, accomplished ascents of the greatest peaks of Africa, Mt. Kenya, Kilimanjaro, and Ruwenzori. He was perhaps unknowingly preparing himself for even greater exploits among the snows of the Himalayas and, ultimately for the greatest honor to which a mountaineer can attain, the leadership of a Mount Everest Expedition, which is at present attacking the greatest of all peaks.

Snow on the Equator is a tale for any taste among those who like adventure of the truest and most whimsical sort, told with a remarkable vividness and a delightful yet casual humor. One finds here an intimate and accurate picture of the heart of the great African continent. As Tilman writes in his closing chapter, "If she (Africa) had not given me the fortune I expected, she had given me something better—memories, mountains, friends."

ARTHUR B. EMMONS, 3RD.

EVERYMAN'S WILD FLOWERS AND TREES

- - - - - - - - - by Miles Hadfield

E. P. Dutton & Co., Inc., $2.00

IN this small field guide to the common trees, shrubs, ferns, and non-woody plants found in the British Isles it is of interest to note that many plants such as *Malva rotundifolia, Geranium Robertianum,* or *Plantago major* are native to both continents. Others have been transplanted either from Europe to our country or in the reverse order. Many of our English ancestors brought over condiment and common garden flowering plants to give an "old home feeling" to their new surroundings. Later these escaped from the confines of a garden and have become naturalized citizens, some of which have added pleasure while others are a detriment to the country. No doubt the British also rue the day when some of our plants found footing in their territory, for a plant out of its environment ofttimes becomes a pest.

The 384 colored illustrations taken from Sowerby's *British Wild Flowers,* are of the old type of stilted drawings which lack detail for separation of closely related species, but the black and white line drawings which number over a hundred have good definition.

This book with its descriptions and illustrations of five hundred of the more showy British plants would be most valuable to those who expect to travel in Europe.

FARIDA WILEY.

YUKON VOYAGE

- - - - - - - - by Walter R. Curtin

The Caxton Printers, Ltd., $3.50

WHEN George Carmack and his two Siwash brothers-in-law, Skookum Jim and Tagish Charley, discovered gold on Bonanza Creek on August 17th, 1896, the greatest gold rush in all history began. Almost over night the Klondike became the end of the rainbow for adventurers from every land. Pat Galvin, a former City Marshal of Helena, Montana, typified the grand-scale promoter of his day. Fresh from the gold fields, and pockets bulging with nuggets, he founded a British-American trading company with the intention of establishing stores, banks, and hotels for the miners throughout the North. He purchased the river steamer *Yukoner* late in 1898 and his first cargo of supplies started up the Yukon River for Dawson. One misfortune after another caused so much delay that the party was frozen in and was forced to winter on the Yukon some fifteen hundred miles from their destination.

Among the inexperienced traders and crew aboard the *Yukoner,* where strife, much unpleasantness, and mutiny prevailed, Walter R. Curtin alone, with a sense of humor and a genuine love for isolation and wilderness, kept a copious record of the whole adventure. *Yukon Voyage* is mainly a compilation from his journal. It is filled with the routine happenings during the long winter's stay and during the trip on up the Yukon the next spring, which ends at Dawson with the complete failure of Pat Galvin's dream. Mr. Curtin is concerned primarily with the people on the boat, even when they go ashore, and only one or two of them are really interesting. The story is fascinating although admittedly prosaic. Also, one cannot help feeling that the author has given too little attention to the country itself and to the life in Dawson and in the other villages along the river.

The book is worth reading, and the numerous reproductions of early photographs, and an extensive and well illustrated appendix on Yukon River boats are of considerable historical value.

ERICH M. SCHLAIKJER.

QUARTZ FAMILY MINERALS

by H. C. Dake, Frank L. Fleener, and Ben Hur Wilson

Whittlesey House, McGraw-Hill Book Co., $2.50

THIS latest mineralogical book is intended for the ever-increasing number of amateur mineralogists and collectors. If the publishers had arranged for a revision of the work before publication by a qualified mineralogist there would be much more to recommend it than there now is. Some of the locality data and information to be found in this book is available in no other place. It is unfortunate that it should be marred by the curious errors which lead the reader to question so much of the rest.

A general introduction to quartz as a mineral and a substance of importance in the development of human culture is followed by a section on the many ways in which it may crystallize. A brief discussion of crystal form and habit follows this, and "symmetry" is here used in a sense entirely incorrect in a crystallographic discussion. A chapter entitled "The Crystalline Forms of Quartz" describes the frequently *crystallized* forms of quartz: rock crystal, amethyst, smoky quartz and citrine; not always with the strictest accuracy. The next chapter, entitled "The Massive Forms of Quartz" discusses milky quartz, rose quartz, sand, sandstone and quartzite; varieties every bit as *crystalline* as the varieties described in the preceding chapter. Although rose quartz crystals are said to be seen only at Harvard and in Boston at the Natural History Museum, the visitor to the Morgan Hall may see rose quartz crystals from three different localities.

The next chapters deal with the cryptocrystalline varieties of quartz, mistakenly called "intermediary" and amorphous. These include flint, chert, chrysoprase, bloodstone, prase, plasma and jasper. Many of the meaningless local names, of which, for a mineral as common as quartz there are legion, are listed as sub-varieties of jasper. New Englanders will be surprised to learn that, according to Messrs. Dake, Fleener and Wilson, their "puddingstone" is a jasper and not the sandstone conglomerate they thought it was. Perhaps it is, in Oregon. And the petrographers will be surprised to know that basanite is only a variety of quartz, "amorphous" at that.

The writers then speak of agate, with which Doctor Dake at least is more familiar, and give an excellent summary of the available information on the subject. Many variety names of purely local significance, are given here as well, but they will be useful for the specialists in agate, who will doubtless be able to multiply such names indefinitely. The locality information is interesting and useful.

A chapter on geodes, "thunder eggs," pseudomorphs, phantom crystals, inclusions and enhydros is interesting and likewise contains much historical information, especially on the Western deposits, that it is well to preserve.

A chapter on opal, and an earlier two paragraphs on tridymite and cristobalite under the "Crystalline Forms" are entirely out of place in a book so titled, however interesting the opal chapter may be. The explanations of the play of color in precious opal are well given and are among the best published in English to date.

A final chapter on the "Art of Cutting Gem Quartz" repeats lapidary information better given elsewhere, omits the very important correct angles for faceted quartz gems, but is useful in containing minute instructions as to materials and operations. The book contains a bibliography and an index.

F. H. POUGH.

FISH PASSES. In connection with Obstructions in Salmon Rivers.

- - - - - by T. E. Pryce-Tannatt

Edward Arnold and Company, London, 3/6

THIS little book is a practical and technical discussion of the various devices constructed to enable salmon and sea trout to pass obstructions in British rivers on their migration up stream to the spawning grounds, illustrated with photographs and diagrams. It will be of value primarily to those faced with the problem of constructing such devices, and also contains some data of general interest to salmon fisherman or naturalist.

J. T. N.

MUSEUM ACTIVITIES DURING THE SUMMER MONTHS

Arctic Birds

A new habitat group, showing the bird life of the Arctic Tundra region, will be constructed soon. Specimens and art studies for this group were obtained by the Rockefeller Hudson Bay Expedition which returned in July from a month's visit to the vicinity of Churchill, Manitoba. The expedition was financed and led by Mr. William A. Rockefeller, patron of the American Museum. He was accompanied by Mr. Raymond B. Potter and Mr. Fred F. Sherer of the Department of Arts, Preparation and Installation. The party was met at Churchill by Mr. Frank A. Farley, of Camrose, Alberta, who assisted in the local work.

Swordfish Study

Part of an extensive plan to make a world-wide study of all the species related to the swordfish, such as marlin, tuna and sailfish, are the investigations being carried on by the Second Lerner-Cape Breton Expedition which left the Museum in July for the swordfish grounds off Louisburg, Cape Breton Island, Nova Scotia.

Among the many mysteries which puzzle scientists as to the habits of these fish is where they breed. It is believed, although never scientifically recorded, that the breeding waters of our swordfish are somewhere off the western coast of Africa. In mature stages of their life cycles the fish migrate in great numbers to the colder Atlantic waters off the coast of North America.

In the early part of 1939 work on this survey will be continued in the Pacific, off New Zealand.

Members of the Second Lerner-Cape Breton Expedition are: Michael Lerner, Field Associate; Francesca La Monte, Associate Curator; Miles Conrad, Assistant Curator, Department of Comparative Anatomy, and Ludwig Ferraglio of the Department of Preparation. The expedition is using the three masted schooner, *Sachem* as a base ship and is collecting specimens from dories and boats of the local fleet. The sail-loft laboratory used in 1936 was re-opened.

This summer's work is a continuation of the work on the fishes of this family carried on in Louisburg in 1936, and in Bimini, Bahama Islands, in 1937.

Doctor Murphy at Philadelphia

At the dedication services of the Benjamin Franklin Memorial of the Franklin Institute, held in Philadelphia, May 19-21, the Museum was represented by Dr. Robert Cushman Murphy. About 250 delegates from educational institutions of the United States and Europe took part in an elaborate program honoring Franklin as statesman, scientist, philosopher, educator and business man.

During the same period Doctor Murphy participated in a symposium at the 33rd annual meeting of the American Association of Museums by reading a paper entitled, "The Need of Insular Exploration as Illustrated by Birds," in the auditorium of the Academy of Natural Sciences of Philadelphia.

Distinguished Visitors

The extensive collections of the Department of Ornithology continue to attract visiting scientists who find much of interest in this reference material for use in connection with their studies. Thanks to the facilities provided in the Whitney Wing, accommodations are available for visitors who come for this purpose. During the summer months the department has been visited by Mr. Emmet R. Blake of the Field Museum of Natural History, Chicago; Mr. James H. Fleming, of Toronto, Ontario; Mr. James Greenway of the Museum of Comparative Zoölogy, Cambridge, Mass.; Count Nils Gyldenstolpe of the Royal Museum of Stockholm, Sweden; Mr. Walter C. Koelz, (recently returned from field work in India); Mr. William H. Phelps of Caracas, Venezuela, who financed and accompanied the recently returned Phelps Venezuela Expedition to Mt. Auyan-tepui, Venezuela; Mr. A. J. Van Rossem of the California Institute of Technology, Pasadena, and Dr. Alexander Wetmore, Assistant Secretary of the Smithsonian Institution, Washington, D. C.

Fossil Finds

Fossil hunting in Texas and New Mexico has proved a fruitful summer occupation for Dr. Harold E. Vokes, Assistant Curator of Invertebrate Palaeontology. Nearly 200,000 specimens from the strata of Pennsylvanian and Permian age in these two states which had not previously been represented in the Museum collections, as well as the beginning of a representative group of the fossil faunas from the Palaeozoic deposits of the southern part of the Appalachian mountain region in northern Alabama and adjacent regions were brought back to the Museum. The work was sponsored by Mr. William O. Sweet of Attleboro, Massachusetts, a student at Harvard University, who accompanied Doctor Vokes into the field. The principal regions visited include the Guadeloupe Mountains just south of Carlsbad Cavern National Park and the Glass Mountains in the Marathon Basin area north of the Big Bend of the Rio Grande River. In both of these ranges the beds are mainly of Permian age, and although some Pennsylvanian fossils were secured in the Glass Mountains the major collections from strata of this period are from north-central Texas in a region extending from San Saba to the vicinity of Mineral Wells and Jacksboro, Texas. Along the route into these areas other collections were made in Ohio, Kentucky, Indiana, Illinois, Missouri and Oklahoma.

Other members of the department in the field or leaving soon include R. T. Bird who is in Montana and Albert Thomson in the White River Oligocene beds of South Dakota, where he will be joined this month by Dr. Walter Granger. Dr. Barnum Brown has left for two months' reconnaissance work in the dinosaur fields of Canada and the northern United States and Dr. Erich Schlaikjer is working in South Dakota and eastern Montana.

Unusual Fish

Most of the collection of South American Fresh Water Fish belonging to the Museum's Fish Department has come to them as the gift of Mr. Albert S. Pinkus of Georgetown, British Guiana. Mr. Pinkus visited New York again this summer and brought with him additional valuable specimens.

Museum Scientists Starred

The sixth edition of *American Men of Science* was published by the Science Press, New York, in July, 1938. This indispensable biographical directory, which was first undertaken close to the turn of the century as a manuscript reference list for the Carnegie Institution of Washington, has now grown to be a massive tome of 1608 pages. It contains approximately 28,000 entries as against 4000 in the first edition, which was issued in 1906. Professor J. McKeen Cattell, the Editor of *Science* and of other publications of the American Association for the Advancement of Science, has remained as editor-in-chief of all the successive editions. In the preface to the present volume he calls attention to the fact that the United States has attained in a single generation a position of leadership among the nations in its contributions to the advancement of science and human welfare.

As in the preceding editions, American scientific men and women have chosen by ballot 250 of their colleagues who in the course of the preceding five years have gained especially distinguished eminence. The fields of research of all these are marked as heretofore by a star or asterisk. This accolade was originally adopted in order to determine the thousand leading American men of science as a group for a study of the effects of heredity and environment. The custom has been much discussed in scientific and educational journals and, despite certain objections advanced, has undoubtedly had an influence in the weighing of scientific accomplishment, determining university promotions, etc. In an earlier edition of the work Dr. Cattell made a guarded statement, which no doubt still holds, to the effect that "The star means that the subject of the biographical sketch is probably among the leading thousand students of science of the United States; but its absence does not necessarily mean that the subject of the sketch does not belong in this group."

As would be expected, the names of most of the more than a hundred members of the scientific staff of the American Museum of Natural History (the exceptions being chiefly those who are still too young to have won their spurs) appear in the sixth edition of "American Men of Science." In addition, the names of nine regular members of our staff and nine research associates are marked with the symbolic star as an indication that, in the opinion of their colleagues throughout the country, they rank among the leaders. The starred names are as follows:

Full-time Staff Members

Dr. Frank M. Chapman
Prof. William K. Gregory
Dr. E. W. Gudger
Dr. Frank E. Lutz
Dr. Robert Cushman Murphy
Dr. N. C. Nelson
Dr. G. Kingsley Noble
Dr. George C. Vaillant
Dr. Clark Wissler.

Research Associates

Dr. William Beebe
Prof. Charles P. Berkey
Prof. T. D. A. Cockerell
Prof. Alfred Edwards Emerson
Prof. Amadeus W. Grabau
Dr. Libbie H. Hyman
Prof. J. Howard McGregor
Prof. Horace W. Stunkard
Prof. A. L. Treadwell.

New Home for Brontosaurus

Last summer the Palaeontology Department undertook to dismantle its famous 66-foot skeleton of *Brontosaurus*. The bones ranging from quite small ones to a ton in weight were removed individually and transferred to a different hall. When the last bone had reached the new hall they were all gathered, repaired, cleaned and reassembled. Thus, 24 days, which Curator Barnum Brown regards as a remarkably short time to accomplish this very exacting transfer, was taken to shift *Brontosaurus* over a distance he could have covered during life in about a half dozen strides.

The occasion for this engineering feat was brought about by the necessity of moving all appropriate exhibits into the new Jurassic Hall which is to be opened to the general public in April, 1939. When rearrangement and installations are completed, four-fifths of the Cretaceous Hall is to be devoted to Upper Cretaceous dinosaurs—of which the American Museum has an incomparable collection. The imposing skeleton of *Tyrannosaurus* and the two *Trachodon* skeletons (duck-bill dinosaurs) dominate the center of the hall, with the horned dinosaurs on the west side, and panel mounts of other trachodont skeletons, low-plated dinosaurs, and toothless dinosaurs, on the east side. The north fifth of this hall will be devoted to fossil birds, phytosaurs, and alligators on the east side; turtles, rhynchocephalians, and flying reptiles, on the west side.

In the Roosevelt ambulatory which leads into the new Jurassic Hall on the fourth floor of the African wing are to be exhibited fossil tracks, plesiosaurs, ichthyosaurs, and mosasaurs.

Skeletons of Lower Cretaceous dinosaurs will be placed in the east end of the new hall for comparison with related Jurassic dinosaurs in the central portion —where *Brontosaurus* is the dominant feature. Triassic dinosaurs and other reptiles follow the Jurassic forms and the large collection of Permian reptiles occupy the entire west end of the hall.

When these two halls and the connecting ambulatory are completely installed, the American Museum will have on exhibition a premier collection of fossil reptilian remains, arranged as far as possible in geologic sequence and relationship, and displayed in an attractive and impressive manner.

Beautiful Butterflies and Moths

Although many small insects are really very beautiful, one usually thinks of certain large butterflies and moths when thinking of beautiful insects. It is for this reason, among others, that the exhibit of "Beauty Among Insects" on the third floor of the Museum is made up of butterflies and moths. Among these the Saturnid moths and butterflies of the widely distributed genus *Papilio* and the strictly American genera *Morpho* and *Caligo* are outstanding. Naturally, of course, their beauty does not detract from their scientific interest and one of the ambitions of the Entomology Department is to have a complete representation in their technical study collection.

The cordial and effective aid of Mr. Frank Johnson, himself an enthusiastic collector of and authority on these insects, has greatly advanced the Department toward the realization of that ambition. His gifts in recent years have included nearly 8000 selected and highly desirable specimens. His most recent gift of about 350 "swallow-tails" (*Papilio*) added thirty-two species and subspecies to the collection as well as strengthening the series of other rare forms.

The public exhibit of beautiful butterflies and moths is divided into six parts, each intended to be a fair, even though very small, sample of the fauna of a major geographic region. It has been interesting to ask visitors to vote in a sort of "beauty contest" among these regions. The Neotropical (Central America, the West Indies, and South America) has been the winner by a small margin. It is the region in which Mr. Johnson is most interested. However, the three regions of the Old World tropics have hundreds of beauties that can claim their share of admiration. Possibly when collections from those regions are more complete the verdict will be different.

Gems in Your Backyard

To combat the mistaken notion among many people that all precious gems come from distant and exotic places, the Museum Department of Minerals and Gems will feature special displays of selected American gems in the Morgan Hall for the next few months. All of the specimens of both the cut and rough material are from the principal precious stone localities in the United States. The gem forms of beryl, emerald, aquamarine, morganite and golden beryl have all been found in this country in areas as widely separated as Maine and Southern California, North Carolina and Colorado.

The display will include the finest specimens of emerald ever found in the United States as well as tourmaline, the quartz gems and some unusual cut stones. Perhaps most striking of all is the inclusion of a number of gems that have been cut from crystals found on Manhattan Island itself. These are contained in an exhibit of minerals from the Metropolitan area of New York City.

Expedition to Persia

On August 16th, George G. Goodwin, Assistant Curator of Mammals and Museum representative on the Legendre Iran Expedition, sailed for Persia on the *S. S. Exeter* intent on a comprehensive collection of mammals from this incompletely studied part of the world.

The area to be investigated is the Elburz Mountains and adjacent territory in Iran and because parts of this region have not yet been thoroughly explored by any museum, prospects are believed excellent for interesting faunal discoveries new to science. The expedition will seek the central Asiatic tiger which live in the foothills of the mountains, as well as sheep, ibex and other mammals living in the higher ranges. Besides making further collections of reptiles and birds, a survey will also be made of the palaeontological deposits in this region. From Teheran the expedition will use pack trains of donkeys, horses and possibly camels to enter the collecting field, where they plan to stay about three months.

The expedition is sponsored and headed by Mr. and Mrs. Sidney J. Legendre, conductors of several other American Museum expeditions to remote quarters of the globe. They will be assisted by Mr. Goodwin whose extensive field experience in North America, Asia and Africa admirably qualify him to deal with the problems that will doubtless confront an expedition into so comparatively unfamiliar a region. The expedition is planned to extend over four months and the Museum is proud to announce that all natural history material collected by the party is to become its property and will be devoted to the purposes of science and education.

Gems under Polarized Light

Readers interested in Photographer Charles Coles' discussion on another page of this issue of the polarized light filter for cameras will have an opportunity of seeing the polarization of light actually work in a display by the Department of Mineralogy showing the spectacular effects observable when certain minerals are viewed under polarized light. Ordinarly seen only by the professional petrographer, experimenting with his microscope, these intensely beautiful color changes are made available to the general public by the advent of the new polarizing film known as Polaroid. A large sheet of muscovite is placed between two opposing films of Polaroid, and as the visitor enters the hall he looks through both to see the effect. The Polaroid is spaced far enough apart so that it is possible to see around the front sheet, the "analyser" and see that there is no color in the mica and that it is purely an effect resulting from the two sheets and the light passing through both of them with the mica between. The sheets of the new type Polaroid film were loaned by The Polaroid Corporation.

Mr. Mutchler Retires

The Department of Entomology has

suffered a severe loss in the retirement of Andrew J. Mutchler, who for many years has been in immediate charge of their large collection of beetles. Not only do beetles form the largest order of insects (more than 190,000 kinds have already been described) but they are very popular with the amateurs and other students who come to the Museum for help. Mr. Mutchler was tireless and efficient in helping others, as he was in the other numerous and varied tasks that make up the life of an entomologist in a museum.

Astronomical Societies

The astronomical societies are resuming their activities, starting in October. The classes conducted by the Amateur Astronomers Association include Elementary, Intermediate and Advanced Astronomy, Practical Astronomy, Practical Optics and Telescope Making and Mathmetics Useful in Astronomy. These classes are open to annual members of the American Museum of Natural History, without charge. For complete details write to the Secretary of the Amateur Astronomers Association, Hayden Planetarium, New York City.

Excavations in Peru

Dr. Wendell C. Bennett, assistant curator in the Department of Anthropology of the American Museum of Natural History, has recently returned from a six months' archaeological expedition into northern Peru where he uncovered the dwelling places, temples, pottery and metal work of a civilization which, thus far known, is one of the oldest in Peru.

Doctor Bennett found whole villages containing as many as fifty subterranean houses. These dwelling places were roofed with tremendous slabs of rock, some of them measuring 12 feet long and 3 feet wide and evidently cut from the mountain sides, but how they were cut and transported from the quarries to the village sites is unknown. The Recuays also made their tombs of great slabs of rock fashioned into boxes.

The site of these ancient ruins is located near the present-day town of Huaraz in the upper part of the Santa river valley at an altitude of 10,000 feet, between the White and the Black Cordilleras. From the evidence in the tombs, such as pottery, copper pins and discs and arrow heads of flint and obsidian, these people of the Recuay civilization predate one branch of the Tiahuanaco civilization and the Inca civilization. According to Mean's method of dating ancient civilizations the Recuay ruins would date around 500 A.D.

Many of the sunken houses extended two stories below the surface and contained five or six rooms with narrow passageways leading from one floor to another and from room to room. It is probable that these people built their homes in such a manner to escape the inclement weather, which in this region is cold, rainy and very windy.

Two temples were found, each having three stories above the ground and rising to 30 feet in height. The position of stone Puma heads in the ruins indicates that these carvings were at one time situated below the cornices of the temples. A large number of carved statues representing human figures were found, scattered throughout the sites.

In the ancient village ten subterranean passageways with but single entrances were also discovered. Some of them extended 60 feet in length, but were only about 5 feet high and 4 feet wide. Pottery found in the tunnels show they were used as dwelling places.

Doctor and Mrs. Bennett also visited the famous ruins of Chavin, noted for the discoveries made there by Dr. Julio C. Tello of Peru. The main temple of the Chavin ruins is an imposing and complex structure, built of stone. At the intersection of two long galleries facing the entrance is a huge, elaborately carved statue representing a mythological tiger god, considered to be one of the finest carvings in the remains of the Chavin civilization. Ceramics found at the ruins of Chavin will prove of great importance in the understanding of this important, but as yet little known, civilization.

Collections made by Doctor Bennett at Huaraz will be classified and later placed on public exhibition in the American Museum's Peruvian Hall.

Beach Mice

Among the unusual specimens collected by the American Museum's trailer expedition is an extensive series of the white-fronted beach mice; a small, pale species so light in color that they can hardly be distinguished when alive from the white sands of the Florida beaches they inhabit. Even more rare specimens of beach mice were collected from Santa Rosa Island off the coast of Florida. Many other kinds of mice, including the lowly, common house varieties, were also assembled. Flying squirrels, short-tailed shrews, cotton and wood rats, opossum, rabbits, bats and other animals round out the collection and total some 504 specimens.

Mr. Campbell's 20,000-Mile African Expedition

Mr. William D. Campbell, Field Representative of the American Museum of Natural History, left New York aboard the *Conte Di Savoia* for a six months' expedition in Africa, covering more than 20,000 miles by motor truck to collect specimens for groups in the Museum's Akeley African Hall.

Starting from Nairobi in Kenya, East Africa, on November 1st, Mr. Campbell will lead his expedition through the heart of Africa directly across Uganda, the Belgian Congo and French Equatorial Africa into the Cameroons on the West Coast. In this region the expedition will collect specimens of the brilliantly colored Mandrill, a large and spectacular member of the baboon family. From this section the safari will swing up into French Guinea to obtain specimens of the rare Black-faced chimpanzee which lives only in this part of Africa. The Black-faced chimpanzee is most distinguished in appearance by wearing a goatee of long white whiskers under his chin.

Correct answers for

INTELLIGENCE TEST

1. Nitrogen
2. An excess of nitrogen
3. A seaweed called sargasso
4. The snake with the black and yellow head
5. No.
6. No.
7. "The Lost World"
8. A biologic isolation zone
9. The oldest known colonizers of the northern southwest
10. 11 minutes

A NEW "LOST WORLD"

Continued from page 120

ward to a camp half a mile from the Urullen landing field, whence our boxes of specimens could be quickly carried out and loaded onto the plane which was to come on March 15th.

And thus the undertaking ended—with interesting incidents aplenty but without accident. The Lockheed arrived according to plan, taking two trips to fly out the members of the party and their impedimenta. When for the last time the plane roared into motion across the savanna, we waved goodbye to the little party of Arecunas who had served us so faithfully, while Auyan-tepui whose treasures and secrets we had rifled, looked indifferently down on the scene.*

*For a formal report on this expedition, see "Geographical Review," Volume XXVIII, No. 3, July, 1938. Pages 452 to 474.

* * *

Recent Museum Publications

NOVITATES

No. 964. Eocene Mollusca from the Subathu Group (Lutetian) Simla Hills State, India. By H. E. Vokes.

965. An Ancient Eusuchian Crocodile from Patagonia. By George Gaylord Simpson.

966. The Birds of the Sage West China Expedition. By Hugh Birckhead.

967. Notes on Carangin Fishes. By J. T. Nichols.

968. The Nasal Bone and Sword of the Swordfish (*Xiphias gladius*). By G. Miles Conrad.

969. A Giant Oxyaenid from the Upper Eocene of Mongolia. By Walter Granger.

970. Two Interesting Mayfly Nymphs with a Description of a New Species. By Herman T. Spieth.

971. A New *Eurema* from Puerto Rico (Lepidoptera: Rhopalocera). By Frank E. Watson.

972. A New Species of Gastrotrichan —*Chaetonotus Robustus*, New Species. By Donald B. Davison.

973. A New Species of Frog of the Genus *Telmatobius* from Chile. By G. K. Noble.

Continued on page 157

THE INDIAN AND THE SUPERNATURAL

Continued from page 126

medicine man would be welcomed. This duplicity was one of the most obvious results of the Indian education of that day; perhaps not conscious duplicity, just a matter of building up a complex of white beliefs in one part of the Indian youth's personality without disturbing or displacing the other complex derived from his elders at home. And that ancient complex was the stronger in the end.

I remember an occasion when an Indian friend of mine took me to call upon a blanket wearing Indian who had just built a modern house with up-to-date decorations and furnishings partly out of the income from his profession as medicine man but chiefly from the rental of certain farm lands allotted to him. He received us in the parlor, sitting in a fine mahogany chair which stood on an oriental rug. After we had visited a while, my companion asked permission to show me the attic. Our host consented but did not go with us. We climbed a narrow dark stairs but when our heads rose above the floor level, we looked in upon a new world, for here was the replica of an aboriginal lodge.

Resting upon the floor of the attic was a large wooden tray, filled with earth, tamped down hard like the natural floor of a lodge. At one side of this earthern floor was a small raised square, or altar, upon which were painted symbols in red and in its center a tiny fireplace, with ashes indicating the recent burning of incense. On the wall behind hung a large bundle of sacred objects. Around the sides of the attic floor were pallets of blankets all ready for the medicine man, his assistants and the singers. Even the drum and the rattles were in position.

This thrifty old Indian knew how to make money in a white man's world. He lived in a beautiful modern house, in every way like that of a well-to-do white man, save that tucked away out of sight in its attic was the essence of living paganism. At least once a day the family climbed those narrow stairs and, shut in from the white man's world, gave whole-hearted devotion to the gods of their fathers.

So in time I came to realize that though a white man and an Indian may walk side by side, they do not see alike. This was the crux of the problems of the old-time reservation: white men knowing but one view of life, that of their forefathers; Indians firm in the faith of their ancestors because they knew no other, with a supposedly enlightened government expecting these white men to lead the Indians along the road to civilization. Here we have a situation to which an old saying applies—the blind lead the blind.

THE COVER THIS MONTH

The cover design this month illustrates the deceptive similarity of two snakes, one of which is harmless, the other poisonous. The poisonous coral snake, *Micrurus fulvius,* is the one whose head is to the right and above. Though brilliantly colored this serpent is primarily nocturnal and in the cypress swamps of northern Florida, its brilliant patterns disappear, leaving only an irregular blotching of grey to mingle with the shadows of the swamp. The other snake is the so-called mimic coral snake, *Lampropeltis elapsoides,* which is also nocturnal and lives in the same area as the coral snake.

Campers and nature lovers can distinguish the venomous coral snake by its black and yellow head. Its mimic, on the other hand, has a bright red head, which, far from being a warning sign, may be taken to indicate that it is quite harmless. If, furthermore, the red body bands are separated from the yellow by black bands, you may safely pick the specimen up for closer examination. But if the black bands are broad and are flanked on each side by yellow bands—watch out!

The coral snakes found in the United States are rarely more than $2\frac{1}{2}$ feet long. Their fangs are short, but the bite is dangerous, for by a characteristic 'nuzzling" method of biting the snake is able to inject a large amount of poison into the lacerated wound. The venom is largely neurotoxic. Fortunately it is not an aggressive snake but is secretive in habit, coming out chiefly at night in search of food.

The coral snakes belong to the same family (Elapidae) as the cobras and the kraits, and are the only terrestrial relatives of the cobras indigenous to this continent. Only two species of coral snakes reach the southern limits of the United States, but in Central and South America there are some 50 species, all long and slender and usually banded or ringed with brilliant colors.

LETTERS

SIRS:

For the benefit of other expeditions which may enter the tsetse fly country of Africa from the American Museum and other institutions, I want to report the successful use of a new insect repellent by the 1937-38 Morse Museum African-Asiatic Expedition.

This repellent was offered to us for test purposes against the tsetse fly by the Experimental Station of New Jersey. During six months' work in the thickly infested districts west of Lake Victoria Nyanza this repellent made it quite possible to rid our camp, cars and persons of this pest of pests so that our work could be carried on in comfort. We emerged from their voracious midst without the usual red blotches and sorely tried nerves that any expedition heretofore subjected to tsetse bites well understands. After careful inquiry and various experiments it is the only repellent that we can say produces freedom from tsetses by day and mosquitoes by night.

The proper method of using it, according to our experience, is as follows:

The milky white liquid stands a dilution of one part to ten parts of water. This should be poured into a good-sized tank of a hand power garden sprayer with sufficient hose length to throw the mist well into the air. The bulk of the sprayer (brought from America) will justify any trouble of transportation as its usefulness is proven.

The sprayer should be pumped so that the mist is carried into any overhanging branches, onto tent tops and through the atmosphere of the camp area and nearby bushes. The spraying must be repeated more often on windless days according to the return of the flies, which occurrence is less and less until in many cases they become completely discouraged. The interior of all tents sprayed once or twice a day will leave them pest free.

Before leaving camp a complete spraying of cars inside and out will do wonders. Tsetses will fly in but depart again without stopping but for a sniff. En route, a small hand sprayer used now and again will permit you to travel in peace.

The liquid was entirely harmless to our skins, although we were careful to avoid eyes and lips. And we found that an occasional application to exposed portions made stalking animals in tsetse bush a pleasurable hunt where in other years we had suffered greatly from being bitten.

The possible value of such a repellent to tsetse research workers, game rangers, herdsmen and their cattle is obvious.

JULIE B. MORSE.

Morse Museum,
Warren, N. H.

* * *

SIRS:

Knowing the importance of factual accuracy in your invaluable magazine, I take the liberty of writing in regard to the forest conservation article, "Green Gold," recently published.

As often happens in an attempt to give a nation-wide picture of any situation, some of the general statements made in this article do not apply to the Douglas Fir region or to the conservation work of the lumber industry here. The following statement, for example, is questionable: "But fire-proofing the forests and forest pathology are only aspects of conservation. . . ." In the Douglas Fir region, all hands agree that keeping fire out is the primary principle of forest conservation. Likewise, it is hardly fair to say that, "it must be acknowledged that federal foresight has instigated the first ambitious measures to preserve our forests, while private owners, interested first in the immediate return, have generally in the past neglected conservation. . . ." In this region the "first ambitious measures" of forest preservation were in the lumber industry's own fire protection organizations and practices. Again, in Washington and Oregon, state "foresight" deserves at least equal credit with the federal.

In the main the article gives the lumber industry of today due credit for its conservation program, which in Oregon and Washington was carried on at a cost of $1,300,000 last year. The article fails, however, to deal with the region's basic forestry problems, as yet unsolved even in theory. Let me touch upon two or three of them.

The President himself has recognized as a major problem the factor of forest senility in the Douglas Fir region, particularly in the Olympic Peninsula, where an estimated 5 billion feet of dead down timber lies among the 79 billion feet of aged standing trees. It is such snags and blowdowns that make up most of the "wastage" described in the caption for your picture on page 332. The logging slash in this picture, too, has plainly endured a severe burn. But that same land will, if fire is kept out, inevitably be covered with dense young growth ten years from now, because of the young seed stock shown in the background of the picture.

Insofar as the Douglas Fir region is concerned, planting is overemphasized in the article. It is neither necessary nor desirable to plant here, except in areas that have been burned beyond hope of natural restocking. Your three young forest pictures on page 335 are, to any woodsman's eye, examples of nature reforesting in Douglas Fir timberlands. At this writing, fires started by tourists and "nature-lovers" have already burned up tens of thousands of acres of such young forests in the Pacific Northwest. Last year only 7.6 per cent of forest fires in the region originated from logging operations.

Incidentally I would correct the misapprehension given in a caption on page 333 to the effect that tree-top sections are used as ships' masts. The tree-top, remember, is a giant bush; trimmed and peeled, its body would reveal as many knots as a County Kerry shillelah. The "spars" for which these tree-top sections serve are used in the logging operations themselves. In high-lead or sky-line logging they provide for a pull from a height on logs as they are skidded from the woods, to lift them over obstructions.

Douglas Fir forest conservation is a vast subject, technically complex, involved in economic questions and principles of land use. Much solid information has been worked up about it by the Pacific Northwest Forest Experiment Station, state forestry departments, and the Joint Committee on Forest Conservation of the West Coast Lumbermen's and Pacific Northwest Loggers Associations. But great areas of the subject are unexplored. With a backround of 35 years as a woodsman and writer in all quarters of the region, I do not think it is possible to give authoritative coverage of these problems in an article at this time.

The President's proposed study by a joint committee of the Congress of the forest land problem of the United States is a step that should have been taken thirty years ago. In the spring of 1934 a delegation from the lumber and timber products industries called on the President, urging action on certain fundamental forest conservation legislation. Succeeding efforts of these industres, climaxed by the National Forest Conservation Conference of 1937, are at last bearing fruit in the proposed Congressional study. When this study is completed and its results published, we shall be in a far better position to interpret the subject for popular consumption.

JAMES STEVENS,
Information and Publicity.
West Coast Lumbermen's Ass'n,
Seattle, Washington.

* * *

SIRS:

Is the old saying "blind as a bat" true? I say that bats can see, but my friends argue otherwise. . . .

RICHARD DURHURST,
Penn Yan, N. Y.

"Blind as a bat," is a comparison which should be used cautiously. If you are speaking of someone who sees poorly that phrase could be safely applied. But bats are not totally blind; they have eyes and can see, some better than others.—THE EDITOR.

* * *

SIRS:

May I call your attention to a minor slip in connection with the article, "The Poisons of Scorpions and Spiders," in the June issue of NATURAL HISTORY. Referring to the illustration on page 48, scorpions, as far as I know, are not carried intermittently on the back of the female but take that position as soon as they get out of the envelope which surrounds them when they are delivered and remain there, so far as our records show, from five to fifteen days.

This is not of any great significance, but I thought you probably would want to know.

W. J. BAERG,
University of Arkansas,
Fayetteville, Ark.

Photo from James Montagnes

A CATTALO, bred from domestic cattle and buffalo. The name cattalo was given by "Buffalo" (Col. C. J.) Jones to hybrids between bison bull and domestic cow, which he had in Dodge City, Kansas. However, before 1843 near Lexington, Kentucky, such crosses were made by a Mr. Wickliffe, who kept the hybrids through several generations at least 20 years, according to a report in Audubon and Bachman.

Recently this type of animal has been developed at the experimental station near Wainwright, Alberta, where 30 of the creatures now roam on pasture. The purpose of the Canadian government is to produce a sturdy type of cattle for farmers in the northern agricultural districts of the Canadian west, where ordinary cattle could not stand the cold or find their own forage in winter. The hide resembles that of the buffalo, with thick, durable hair; the meat is said to have all the qualities of beef cattle.

RECENT MUSEUM PUBLICATIONS

Continued from page 153

No. 974. African Muscidae.—V. by C. H. Curran.
975. New American Diptera. By C. H. Curran.
976. A New Genus of Bat from Costa Rica. By George G. Goodwin.
977. Birds Collected During the Whitney South Sea Expedition. XXXVII. On Pan-Antarctic Terns. By Robert Cushman Murphy.
978. Osteography of the Ear Region in Monotremes. By George Gaylord Simpson.
979. The African Lauxaniidae (Diptera). By C. H. Curran.
980. Mongolian Mammal Names. By George Gaylord Simpson.
981. Coleoptera from the Galapagos Islands. By Andrew J. Mutchler.
982. Results of the Archbold Expeditions. No. 18. Two New Muridae from the Western Division of Papua. By G. H. H. Tate and Richard Archbold.
983. Bees from Prince Albert Park, Saskatchewan. By T. D. A. Cockerell.
984. A Large *Tentaculites* from the Shriver Formation (Oriskany) of Pennsylvania. By H. E. Vokes.
985. New Metopiidae and Tachnidae from Africa (Diptera). By C. H. Curran.
No. 986. Birds Collected During the Whitney South Sea Expedition. XXXVIII. On a Collection from Erromanga, New Hebrides. By Ernst Mayr.
987. Four New Mammals from Costa Rica. By George G. Goodwin.
988. Upper Miocene Mollusca from Springvale, Trinidad, British West Indies. By H. E. Vokes.
989. A New Marsupial from the Eocene of Patagonia. By George Gaylord Simpson.
990. Results of the Archbold Expeditions. No. 19. On Some Non-Passerine New Guinea Birds. By A. L. Rand.
991. Results of the Archbold Expeditions. No. 20. On Some Passerine New Guinea Birds. By A. L. Rand.
992. Results of the Archbold Expeditions. No. 21. On Some New Guinea Birds. By A. L. Rand.
993. Results of the Archbold Expeditions. No. 22. On the Breeding Habits of Some Birds of Paradise in the Wild. By A. L. Rand.
994. Studies of Peruvian Birds. No. XXIX. The Genera *Myiarchus*, *Mitrephanes*, and *Cnemotriccus*. By John T. Zimmer.
995. A Study of Proportional Changes During the Post-Larval Growth of the Blue Marlin (*Makaira nigricans ampla Poey*). By Sidney Shapiro.
No. 996. Parasites of the Swordfish, *Xiphias gladius* Linnaeus. By Ross F. Nigrelli.
997. Halictine Bees from Morocco. By T. D. A. Cockerell.
998. Notes on Carangin Fishes. III.—On *Caranx sexfasciatus* Quoy and Gaimard. By J. T. Nichols.
999. The Types of Lepidoptera Described by J. D. Gunder. By Cyril F. Dos Passos.
1000. The Osteology and Relationships of the Wahoo (Acanthocybium solandri), a Scombroid Fish. By G. Miles Conrad.

BULLETIN Volume LXXIV, Article III: Studies of Birds from Eastern Brazil and Paraguay, Based on a Collection Made by Emil Kaempfer. By Elsie M. B. Naumburg.
" Volume LXXIV, Article IV: Observations on the Body Form of the Blue Marlin (*Makaira nigricana ampla Poey*). By G. Miles Conrad and Francesca La Monte.
" Volume LXXIV, Article V: Crossochelys, Eocene Horned Turtle from Patagonia. By George Gaylord Simpson.

Who · When · Where

SEPTEMBER CALENDAR OF ENTERTAINMENT

On these pages will be found a calendar of museum events in metropolitan New York for September. It is hoped that this list will enable those at a distance who contemplate a visit to New York to plan more efficiently, and that those who live in or near the city may be able to choose lectures and other activities that fit their needs or interests.

CHARLES RUSSELL,
Curator of the Department of Education, American Museum of Natural History

General Information

AMERICAN MUSEUM OF NATURAL HISTORY
Central Park West at 79th Street
New York City

Hours: Daily 9:00 a. m. to 5:00 p. m. Sunday 1:00 p. m. to 5:00 p. m. Open holidays 9:00 a. m. to 5:00 p. m. Admission Free.

Exhibitions of gems, human and animal habitat groups, prehistoric creatures, and fossil arrangements showing evolution.

AQUARIUM
Battery Park, New York City

Hours: Daily 9:00 a. m. to 5:00 p. m. Admission Free.

Collections of living aquatic animals; fresh-water and marine, principally fishes but including other groups.

BROOKLYN BOTANIC GARDEN
1000 Washington Avenue, Brooklyn

Hours: Daily from 9:00 a. m. until dark. Sundays from 10:00 a. m. Conservatories open from 10:00 a. m. until 4:00 p. m. Admission Free.

Rose garden; wild flower, Japanese rock, and wall gardens; horticultural displays; conservatories.

BROOKLYN MUSEUM
Eastern Parkway and Washington Avenue
Brooklyn

Hours: Daily 10:00 a. m. to 5:00 p. m. Saturdays and holidays 10:00 a. m. to 6:00 p. m. Sundays 2:00 p. m. to 6:00 p. m.

Admission Free, except Mondays and Fridays, when charge is 25¢ for adults and 10¢ for children.

Arts of the world arranged in chronological and geographical order to illustrate the history of cultures.

THE CLOISTERS
Fort Tryon Park (190th Street Subway Station)
New York City

Hours: Daily 10:00 a. m. to 5:00 p. m. Saturdays and holidays 10:00 a. m. to 5:00 p. m. Sundays 1:00 p. m. to 5:00 p. m.

Admission Free, except Mondays and Fridays when charge is 25¢.

Branch of the Metropolitan Museum of Art devoted to European medieval art.

FRICK COLLECTION
1 East 70th Street, New York City

Hours: Weekdays 10:00 a. m. to 5:00 p. m. Admission Free.

14th-19th century paintings, Renaissance bronzes, Limoges enamels, Chinese and French porcelains, period furniture.

METROPOLITAN MUSEUM OF ART
Fifth Avenue and 82nd Street
New York City

Hours: Daily 10:00 a. m. to 5:00 p. m. Saturdays and holidays 10:00 a. m. to 5:00 p. m. Sundays 1:00 p. m. to 5:00 p. m.

Admission Free, except Mondays and Fridays, when charge is 25¢.

Collections of Egyptian, Classical, Oriental, European, and American art—paintings, prints, sculpture, and decorative arts.

MUSEUM OF THE AMERICAN INDIAN
Broadway and 155th Street
New York City

Hours: Daily 2:00 p. m. to 5:00 p. m. Sunday 1:00 p. m. to 5:00 p. m. Admission Free.

Anthropological collections from the aboriginal inhabitants of North, Central, and South Americas, and West Indies.

MUSEUM OF THE CITY OF NEW YORK
Fifth Avenue and 103rd Street
New York City

Hours: Daily 10:00 a. m. to 5:00 p. m. Saturdays and holidays 10:00 a. m. to 6:00 p. m. Sundays 1:00 p. m. to 6:00 p.m. Closed Tuesdays. Admission Free, except Monday, when charge is 25¢.

Exhibits of the chronological development of New York City life from earliest times to the present.

MUSEUM OF MODERN ART
11 West 53rd Street, New York City

Hours: Daily 10:00 a. m. to 6:00 p. m. Sundays 12:00 m. to 6:00 p. m.

Admission Free on Monday, other days 25¢.

Art of today—showing American and European painting, sculpture, architecture, industrial art, photography, motion pictures.

MUSEUM OF SCIENCE AND INDUSTRY
RCA Building, Radio City, New York City

Hours: Daily 10:00 a. m. to 5:00 p. m. Sundays 2:00 p. m. to 5:00 p. m. Admission 25¢.
(Free to teachers with classes.)

Exhibits in transportation, communications, power, food, housing, electro-technology and other scientific and industrial fields.

NEW YORK BOTANICAL GARDEN
Bronx Park, Bronx, N. Y.

Hours: Museum and Conservators open daily 10:00 a. m. to 4:30 p. m. Admission Free.

Extensive greenhouses, outdoor plantings, floral displays and museum collections of economic, drug and fossil plants.

STATEN ISLAND MUSEUM
Stuyvesant Place and Wall Street
St. George, Staten Island

Hours: Daily 10:00 a. m. to 5:00 p. m. Sunday 2:00 p. m. to 5:00 p. m. Admission Free.

Collections in science, art and history, especially relating to Staten Island.

WHITNEY MUSEUM OF AMERICAN ART
8-12 West 8th Street, New York City

Hours: Daily 10:00 a. m. to 6:00 p. m. Sunday 2:00 p. m. to 6:00 p. m. Closed Monday. Admission Free.

Collection of sculpture, paintings, watercolors, drawings and prints by American artists.

(The Museum is closed from June 1st to September 15th.)

SEPTEMBER 3

METROPOLITAN MUSEUM OF ART

2:30 p. m.—Motion picture—"Firearms of Our Forefathers Daniel Boone" (Yale Chronicles of America Photoplay)—Classroom A—Open to public.

SEPTEMBER 4

BROOKLYN MUSEUM

4:00 p. m.—Concert—Gramercy Chamber Trio—Sculpture Court—Open to public.

METROPOLITAN MUSEUM OF ART

2:30 p. m.—Motion picture—"A Visit to the Armor Galleries; Behind the Scenes in the Metropolitan Museum"—Classroom A—Open to public.

SEPTEMBER 6

METROPOLITAN MUSEUM OF ART

2:30 p. m.—Motion picture—"The Making of a Bronze Statue; The Temples and Tombs of Ancient Egypt"—Classroom A—Open to public.

GUIDE SERVICE

•

The following institutions offer free lecture tours of their collections:

AMERICAN MUSEUM OF NATURAL HISTORY

Wednesdays, Fridays and Saturdays at 11:00 a. m. and 3:00 p. m. Meeting Place: 2nd Floor, Roosevelt Memorial.

METROPOLITAN MUSEUM OF ART

Tuesday, Wednesday and Thursday at 3:30 p. m. Meeting Place: Main Hall.

MUSEUM OF MODERN ART

Daily at 11:00 a. m., 1:30 p. m., 3:00 p. m., and 4:30 p. m.

SEPTEMBER 7

BROOKLYN MUSEUM

2:30 p. m.—Motion Picture—"China"—Classroom A—Open to public.

MUSEUM OF THE CITY OF NEW YORK

2:00 p. m.—Motion picture—"Preview New York World's Fair"—Open to public.

SEPTEMBER 10

METROPOLITAN MUSEUM OF ART

2:30 p. m.—Motion picture—"Digging into the Past; The Daily Life of the Egyptians—Ancient and Modern"—Classroom A—Open to public.

NEW YORK BOTANICAL GARDEN

3:00 p. m.—Lecture—"Exhibiting and Judging of Flowers," by Ethel A. S. Peckham—Open to public.

SEPTEMBER 11

BROOKLYN MUSEUM

4:00 p. m.—Concert—Gramercy Chamber Trio—Sculpture Court—Open to public.

Metropolitan Museum of Art

2:30 p. m.—Motion picture—"The American Wing; The Pottery Maker"—Classroom A—Open to public.

SEPTEMBER 13

Metropolitan Museum of Art

2:30 p. m.—Motion picture—"Columbus" (Yale Chronicles of America Photoplay)—Classroom A—Open to public.

SEPTEMBER 14

Museum of the City of New York

2:00 p. m.—Motion picture—"Historic Governors Island"—Open to public.

SEPTEMBER 17

Metropolitan Museum of Art

2:30 p. m.—Motion picture—"Behind the Scenes in the Metropolitan Museum; The Etcher's Art"—Classroom A—Open to public.

New York Botanical Garden

3:00 p. m.—Lecture—"Mushrooms of the Autumn Woods," by William S. Thomas—Open to public.

SEPTEMBER 18

Brooklyn Museum

4:00 p. m.—Concert—Gramercy Chamber Trio—Sculpture Court—Open to public.

Metropolitan Museum of Art

2:30 p. m.—"Tapestries and How They Are Made; The Making of a Stained-Glass Window"—Classroom A—Open to public.

SEPTEMBER 20

Metropolitan Museum of Art

2:30 p. m.—Motion picture—"The Making of Wrought Iron; The American Wing"—Classroom A—Open to public.

SEPTEMBER 21

Museum of the City of New York

2:00 p. m.—Motion picture—"The Real New York"—Open to public.

SEPTEMBER 24

Brooklyn Museum

3:00 p. m.—American Indian Day Festival—Sculpture Court—Open to public.

Metropolitan Museum of Art

2:30 p. m.—Motion picture—"A Visit to the Armor Galleries; The Making of a Bronze Statue"—Classroom A—Open to public.

PLANETARIUM

Schedule for September

★

"The End of the World"

Weekdays—2:00, 3:30, and 8:30 P. M.

Saturdays—11:00 A. M., 1:00, 2:00, 3:00, 4:00, 5:00 and 8:30 P. M.

Sundays and Holidays—2:00, 3:00, 4:00, 5:00 and 8:30 P. M.

General Admission Afternoons	25¢
Reserved Seat "	50¢
General Admission Evenings	35¢
Reserved Seat "	60¢

General Admission for Children under 17, accompanied by adults, 15¢ at all times. (No reduced price for reserved seats occupied by children.) Children under 5 not admitted. Doors close on the hour. Special facilities for the hard of hearing.

New York Botanical Garden

3:00 p. m.—Lecture—"Autumn Flowers around New York," by E. J. Alexander—Open to public.

SEPTEMBER 25

Brooklyn Museum

4:00 p. m.—Concert—Gramercy Chamber Trio Sculpture Court—Open to public.

Metropolitan Museum of Art

2:30 p. m.—Motion picture—"Digging into the Past; The Daily Life of the Egyptians—Ancient and Modern"—Classroom A—Open to public.

Metropolitan Museum of Art

3:00 p. m.—Lecture—"Elements of Design" by Grace Cornell—Open to public.

SEPTEMBER 27

Metropolitan Museum of Art

11:00 a. m.—Lecture—"Color and Its Use" by Grace Cornell—Open to public.

Metropolitan Museum of Art

2:30 p. m.—Motion picture—"The Pottery Maker; Alexander Hamilton" (Yale Chronicles of America Photoplay)—Classroom A—Open to public.

Metropolitan Museum of Art

3:00 p. m.—Lecture—"Elements of Interior Design" by Grace Cornell—Open to public.

SEPTEMBER 28

Museum of the City of New York

2:00 p. m.—Motion picture—"A Highway to the Sea—the Story of the Erie Canal"—Open to public.

SEPTEMBER 30

American Museum of Natural History

10:30 a. m.—Lecture—"People of the North," by Marguerite Newgarden—Auditorium—Open to public.

SEPTEMBER RADIO PROGRAMS

SEPTEMBER 1

1:05 p. m.—Organ Recital—Station WNYC—Brooklyn Museum.

SEPTEMBER 2

9:45 p. m.—"A Pharaoh: His Statue in the Museum and His Obelisk in the Park" by Edwin Taggart—Station WQXR—Metropolitan Museum of Art.

1:05 p. m.—Organ Recital—Station WNYC—Brooklyn Museum.

SEPTEMBER 3

10:00 a. m.—Organ Recital—Station WNYC—Brooklyn Museum.

12:00 m.—"This Wonderful World," (Question and Answer Program)—Station WOR—Hayden Planetarium.

SEPTEMBER 5

3:45 p. m.—"What Telescopes Are Largest?" by C. A. Federer—Station WINS—Hayden Planetarium.

5:45 p. m.—"New Horizons"—Station WABC—American Museum of Natural History.

SEPTEMBER 6

1:05 p. m.—Organ Recital—Station WNYC—Brooklyn Museum.

SEPTEMBER 7

5:45 p. m.—"Exploring Space"—Station WABC—Hayden Planetarium.

SEPTEMBER 8

1:05 p. m.—Organ Recital—Station WNYC—Brooklyn Museum.

SEPTEMBER 9

1:05 p. m.—Organ Recital—Station WNYC—Brooklyn Museum.

SEPTEMBER 10

10:00 a. m.—Organ Recital—Station WNYC—Brooklyn Museum.

12:00 m.—"This Wonderful World," (Question and Answer Program)—Station WOR—Hayden Planetarium.

SEPTEMBER 12

3:45 p. m.—"Can I Make a Telescope?" by C. A. Federer—Station WINS—Hayden Planetarium.

5:45 p. m.—"New Horizons"—Station WABC—American Museum of Natural History.

SEPTEMBER 13

1:05 p. m.—Organ Recital—Station WNYC—Brooklyn Museum.

SEPTEMBER 14

5:45 p. m. — "Exploring Space" — Station WABC—Hayden Planetarium.

SEPTEMBER 15

1:05 p. m.—Organ Recital—Station WNYC—Brooklyn Museum.

SEPTEMBER 16

1:05 p. m.—Organ Recital—Station WNYC—Brooklyn Museum.

SEPTEMBER 17

10:00 a. m.—Organ Recital—Station WNYC—Brooklyn Museum.

12:00 m.—"This Wonderful World" (Question and Answer Program)—Station WOR—Hayden Planetarium.

SPECIAL EXHIBITS

The complete graphic works of Paul Gaugin are on view in the Special Exhibition Hall of the Brooklyn Museum until October 2nd.

●

Increased to three times the size of last year's exhibit, the New York Aquarium Society show this year boasts the presence of the rare fish Neon Tetra which has been bred in this country for the first time, as well as many other rare and exotic fresh and salt water forms. It will be held in Education Hall of the American Museum from September 3rd through 5th.

SEPTEMBER 19

3:45 p. m.—"How Can I Learn Astronomy?" by C. A. Federer—Station WINS—Hayden Planetarium.

5:45 p. m.—"New Horizons"—Station WABC—American Museum of Natural History.

SEPTEMBER 20

1:05 p. m.—Organ Recital—Station WNYC—Brooklyn Museum.

SEPTEMBER 21

5:45 p. m. — "Exploring Space" — Station WABC—Hayden Planetarium.

SEPTEMBER 22

1:05 p. m.—Organ Recital—Station WNYC—Brooklyn Museum.

SEPTEMBER 23

1:05 p. m.—Organ Recital—Station WNYC—Brooklyn Museum.

SEPTEMBER 24

10:00 a. m.—Organ Recital—Station WNYC—Brooklyn Museum.

12:00 m.—"This Wonderful World" (Question and Answer Program)—Station WOR—Hayden Planetarium.

SEPTEMBER 26

3:45 p. m.—"What Is Practical Astronomy?" by C. A. Federer—Station WINS—Hayden Planetarium.

5:45 p. m.—"New Horizons"—Station WABC—American Museum of Natural History.

SEPTEMBER 27

1:05 p. m.—Organ Recital—Station WNYC—Brooklyn Museum.

SEPTEMBER 28

5:45 p. m. — "Exploring Space" — Station WABC—Hayden Planetarium.

SEPTEMBER 29

1:05 p. m.—Organ Recital—Station WNYC—Brooklyn Museum.

SEPTEMBER 30

9:45 p. m.—"The Role of the Museum in Community Life," by Dr. Charles Russell, Curator of Education, American Museum of Natural History—Station WQXR.

1:05 p. m.—Organ Recital—Station WNYC—Brooklyn Museum.

THE POLARIZING FILTER

By CHARLES H. COLES

Chief Photographer, American Museum of Natural History

HAVE you tried the relatively new polarizing filters on your camera? No? Well, if you make up your mind to do it soon you will be in for some very delightful surprises. Perhaps you are wondering what these new gadgets will do to improve your pictures, so let's look into the possibilities of the strangely acting discs.

First of all, what is a polarizing filter? Unlike the filters commonly used in photography which are various shades of yellow, red, blue, etc., the polarizing filter has only a clear grayish tinge. Instead of excluding light of certain colors, it excludes one-half of all the light, regardless of color, but it does this in a rather peculiar fashion. It filters out only the rays that are vibrating in a certain direction. Polarization is a quality of light that the eye cannot perceive, but it is readily demonstrable with two polarizing filters. Through either of them, separately, a source of light looks only diminished in brightness; but if the two filters are placed together and one rotated, a position will be reached where the light is completely blotted out. When this occurs, one filter is excluding the "up-and-down" vibrations of the light, while the other is excluding the "back-and-forth" vibrations.

With the polarizing filter on the camera in any position, only half the light entering the filter passes through, hence the minimum filter factor of a completely polarizing filter will be two times. The fact that the polarizing filters now available for cameras consist of layers of microscopic crystals which have a slight grayish tone, the filter factor is slightly higher than two, usually running about three times for the more completely polarizing types.

Polarizing filters are made practical on a camera by the fact that almost all nonmetallic objects polarize the light that is reflected from them. Even the blue of the sky is a reflection from the air; so it, too, is polarized.

Suppose we want to photograph a distant mountain. The sun is high overhead and a blue haze veils the far-away peak. We know that this haze is very difficult to penetrate with our films so we try a red filter to absorb the blue rays. Of course, our camera is loaded with panchromatic film, otherwise it would be impossible to photograph through a red filter. But wait! That red filter demands that we make our exposure about six times as long as we would without it, which means that we'll have to take out our tripod and fuss with time exposure. We realize that the slight wind that is blowing won't help matters during a time exposure, so we start to think:

We know that the blue of the sky results from the reflection of sunlight by the air. We realize that we can reduce this reflection by absorbing the polarized component of the reflected light. Now this haze between us and the distant mountain is really nothing but reflecting air, so why not try the effect of a polarizing filter to darken the "sky-blue" of the haze?

By looking through the polarizing filter and turning it, the angle at which it is most effective is readily found and the picture made through the filter at that angle. The exposure is only increased a bare three times, and with the right conditions a remarkable clearing of the distance will be obtained. Then, too, the picture will not have the bizarre appearance that a red filter so often produces.

If you are using one of the popular natural color processes, the polarizing filter will be of even more use. The author spent some time photographing in the Southwest this summer and noted that a color picture of a brilliant red cliff would show an unwanted purplish cast. This was due, obviously, to the light reflected from the blue sky mixing with the red of the cliff. The reason that the camera produced an effect that did not agree with the spectator's visual impression was that the eye had been exposed to the bright blue of the sky all day long and was fatigued to blue. The blue sensitivity of the eye being thus depressed, it failed to register the admixture of blue with the red of the cliff.

If, now, a polarizing filter be held before the eye and the disc rotated to the proper angle, the blue sky reflection will disappear and the red sandstone will glow a bright and pure color. Maintaining the proper angle of the filter and slipping it over the camera lens, a picture can then be taken which will far more resemble what your eye saw than anything that might be obtained in a direct photograph. Photographs made in this way of the Grand Canyon are strikingly rich in color.

Another use of the marvelous filters may be found when photographing a cliff or building face that is in shadow. The sun may be at the right or left of the subject. The sky in this case will be so bright compared to the subject that it will be almost impossible to show any clouds or color in the sky. By applying the polarizing filter, the sky may be reduced in intensity until it photographs well with the shady subject.

Some of the trick effects obtainable with these filters are quite striking. At the proper angle with the surface of water, a polarizing filter will enable a camera to penetrate the reflection of the sky on the surface and apparently see into the water easily. Stones, shells, and fish near the bottom of a shallow sunlit pool will be remarkably clear. Glass windows and show cases may be as readily penetrated.

A red filter used with a polarizing filter will produce in some cases a dead black sky. The clouds will blaze brightly against what appears to be a night sky. The use of one of the new very high speed panchromatic films is indicated by the excessive exposure which otherwise would be required (about 20 times normal exposure).

You'll have a lot of fun with a polarizing filter and do tricks with one that previously were exceedingly difficult. It is to color film what the yellow filter was to monochrome film.

Unusual Services

A NEW LANGUAGE AT HOME—An explorer heading a safari, a savant going on an expedition to Persia, a movie actress has a new part, an author on his way to Sweden to accept the Nobel Prize, a businessman going to Brazil, a traveler planning a tour of France. When such call comes to learn a foreign language quickly, yet thoroughly and with perfect native accuracy, men and women like Sir Hubert Wilkins, arctic explorer; Paul Muni, motion picture star; Emil Ludwig, writer; Burton Rascoe, critic; Eva Le Galliene, actress; Sinclair Lewis, novelist; and a host of others write or telephone the Linguaphone Institute to deliver a Linguaphone set. In an incredibly short time they master the language of their choice in the privacy of their own home.

•

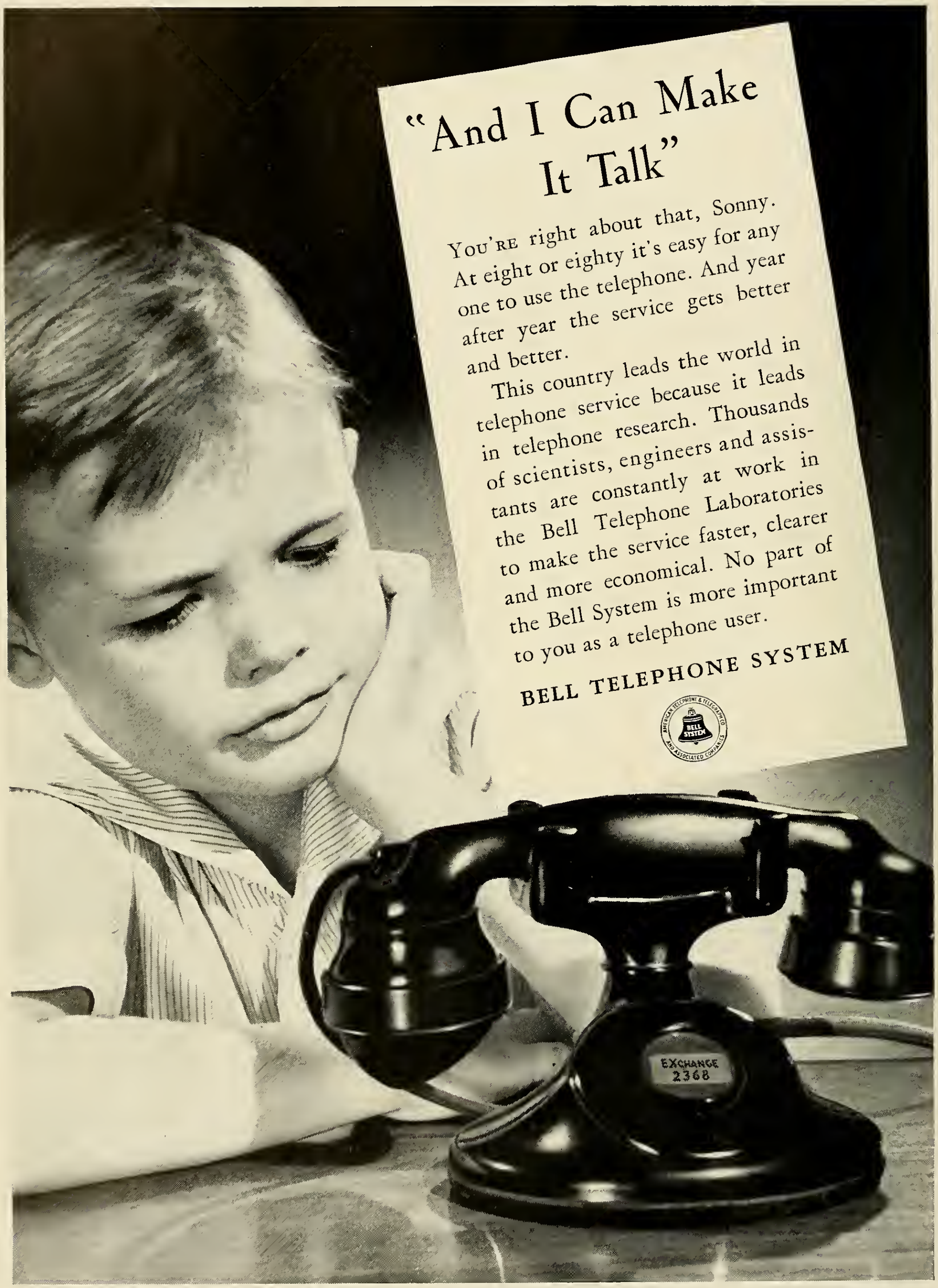
A **FRUIT CAKE** that is really made from fruit with no flour, no shortening, no eggs, no spices, no baking powder or flavoring, but just fruit and nuts is indeed a novelty to be desired. Being uncooked, this fruit cake retains the original flavor of the fresh fruits and nuts. It is rich but easy to digest because of its lack of starches. A health food that may be kept for three months or more, in fact improving with age. The Canoga Farms, Box 8, Encino, California have found a unique use for fruit in this delightful cake made of fifteen different kinds of selected fruit and nuts. Something new to eat for young and old, this delicious 5 pound cake may be had for only $3.50. Express prepaid.

•

Few are the people who at some time have not wanted to write. Many have tried—unsuccessfully. Everyone has a story. No life is so dull that experience and memory cannot produce the makings of a real tale—dramatic, tragic or amusing. From letters, diaries and notes a wealth of material can be produced to add to the color of your story. Writing and selling your work need the experienced guidance of an agent. Eugene Filteau at 274 Madison Avenue can help you. Perhaps a little friendly encouragement may start you toward achieving the satisfaction of seeing your story in print.

•

When visiting **FRED LEIGHTON'S** shop, 15 East 8th St., you will forget the noise and restlessness of the big city . . . you will think of Indian Tom-toms beating, visualize Navajo squaws sitting under shady trees, weaving their thoughts into exquisite rugs. The brilliance of the sky and the silver of their waters are captured in Indian jewelry, the ruggedness of their earth in beautifully formed pottery. Their costumes tell of War-dances, rhythmic and powerful. Now and then an Indian puts this down on skin or paper in vivid colors, so that his art and traditions are preserved for you to see. . . . Drop in this delightful shop, or send for a leaflet.



Your good telephone service is made possible by the constant research of Bell Telephone Laboratories

NATURAL HISTORY

The Magazine of the American Museum of Natural History

FREDERICK TRUBEE DAVISON, President | ROY CHAPMAN ANDREWS, Sc.D., Director

VOLUME XLII—No. 3 ★ ★ ★ ★ ★ OCTOBER, 1938

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

EDITOR: Edward M. Weyer, Jr., Ph.D.

ASSOCIATE: D. R. Barton.

PRODUCTION: Frederick L. Hahn.

ART: Charles Curtis Hulling.

Manuscripts should be sent to the Editor, The American Museum of Natural History, N. Y.

SUBSCRIPTIONS. NATURAL HISTORY is sent to all members of the American Museum as one of the privileges of membership. Membership Secretary, Charles J. O'Connor.

ADVERTISING DEPARTMENT: Sherman P. Voorhees, Manager. W. Ware Lynch.

REPRESENTATIVES:
Frank S. Whitman, Chicago, Ill.
Warwick S. Carpenter, Santa Barbara, Calif.

NATURAL HISTORY is published monthly (except July and August) at New York, N. Y., by The American Museum of Natural History, Seventy-ninth Street and Central Park West. Subscription price $3 a year, single copies fifty cents. These rates also apply to Canada, Newfoundland, and all foreign countries. Entered as second class matter March 9, 1936, at the Post Office at New York, New York, under the Act of August 24, 1912.

JOHN C. HATLEM

A City Refuge For Birds

CENTRAL PARK, NEW YORK

CAREERS IN NATURE—*No fortune-hunter need apply, but if a full and useful life devoted to science appeals, make a lifetime job of your naturalist hobby for its inherent worth and deep personal satisfaction*

By Donald Culross Peattie

A young woman in the suburbs of New York City with a living to make discovered that she knew more about the birds that passed through the great metropolis than about her 7,000,000 neighbors. With city parks as migrating rendezvous for bird life, she believed that conducting bird walks would prove an appealing diversion from brick walls and stone pavements. New Yorkers soon recognized that birding in Central Park held many advantages for them—outdoor exercise close at hand among pleasant companions, in the form of an unbounded hobby! She used the exhibits at the American Museum of Natural History, just off the park, as a supplementary classroom. There she attracted the attention of museum scientists, always on the watch for gifted young people, and before long she found herself bound for British Guiana, to collect birds for the museum. She may well become a leading authority on the bird life of South America.

Born naturalists

This girl got what she wanted most in life—a career devoted to Nature—by conspicuous ability and service. Naturalists, and others in careers related to the natural sciences, are like born musicians; you can't keep them from the thing they want. Not even by the discouragement of modest salaries. Not even by the shackles of city life, where Nature is at its thinnest. They've been known to investigate street sparrows or prison beetles and make themselves famous with such poor materials.

In fifteen years of writing newspaper columns, magazine articles, and books about Nature, I have received hundreds of inquiries from young people (or their parents) who want to make careers in the Nature field. They ask where to get the training, what it should be, how long it will take, what it will cost. How shall they find jobs? What rewards can they expect?

My problem has been to encourage those who had some chance of succeeding, and gently to dissuade others who might love Nature but not more than they love material success. All careers in Nature are aspects of science, and science discourages fortune hunters. It offers narrow scope to fame seekers. There are famous naturalists, but they are humble about it.

But if you have a bent for natural history that nothing can iron out, if you can take the training and emerge with highest grades, then there are careers open to you. Old fellows die off; young ones are needed. The world can use geneticists, agricultural explorers, plant pathologists, ornithologists, entomologists, foresters and experts in range land, wild-life and game management, conservation experts and taxidermists.

How to begin

As for training, college degrees are today almost indispensable for highest advancement, except in the lower gradations of Forest Service work. One young man, however, has recently shown that by serving a four-year apprenticeship to the Museum of Comparative Zoology at Harvard he may become chief taxidermist without a general university education. Still, that training was the equivalent of college years in money and application. If you want to know where to go and what to study, you should write to the Educational Conservation Society, at 4313 Laurel Hill Boulevard, Woodside, New York. And from the Department of Agriculture, at Washington, obtain Wild-life Research and Management Leaflet BS-98.

Uncle Sam is the biggest single employer of naturalists in the world. Four of the old-line departments, aside from special New Deal work like the Civilian Conservation Corps, embrace most of the fields for aspiring naturalists. The Department of Agriculture is more or less in the Nature line from top to bottom, though for our purposes its three outstanding subdivisions are Forest Service, the Biological Survey, and the Bureau of Entomology. The Department of the Interior embraces the National Park Service, which will, above all, attract those who are die-hard conservationists at heart. The Department of Commerce manages the Bureau of Fisheries. And the Smithsonian Institution, with its National Museum and National Herbarium, is the ideal field for the purely theoretical naturalist.

Uncle Sam is a modest but steady paymaster. Political upheavals and patronage have no effect on the jobs of government scientists; the work is too hard and the pay too low to interest sinecure-seekers or their Congressional friends. Only the Secretaries and Assistant Secretaries, and sometimes an obstreperous chief of Bureau, undergo job decapitation.

Taking up the departments in the order named:

Inquiries about the life of a forest ranger are commonest on my desk. Lovers of out-of-door adventure, youngsters eager to do something heroic, worshippers of the deity that is in trees, ask thirstily about Forest Service. Even girls want to be forest rangers, though this is the one branch from which their sex are excluded by the hard life.

More grind than glory

There is an unusual turnover in Forest Service employment, so that the chances of getting a job there are better than in some other civil services for naturalists. To visualize what your life would be like, and what you can hope to get, as well as the needful preliminary training, write for U. S. Department of Agriculture Miscellaneous Publication No. 249, entitled *Careers in Forestry*. There is more grind than glory, but there are deep satisfactions in knowing that what you are doing is a genuine national service. People who can't stand to see a tree felled must realize, though, that Forest Service is in the business and science of cropping trees.

Boys born into and trained in the white-collar world start with physical and background handicaps, so far as ranger life is concerned; such boys should steer for the research and technological jobs. The successful lumber expert in Forest Service usually has had a lot of tough practical experience in lumber camps. The ranger who can manage Forest Service's immense holdings of unforested range or browse land is usually a boy who grew up in cattle country, understands grass and steers, and, most important of all, likes cattle men and can handle them.

But Forest Service maintains research laboratories. So it uses a limited number of experts in wood technology. Its publicity department includes nature writers of marked gifts. A big business, it needs accountants, clerks, statisticians. Indeed, all the careers in Nature offer special rewards to those who are both scientists and possessed of good business heads. For every one such there are thousands who love Nature and obey the disciplines of science and yet, like myself, cannot keep their personal accounts, much less those of a corporation.

The records of the Bureau of Entomology contain some of the greatest stories of pure natural science, practically applied, in history. The Bureau isn't big, but it is mighty, and the lad who is laughed at by his companions for his beetle collection may be a future L. O. Howard, the veteran "insect fighter" of the Bureau. Or a Theobald Smith, who won the battle against Texas cattle fever.

Wild-life management

The Biological Survey is in many ways the most fascinating of all the services in the Department of Agriculture. Its business is wild-life management. It selects, purchases, builds up and maintains bird refuges and game animal sanctuaries. Hunters demand that it shall produce, at the public expense, an annual crop of furry and winged game for them to shoot; conservationists demand that it shall protect animal lives. To steer a middle course, to keep the pulsations of animal life in the desired rhythm, the Biological Survey employs both theoreticians and practical field men (indeed, its employees have to make themselves both!).

At the same time that it may assign some young man to years of work on the life history of the field mouse, it sets another to work seeking a new way to poison rats without poisoning anything else. The man who knows more about polar bears than anyone else in the world, works at the desk next to the game warden who has had to have gun battles with criminal plume-hunters and game bootleggers. It is a service of every sort of talent in the all-embraced word, Nature.

Over in the Department of the Interior is lodged the splendid National Park Service. I have just been making a tour of western parks. A finer lot of young men than the park employees I never met. Trained, intelligent, manly, with a healthy life and permanent employment, they may look forward to full careers. (I noticed, too, how thick the girls were, near the park uniforms—college girls doing summer waitress work in the park restaurants, for instance.) If there is a man I envy it is the fellow who holds down the post of Park Naturalist, up there in the country of deer and bear, snowshoe rabbit and ptarmigan, giant spruce, redwood, and alpine wildflowers.

The Bureau of Fisheries, in the Department of Commerce, is the field for the future Agassiz or Prince of Monaco. It is Izaak Waltonism made a science, with management of our water life—fisheries, hatcheries, and oyster beds. Both practical work and technical research are in its vast field, and if it is not a large bureau it is a fascinating one. Marine life has engaged the first attention of the philosophers of science, from Aristole at the seashore to Beebe in his bathysphere.

All these services come under civil-service examination. The inside track, in my experience, is to make contacts and friends in the branch that attracts you, while still training, learn what posts are really open, and let your friends guide your training. If you have graduated from a college with stiff scholastic standards, civil-service examinations are easy.

Scientific foundations

Those whose bent in natural history is close to the medical, but who are tempermentally not cut out for the life of a practicing physician, may find themselves happiest under the aegis of one of the great "foundations" like the Rockefeller Foundation or the Carnegie Foundation. They send you places, and you see things, if you have conspicuous gifts for genetics, vital statistics, parasitology, theoretical bacteriology, archaeology, ethnology, primitive linguistics. Immortal Noguchi had such a career, starting early as a boy in Japan and dying a martyr for science in Africa. The road to these Foundations is through your college professors and outstanding ability.

I make no mention of teaching as a career in Nature because it is well understood. Its long vacations appeal to naturalists, and if you don't mind modest pay and the pedagogic grind, it is a good career. If what you want is research and quiet study, you are no born teacher. Your place is probably in one of the museums, and all large cities and a surprising number of small ones now have natural history museums. The Government's museum is the Smithsonian Institution, where theoretical rather than applied science is stressed. The public thinks that museums exist in order to put curious and colorful objects on display. But that, though important to donors and taxpayers, is only one phase of museum work. Behind "No Admittance" doors the real work of the museum goes on—tranquil, lifelong, fascinating to those with the temperament for it, a delightful fellowship in study among the miles of specimens too important to waste on the cases outside. The pay is as modest as the soul satisfactions are great.

Raymond Ditmars, in his autobiography, tells how as a boy he got into the American Museum of Natural History. His collection of snakes, lizards, frogs, and live flies had been banished by an indignant family. They made no objection to his collection of moths, however, and with this, a hobbledehoy still, he trudged into the museum, demanding to have some puzzling specimens named. The old scientist who admitted him peered incredulously at a splendid series of a rare species, five times as extensive as the museum's own collection. Young Ditmars was told that the museum needed a young fellow to mount and label specimens, and that he might come back some day to apply for the job. He turned up next morning. For years, thereafter, he toted equipment for bigwigs, kept his eyes and ears open. Today he is A-1 man in herpetology around the museum and at the zoo.

Sometimes a wise parent bends the twig this way. A girl who had to spend a year in bed was given a marvelous collection of shells to amuse her. She became so fascinated that she studied conchology when she got to college, and soon afterwards was head curator in her subject at a great museum.

Self-made careers

In Dr. Alexis Carrel's laboratory, William Beebe noticed a young woman doing outstanding work. He took her on his oceanographic trip to the Bermudas. There she devised a method for making fish transparent for study. Obviously she has a lifetime future ahead of her.

A widow in Chicago, holding down a dull proofreading job, became so fascinated by botany that she would go out on Sundays with a famous botanist, carrying equipment, looking and learning. Today, in our leading museum of plant collections, she is an expert on the most economically important plants in the world—the grasses. She is as well known in Vienna or Kew as in Washington.

Museums also employ artisans and artists with a bent toward Nature. Can you blow glass? The Blaschka family worked themselves into life employment making glass flowers for Harvard. Herman Mueller, glass-blower, has found a career in the making of models of microscopic life at the American Museum. Draftsmen with delicate skill and keen observational powers are needed for museum exhibits and publications. No impressionists need apply. Exhibit work requires people with the knack of rigging things up, people skilful with their hands, able to make wax, paper, glass, cloth, and plaster look like living tissue.

Natural history today cannot get on without photography, though it is admittedly of a very special sort. Anyone good at night photography, microphotograph, X-ray and infra-red photography, brilliant, swift out-of-door work, would be so valuable to many institutions that, if he had any original bent toward Nature, he would be worth training especially.

And private industry utilizes Nature career men. Pharmaceutical houses employ botanists; associations of fruit growers employ pathologists; biological supply houses that make up the demonstration materials for schools and colleges use technical biologists who are good with their hands and know what to collect and where to find it.

A southern lumber company, losing tens of thousands yearly from fungus ravages, sought an expert. They found him working quietly on the theoretical side of fungus science in the laboratories of a botanical garden. But the practical controls he devised are so valuable that he is regularly retained by timber interests.

Agricultural explorers

The United Fruit Company holds out possibilities for botanists, pathologists, soil experts. It sends young men to learn banana culture in Central America. When I was at college the fruit company had placed one student in our laboratory to make a special investigation of pineapple diseases. The life of a top man in the company's Central American plantations is colorful and delightful. The career of one of its most successful men is well known to me. Wilson Popenoe, raised in the citrus and date country of California, grew so fascinated by pomology that he trained at Pomona College and entered the U. S. Department of Agriculture as an agricultural explorer. The avocados he brought out of Latin America, as well as the flawless Spanish he acquired, attracted the company's attention so that he was bought away from Uncle Sam at a handsome figure.

In all these stories of successful Nature careers there are obvious morals. First is the need of long training and patient apprenticeship, second is the need of outstanding ability. Just as important is an initial love of the whole field, that cannot be stopped. These successful careerists all threw their hearts in, all started at the bottom, took orders like soldiers, had insatiable curiosity, worked fast, thoroughly, and cleverly. They were not after money or fame; they wanted to serve. These are the same qualities that make one successful in any profession.

So we hear stories of a college boy who became so fascinated by bird-banding that his studies and results attracted the attention of older men, and today he manages bird refuges for the Biological Survey. If your boy is driving the family distracted with insistence that keeping records of his pigeon-breeding is the most important thing in life, perhaps he is a future Mendel. At any rate, it is worth a parent's while to ponder the possibility that early enthusiasm for Nature in some guise might be moulded and forged into a life career.

Lifetime employment

I cannot say too often that the training is hard and the salaries are extremely modest. But I can say this for careers in Nature: employment, once obtained, is usually for life. Scientists, already poor but doing a useful work nobody else could replace, did not suffer in the depression comparably with commercial employees. And a man contented with three thousand dollars is richer than a man miserable because he has only three million.

Naturalists are a contented lot. They have the deep satisfaction of doing what they want to do, and they believe that it is more precious than boosting the sales curve on soft drinks. Personally, and in their private lives, Nature career men reflect the certainty they enjoy of doing something true and doing it well.

J. C. HATLEM

White Pelican

THE MAPPING OF

By H. E. VOKES
Assistant Curator, Invertebrate Palaeontology, American Museum

ANCIENT SEAS

Showing how the geologist and palaeontologist reconstruct the scene of prehistoric "cataclysms" that have radically changed the face of the earth, and re-create the animals that struggled and died beneath long-vanished seas

A HYPOTHETICAL "DEPRESSION"

The entire eastern section of the United States would become an island if the continent sank a mere hundred fathoms, leaving Chicago submerged and converting St. Louis and Little Rock into thriving seaport cities. Changes in the earth's surface far greater than this have occurred many times in the past, but a million years or so at the normal rate would be required to produce the conditions shown at the left. The blue tint shows the extent of the encroaching seas on the present continental surface

PICTURE the continent of North America, that you know and live on, slowly sinking until the shore line of 1938 lies 100 fathoms below the surface of the ocean. This would be "a depression"—a geologic depression so vast and so far-reaching in effect as to dwarf nearly to insignificance the changes wrought by the all too familiar economic variety.

St. Louis, Little Rock and Dallas would become thriving seaports on the western margin of a broad shallow sea that stretched through the Mississippi Basin and northward, by a connecting strait, into a narrower seaway comprising the Great Lakes and the St. Lawrence Valley area, as shown on the accompanying map. Louisville and Birmingham, no longer famed for race horses and steel mills respectively, would be shipping centers on the western and southern shores of a large island containing most of the eastern states of our country. That portion of New England and the Maritime Provinces of Canada which was not under water would form another, smaller island separated from that to the south by a narrow channel occupying the present Hudson River valley and Lake Champlain region. In the north, Quebec and Labrador would be connected to the rest of the continent by a narrow isthmus separating the Great Lakes from a considerably expanded Hudson Bay.

This "great geological depression of 1938," if it ever did happen, would require a million years or so at the normal rate. But this is not so breath-taking a span of years as time is measured in geology. Equally astonishing alterations in the earth's surface have actually taken place several times in the past.

Let us assume that after being submerged our continent was once again elevated to its present position —say by the year 1,193,800. The record of its submergence would be left by the receding waters in deposits of mud and silt which would in time have become sandstones, shales and limestone. We would have only to plot their distribution on maps to determine the nature and extent of the old seas. Moreover, the character and general outline of the areas that had always remained above water throughout the inundation would be reflected to a certain extent in these sediments. For instance, if we were to find thick deposits of conglomerate and coarse sandstone it would tell us of highlands near the sea from which torrential streams flung a burden of gravel and cobbles, while thick shales would imply relatively low-lying lands near the shore. Beds of limestone and coral reefs such as we would find if we revisited Florida, would speak of warm, clear waters with lands too far distant or too near sea-level to add materials to the marine deposits.

Were we to plot the distribution of these deposits within a few hundred years after the re-elevation of the continent we would expect to find an exact mapping of the outline of the former seaways. But the very elevation which permitted our examination would also expose the deposits to the destructive work of the forces of erosion. In many details, particularly with respect to the shore lines, the exact configurations would thus be destroyed. Our problem would be still further complicated, if submergences later than the original one had resulted in deposits of sediment burying many of those formed in the period which we were studying. It is under these conditions that the fossils—the remains of animals and plants entombed in the sediments—would attain great significance.

By tracing the evolutionary development of these buried forms, we are able to separate them into earlier and later stages of adaptation. Thus, even if two beds of rock are not lying together, when the fossil content of rock-bed A shows itself to be distinctly lower down in the evolutionary picture than that of rock-bed B we are safe in assuming that the animals and plants in bed B lived during the time of a later inundation and that consequently bed B is the more recent of the two. Furthermore, by charting the distribution of fossil-containing beds that yield creatures on the same evolutionary plane, we gain valuable information about the shape and extent of the seas in which they lived, and from this we may determine much of the geography of the continent at their time of life.

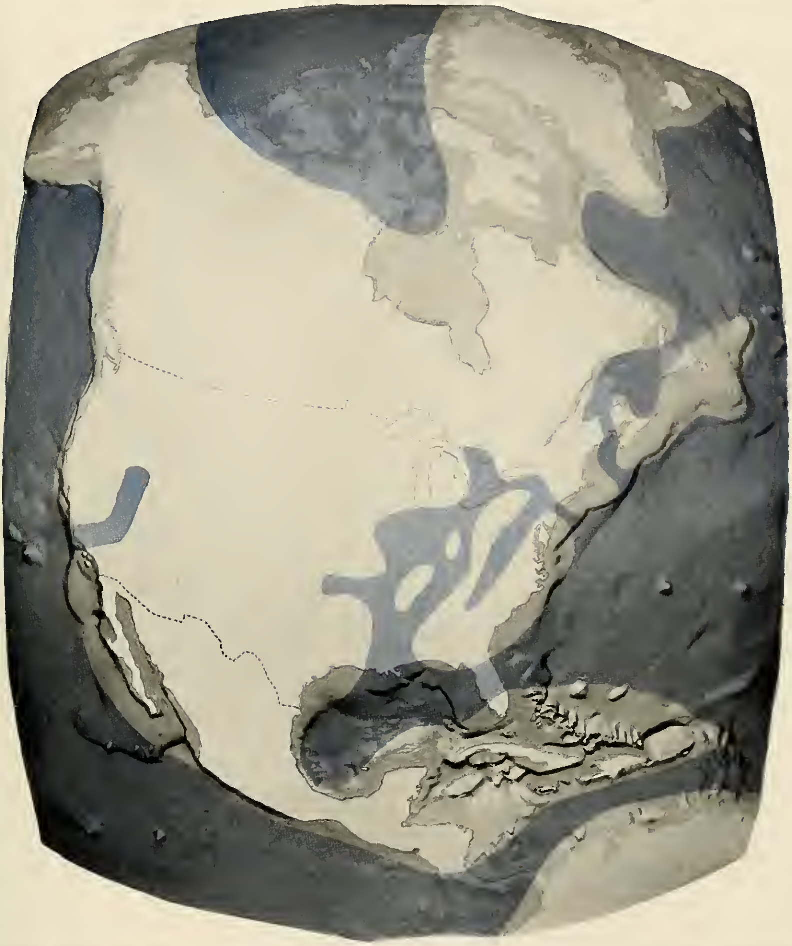
In this purely hypothetical submergence and re-elevation, we have roughly sketched the general approach and methods of the student of paleogeography —the scientist who works from a combined knowledge of geology and palaeontology. It can be seen at once that there is no magic about his ability to reconstruct a continent as it appeared in the long ago. He simply uses a thoroughly acquired knowledge of the material which the earth yields to him, and the only difference between him and the average hiker is the trained eye that enables him to interpret what he sees and finds around him.

North America 375 million years ago

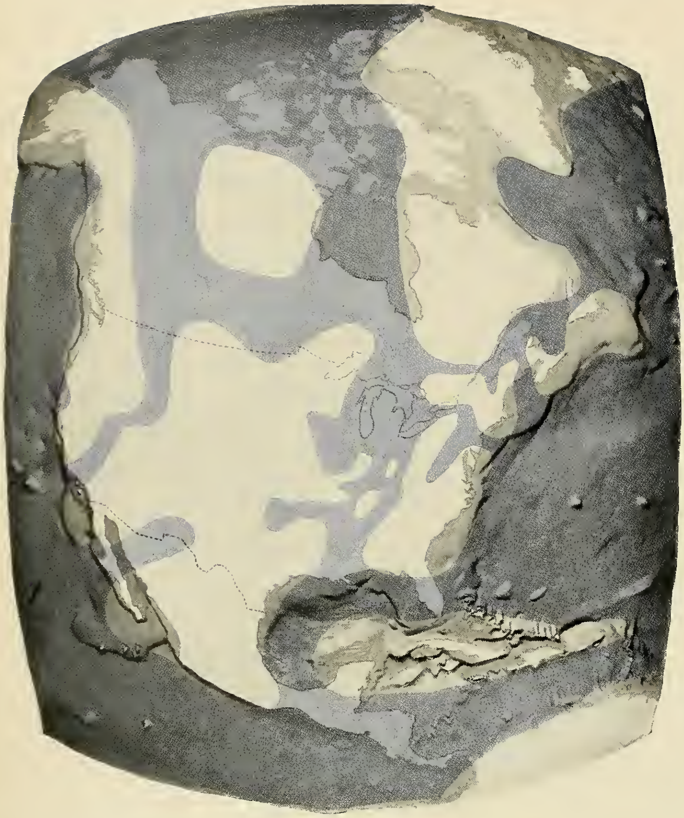
We begin our story at the opening of the Silurian Period when North America was almost wholly above sea level. As shown on the following pages, North America was successively flooded by the sea in the ensuing 100 million years and was the scene of a changing and varied assortment of ancient marine plants and animals.

Note that a strait ran from the Gulf to Lake Erie and thence to the Atlantic. Also that a large tongue of land extended over what is now the Caribbean Sea, and that the areas from Hudson Bay over Greenland were high and dry. The Atlantic and Pacific coastlines even in that distant day were largely controlled by the limits of the continental shelf, which is shown here in relief as it exists today. The Grand Banks, now so important to fishing industry, were then dry land.

Along our present eastern coast a chain of mountains extended from about the vicinity of New York City northward with interruptions to central Newfoundland. Encroaching seas passed to the west of these mountains in a shallow trough which occupied the region now marked by the Appalachian Mountains, the Catskills and the Hudson River Valley. Into the Appalachian trough, streams from the eastern mountains carried large amounts of sediment, which became rock. These deposits were laid down from New York to Alabama, and can be seen on the southwest face of the Catskills at the crest of Shawangunk Mountain. In the gorge of the Niagara River they are at water level at the whirlpool. The westward flow of the streams which carried these sediments can be traced by the increasing fineness of the deposits farther and farther from their source.



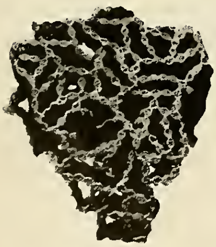
It is this trained eye that has enabled him to see that several times floods mightier by far than any that have plagued our continent in historical times have slowly and irresistibly moved in from the oceans to submerge great areas of our continent. The greater of these buried more than 57 per cent of the known land area of North America beneath the sea. It has been possible to build up a picture of our country as it was during and after these floods by methods much the same as those mentioned in the foregoing imaginary investigation. The advance and recession of the waters during these periods of flood have furnished convenient markers separating distinct periods of time, and these have been given names to simplify the work of the geologist in discussing their histories. The following maps and pictures show some of the interpretations which have been made for two of these periods, and some of the types of evidence upon which they are based.



By MIDDLE SILURIAN TIME North America was complexly intersected by seas. The mountains of Lower Silurian time had been worn down, and the fine muds and limestones deposited in these seas tell of low-lying continental lands. Great volcanoes were active in Maine and New Brunswick at this time. Lava flows and ash falls with a total thickness exceeding 10,000 feet tell a tale of volcanic craters rivalling any we see today.

The rocks formed of water-borne sediment are shown typically about Niagara Falls. The edge of the falls is formed by limestones, which also rim the gorge in cliffs more than 100 feet high. Below these are shales, less resistant to the action of water, which have been undercut behind the falls in places so as to leave the heavy limestones without support. The latter consequently often break off in large blocks leaving the piles of debris which have so materially changed the American Falls during recent years.

(Right) A TYPICAL SCENE on the sea bottom in the Niagara region during Middle Silurian times as reconstructed from fossil evidence. The reef on the right is composed of corals, algae, and bryozoans. Living on the reef and in the left foreground are tall flower-like relatives of the star-fish: crinoids and cystoids. In the foreground are four kinds of trilobites, arthropods related to modern crabs. The elongate animals, one of which is seen capturing a trilobite, are cephalopods, relatives of the living pearly nautilus



THE ABUNDANCE of brachiopods in certain areas in the mud of these Middle Silurian seas is indicated by the 32-inch block of fossils shown below. This solid mass of brachiopods was found near Rochester, N. Y. It represents a type *(Pentamerus oblongus)* that enjoyed almost world-wide distribution at this time

(Left) THE CHAIN CORAL, *Halysites,* which lived in all parts of the world during the Silurian Period

(Right) A BEAUTIFULLY ORNAMENTED BRACHIOPOD, *Dictyonella reticulata,* characteristic of the Middle Silurian in the Mississippi Valley region. This figure is enlarged about six diameters

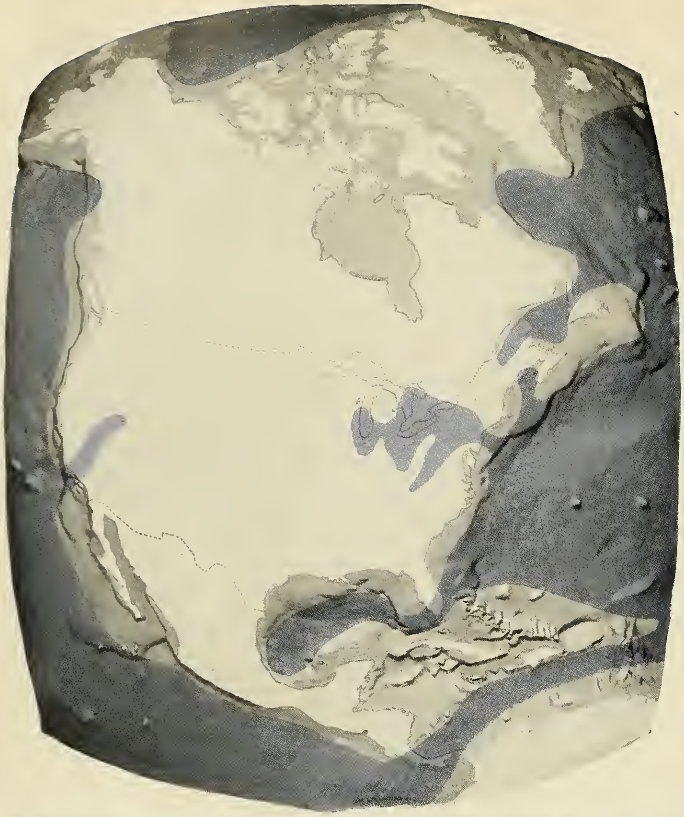
AMNH Photos by Bierwert

Buffalo Museum of Science Photo

(Right) A CRINOID OR SEA-LILY (*Eucalyptocrinus crassus*): a flower-like animal related to the star-fish, showing the body, stem and root-like processes by which it fastens itself into the mud. This is one of the finest specimens of its kind ever found. It was collected near Waldron, Indiana

(Below) TRILOBITES: ancient arthropods, a division of the animal kingdom which includes lobsters and crabs. These are a well-known type of fossils which in a variety of forms reward the collector who explores in rocks of the Paleozoic Era. With the specimens shown here *(Calymene)* are seen several brachiopods *(Strophonella)*. The specimen comes from Lockport, N. Y.

AMNH Photos



LATE SILURIAN. In this map several million years have rolled past and most of the continent has risen from the sea, exposing a land, however, which differed widely from that we know. Some shallow waters persisted, but in general we had a broad flat continent with no elevations to chill the westerly winds after they had crossed the interior of the continent. The eastern region became subject to long drouths, producing a great desert basin extending from western New York to Michigan and Ohio. Conditions must have resembled those about the Persian Gulf today. Around the shallow arm of the sea which entered the basin, great sand dunes moved restlessly before the hot winds. These same winds caused excessive evaporation in the waters of the sea, resulting in the deposition of great thicknesses of salt and gypsum. At Ithaca, N. Y., there are seven beds of salt with a total thickness of 250 feet. Since the deposition of one cubic foot of salt requires the evaporation of about 80 cubic feet of normal sea water it is clear that desert conditions must have persisted for a very long time

(Right) REMAINS of a eurypterid *(Eusarcus scorpionis)* from a quarry at Buffalo. Its close relative the scorpion, living at this time, crossed the strand line and became the first air-breathing, land-living animal

(Below) ROCKS deposited in these ancient seas: a quarry wall near Manlius, N. Y. The lower walls are of Upper Silurian limestones, while above are similar rocks with Middle Devonian brachiopods and corals. The irregular contact *(white line)* is due to erosion during the Lower Devonian Period

AMNH Photo

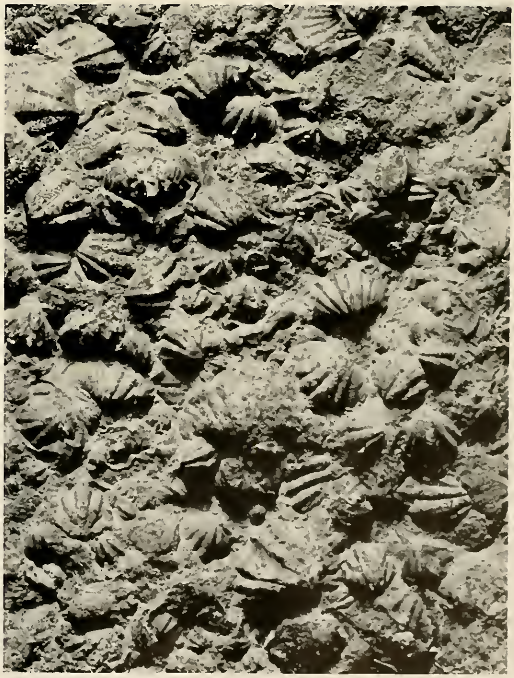
Buffalo Museum of Science Photo

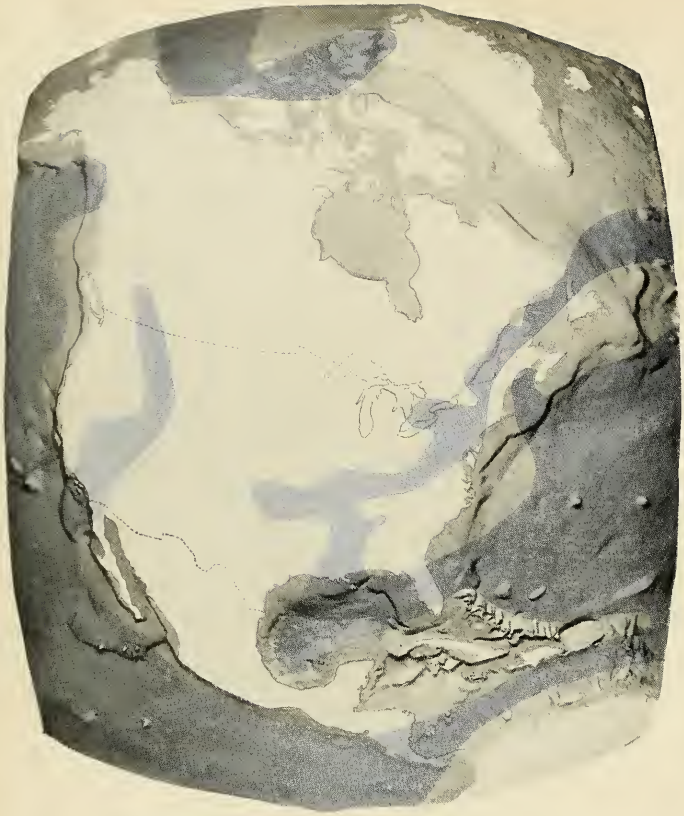
ABOVE ARE SHOWN some of the unique assemblage of scorpion-like animals which lived in the abnormally salty waters in the region about Buffalo, N. Y. Some of these animals, known as eurypterids, reached a length of nine feet. Several types are shown in the reconstruction, some of which are feeding on worms *(Bertiella)*, which probably constituted their main article of diet. Here and there among the waving "seaweed" *(Buthotrephis)* may be seen the coiled shells of the cephalopod *Mitroceras* and the almost flat, oval shells of a snail, *Hercynella*

ALTHOUGH most of the continent was above the water at this time a small waterway extended a short distance down the Appalachian region and great numbers of fossils indicate an abundance of life in the sea. The picture at right shows a portion of a large block crowded with the shells of the brachiopod, *Spirifer vanuxemi*, which lived only during this time and is, therefore, considered a guide fossil to the rocks of the Upper Silurian time.

At the close of Silurian time the sea seems to have withdrawn from the whole of the continent and to have left it exposed for a considerable period

AMNH Photo





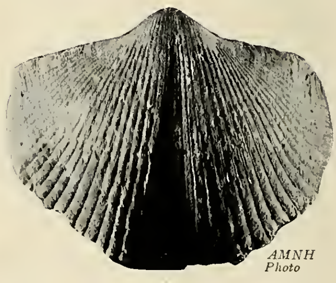
WHEN THE SEAS RETURNED at the beginning of the Devonian Period about 340 million years ago they brought an aggregation of animals that showed many evidences of evolutionary changes. The seas first encroached on the continent through a narrow trough and extended southwest as far as the region of the Arbuckle Mountains of Oklahoma. A similar narrow trough permitted the waters of the Pacific to cross Nevada and reach the region occupied today by the Rocky Mountains. The shores of these seas were very low, and limestones are the normal deposit found. In the New York region, however, some streams carried fine muds into the sea which today are found as shaley beds between the limestones. At one horizon there occurs a relatively thin zone of very pure quartz sand. It has been suggested that it was formed by the deposition in the sea of some of the sand of the dunes which were present during the late Silurian

(At right) A RESTORATION of the life beneath the seas of Lower Devonian times based on fossils found in the Helderberg scarp *(below, left)*. The development of spines and frilly

(Below) A WORLD FAMOUS collecting locality for Lower Devonian fossils: the Helderberg scarp at John Boyd Thatcher State Park near Albany, N. Y. The upper beds of the massive limestone cliffs and the slopes above are Lower Devonian rocks; the lower beds are of Upper Silurian age

AMNH Photo by Bierwert

CHARACTERISTIC Lower Devonian brachiopods, a form of shell-bearing animal life not common in modern seas, but numerous and varied in the deposits of these ancient times: *(above) Eospirifer macropleura; (below) Spirifer arenosus*



AMNH Photo

Photo from N. Y. State Museum, Albany

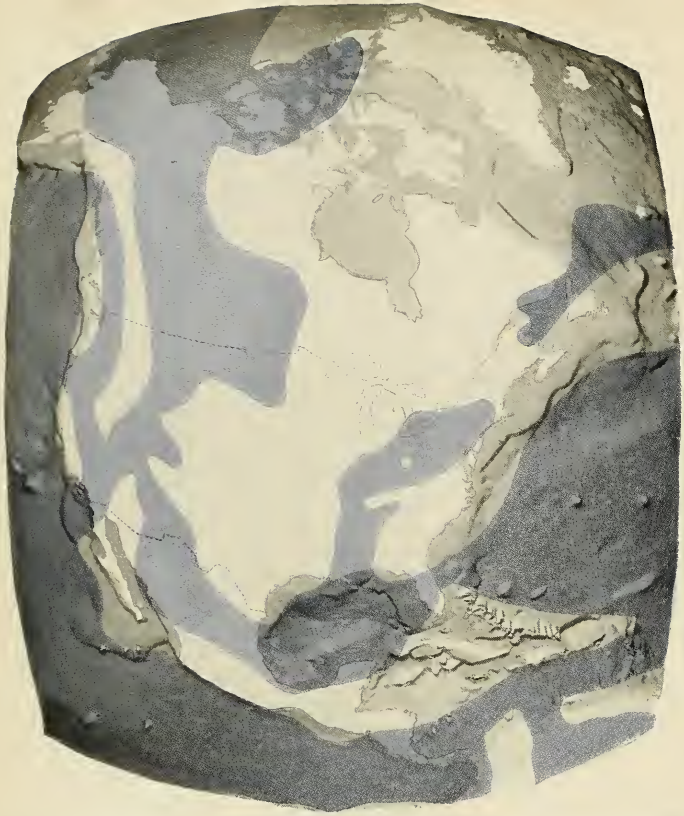
ornamentation on many of these animals is a noteworthy feature considered by some students an effort on the part of these animals to ward off the attacks of large shark-like fishes which first became widespread during this period. Many of these fish had flat, pavement-like teeth probably adapted for crushing the shells of trilobites, of which four types are shown above, and snails, a highly spinose type of which is seen in the rear at the right

(*Left*) ONE OF THE MOST abundant types of animal found fossil in the sandy beds of the Lower Devonian: a marine snail, *Platyceras*

AMNH Photo

(*Right*) A BEAUTIFULLY PRESERVED BODY of the crinoid *Mariacrinus nobilissimus* Hall, collected at Wheelock's Hill, Litchfield, N. Y. Here is shown only the flower-like upper portion of this creature, whose general appearance is depicted in the restoration above *(left, foreground)* where a related form waves gently beneath Lower Devonian seas

AMNH Photo by Bierwert

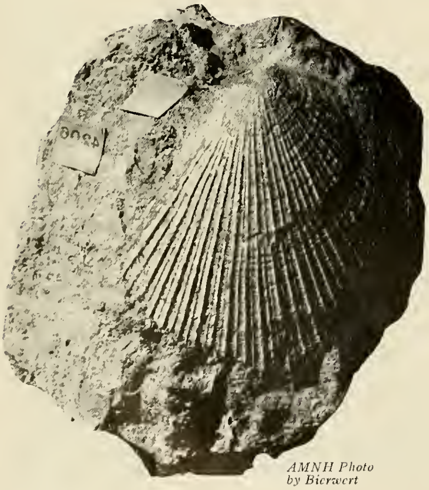


THERE was no emergence at the close of the Lower Devonian Period. Instead, during the Middle Devonian *(map at left)* the seas spread further over the lands; and since the border lands were very low, vast sheets of pure limestone were deposited in nearly all the seaways. At first the waters were very clear, and corals found conditions so greatly to their liking that these deposits are everywhere characterized by the great abundance, both of species and of individuals, of these animals.

Later, however, mountains began to rise in a chain extending from the Maritime Provinces of Canada, where they appear to have reached their greatest development, southward at least as far as the latitude of Cape Hatteras. Streams flowing from these mountains began to carry great quantities of sand and mud into the sea, building large delta deposits at their mouths much like that now being formed by the Mississippi River. These deltas gradually built out the shore line and accumulated the vast thicknesses of sandstones which today form the Catskill Mountains

AT RIGHT is reproduced a corner near a reef on the sea bottom of Middle Devonian time. The great abundance of life in these waters is vividly shown in this dioramic reconstruction

(Below) A PELECYPOD, or clam *(Aviculopecten pecteniformis)*. Pelecypods were abundant on the sands during the latter part of the Middle Devonian, when the seaways began to be filled by the sediments from the mountains to the east



AMNH Photo by Bierwert

(Below) TRILOBITES were common in the seas of the Devonian Period but rapidly declined before the onslaught of the preying fishes and after a few million years became entirely extinct. These specimens *(Dalmanites selenurus)* collected near Ovid, N. Y., represent one of the most characteristic species of the Middle Devonian faunas

AMNH Photo

Buffalo Museum of Science Photo

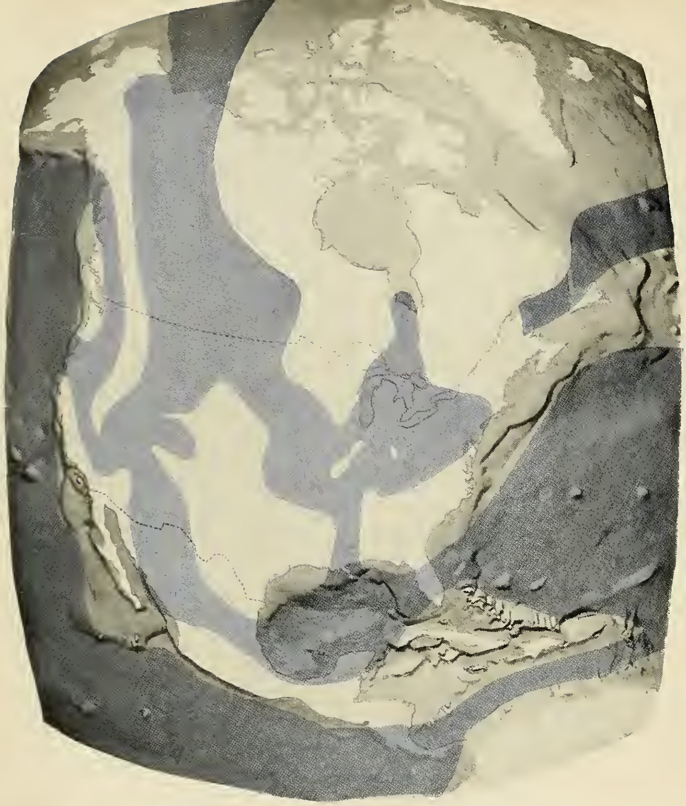
The large mushroom-shaped masses and the groups of tubular objects are corals, growing in colonies as do most of those now living. The cone-shaped objects are solitary corals and the elongate spiny animals are sponges. At the right is a clump of sea-lilies, or crinoids, animals despite their plant-like appearance. On the bottom are star-fish and brachiopods, and straight and coiled cephalopods, animals related to our squids and pearly nautilus. Large sharks are swimming in the waters in the background. The abundance of these animals has caused the Devonian to be called the Age of Fishes

AMNH Photo

Two views of a solitary or cup coral *(Zaphrentis dilatata)*. Some of these, about 300 million years old, measure 24 inches in length, dwarfing any coral now living

AMNH Photo

(Below) An exceptionally fine exposure of Middle Devonian limestones in the plunge basin of Oatka Creek near Leroy, N. Y. The rocks at this locality contain many corals similar to that shown at left, as do many other rocks of the Paleozoic era ranging from 540 to 200 million years old. Modern corals require warm, clear waters; and abundant remains of these animals suggest that such conditions were also present at the time these beds were being formed



In the latter part of the Devonian Period the sea gradually withdrew from the continent, so that at the close of this period no portion of it remained under water so far as geologists have been able to discover. Our map shows conditions at a relatively early point in this withdrawal; nevertheless, the sediments from the rising mountainous lands had greatly reduced the area covered by the seas in the eastern portion of the continent. The waters persisted longest in the western trough which extended through the region now occupied by the Rocky Mountains.

Not since this time has the region occupied by New York State been subject to any extensive submergence, although the waters did reach from the Gulf of Mexico up as far as eastern Pennsylvania at one time during the next few million years

At right is shown a reconstructed scene from the entrance of a cave on the sea floor of Upper Devonian time. The animals attached to the bottom at the entrance of the cave are sponges. Sponges of this type, similar to the modern

(Below) A typical scene in central New York during Upper Devonian time. The bottom of the sea was composed of sands and muds and the waters were not sufficiently clear to permit the development of coral reefs such as we noted in the Middle Devonian seas. Nearly all the other types of animals were still to be found, including fish, cephalopods, pelecypods, brachiopods, star-fish, crinoids and sponges. Trilobites, however, were already becoming somewhat depleted in numbers and are not commonly found *(Courtesy N. Y. State Museum, Albany)*

"Venus Flower Basket" of the seas about Japan, were locally quite common at this time, the restoration above being based on specimens collected in Cattaraugus and adjoining counties of New York. These sponges are characterized by the presence of a supporting skeleton composed of silica. Sponges similar to the bath sponge of commerce, are almost unknown in the fossil record because the spongin which supports the body tissues is not sufficiently resistant to be preserved. In general only the hard portions of an animal or plant are preserved as fossils, and animals lacking such elements as bone or shell are very rarely found *(Courtesy N. Y. State Museum, Albany)*

(Below) A SPONGE found in Upper Devonian rocks. The fossil is formed of mud which filled the body cavity of the animal at death, the reticulate pattern being produced by the spicules which supported the body tissues

(Below) A CEPHALOPOD *(Manticoceras sinuosum)* found near Sonyea, N. Y. These animals are of the same type as the pearly or chambered nautilus. The shell differs from that of a snail in having shelly partitions inside which divide it into separate chambers. The lines formed where these partitions joined the shell may be seen in the upper left

AMNH Photos

Photo from N. Y. State Museum, Alb

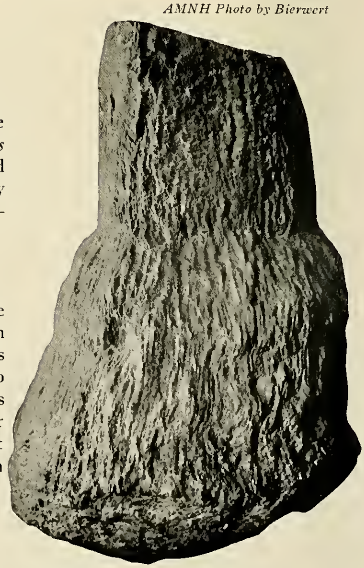
THE TRUE FOREST PRIMEVAL, a reconstruction of the first known forest. These fossil plants were found near Gilboa, N. Y., specimens being recovered during the construction of the Gilboa Dam, a unit of the New York City water supply system. The waters impounded by this dam now cover the locality. In the foreground is a reproduction of the conditions at Gilboa with the fossil tree trunks as they were found. The background shows the trees as they must have appeared in those distant days, growing on the swampy shores of the Middle Devonian Catskill delta

THESE TREES had fern-like leaves similar to the Upper Devonian form *(Cyclopteris)* shown below, but since they reproduced by means of seeds, rather than spores, it is known that they were more a highly specialized type than the true ferns

AMNH Photo

(Right) ONE OF THE STUMPS of the trees found at Gilboa *(Eospermatopteris textilis)*. The base is bulbous, as would be expected of a tree growing in swampy conditions. Some are known with a circumference of nearly 12 feet

AMNH Photo by Bierwert



The close of the Devonian saw life abundant. Sharks ruled the sea, while on land primitive amphibians and scorpions lived among the first seed plants. No flowers livened the landscape; no insects or birds flew the air; no dinosaurs or mammals trod the earth. But the great invasion of the air and land had begun

THE STORY OF ORCHIDS—*Behind the luminous splendor of milady's corsage lies a drama of danger and death in steaming jungles and endless scientific patience in the cultivator's laboratory*

By VIRGINIA S. EIFERT

All drawings by the author

A BRIDE may carry a bouquet of Laelio-Cattleyas —wonderful, lavender and gold flowers with spreading, ruffled, purple trumpets. A debutante may have a shoulder-corsage of spray orchids, or a sheaf of waxen, pale green, lady's slippers. The queen at court may have rare yellow Cattleyas; the dowager may add to her velvet and diamonds with mauve hybrids; the young girl may wear a single pink Cattleya and feel like a queen. For each one of these orchids, swelled with the sultry pride of its savage parents, radiates a strange, compelling charm which, as one thinks of flowers, is far from flower-like. They are all sensuous blossoms, with a brooding, physical beauty which has become a part of that strange something which no other flower can have—the orchid personality. Each is a separate entity of glowing light and color. Its crystalline petals seem too fragile to be touched, yet they will live for weeks without withering.

As related to man, orchids belong to the highest type of civilization, yet they are but recently removed from the primitive jungle. More than any other flowers, orchids show evidence of the highest degree of specialized botanical development. They are the product of many millions of years of adaptation to their environment in both their floral and vegetative growth. Horticulturally the hybrids between species of two and three genera represent the triumph of science in applying the natural laws which govern closely allied genus groups to produce beautiful and large flowers.

But so infinite is their variety that they are also capable of evoking the most sanctified responses. The Spanish friars who came to Mexico found a strange, exquisite, magnolia-like blossom with which they were able to illustrate a point in their teaching. In a terrestrial orchid of alabaster whiteness, from which there drifted a heavy, compelling fragrance, lay the snow-white image of a dove.

"Espiritu Santo!" exclaimed the first priest who saw it. He called it the Dove of God, the visual form of the Holy Ghost. In their teachings, the Spanish priests used the Dove Orchid to illustrate the miracle of the Holy Ghost. The Indians ever since have regarded the flower with unwavering devotion. "Espiritu Santo" they still call it, and even today the startling resemblance to a snow-white dove is seen in the pure cup of the Holy Ghost Orchid (*Peristeria elata*).

The life story of an orchid can conveniently start with the ripe seed pod, hidden deep in the sweltering rain forests of a Costa Rica mountain jungle. When the turgid brown pod splits, myriads of powder-fine seeds, sometimes a million in a single capsule, are sent out on the wind. Some of the seeds fall among the ferns; some fly a long distance and lose their viability before they can find an environment suitable for germination; some lodge against tree trunks, others fall in the water. With such an enormous number of seeds produced in one pod, nature allows for a large mortality rate among orchids. In order to germinate, the orchid seed must fall where conditions are perfect for growth. That condition is most often found on the lichen-coated trees, which provide an environment peculiarly well adapted to the needs of the orchid seedlings.

Lichens and mosses are constructed to hold moisture and at the same time to protect the seed that falls within them. The rains come. The orchid seed begins to swell. As it swells the spores of a fungus enter the softened body and surround it with jelly-like substance in which the young orchid sends out an almost microscopic root and a single seed-leaf or cotyledon.

Dry seasons and wet seasons pass; in a year the orchid is only an inch high, and has added but three more slender leaves. In spite of a tropical environment which usually is a stimulant to rapid growth, development among the orchids is very slow. Year after year the plant increases in size, yet in all this time there is no evidence of any blossom. The food-roots dangle freely in the moist air, but although the orchid plant is dependent upon the tree for a resting place, the tree itself is nothing more than a support. The orchid absorbs salts and minerals from decayed vegetation among the lichens; it is supplied by the air roots with water; and in the presence of direct and indirect sunlight, manufactures its own food.

Thus the orchid is a self-sustaining plant and not a parasite.

From seven to twelve years after the seed germinates, the orchid puts forth a slender green bud encased in a sheath. This may occur any time of the year, depending on the locality and the species. Daily the bud grows larger and at last the glistening, lavender-pink sepals and petals curl back; and the slender, translucent trumpet spreads its wine-red, fluted lip to the faint sunshine that penetrates the jungle ceiling in a forest where there is usually copious moisture. During the dry season many of the tropical orchids draw upon the bulbous reservoirs or pseudo-bulbs at the base of each leaf for supplies of moisture and plant tissue reserves to sustain them until the wet season comes once more.

While some species of orchids resort to self-pollination, most of them are constructed for a specialized insect sponsor, and if the specific agent does not come at the required time, sterility of the ovaries results. We may assume, for instance, that there is a certain bee that is especially fitted to enter a given species of Cattleya. As the bee enters the Cattleya's

Many tropical orchids, like the Cattleyas above, are soilless plants which dwell high in the trees and never have contact with the earth

(Above) *A strange magnolia-like blossom which the Spanish friars found in Mexico and used to illustrate a point in their teaching. Even today the startling likeness of a snow-white dove is seen in the pure white cup of the Holy Ghost Orchid*

lip, his thorax brushes lightly against the glue gland or rostellum, which provides a sticky substance. The membrane of the gland is broken, simultaneously the glue exudes and draws with it the pollen mass, fastening it tightly on the bee's back as he recedes from the flower. When he resumes his repast in another flower, presumably on another plant which is in a receptive stage, the pollen masses flip into the vaginal stigmatic cavity, which is highly glutinous, and there break off in part or stick fast wholly. Obviously it is a tight fit, and the movement of the bee has been well calculated so that no error in his operations may occur. Once a flower has been pollinated, its function has passed and within a few hours it withers and dies.

Orchids may blossom for a dozen or more years without being successful, owing to their highly specialized mechanism for pollination. When successful, the union of the male cells with the ovules in the ovary is accomplished by the growth of tiny tubules from each pollen grain. These contain the male element, which finally enters the ovules where the two sexes are fused and their various characteristics re-

(Above) *A cross between a Cattleya and a Laelia: a pale lavender flower with a large, ruffled trumpet of deepest, vivid, glowing purple and gold*

produced in the seed. Fully a year is required in the case of Cattleya for the maturing of its microscopic seed. Once they are ripe they are scattered by the wind or float on some stream to favorable environments. Less than two per cent of orchid seeds in Nature meet this happy goal.

To read the history of man's relationship to orchids is to delve into the legends of jungle villages. But transcending legend, the actual history of orchids begins with the early explorers of orchid countries. It was in 1513 that vanilla was discovered by roustabouts who fought with Cortez in Mexico. Vanilla orchids had long been cultivated by the Aztecs, and the seed pods with their strong flavor of vanilla essence were used to increase the tastiness or chocolatl, the national drink. The vanilla, festooned over forest trees, hung out its green-white, scented flowers for its specific sponsor. The vanilla orchid was perhaps the best known among Mexican orchids, but today it is but little cultivated in the land where it was discovered.

Toward the end of the seventeenth century, Central American orchids were among the first to be introduced into European greenhouses. Certain Mexican orchids had been discovered and described in 1651 by Hernandez, but not until much later was anything more known about the orchid flora of Central America. Perhaps the first botanical collector in the region was the Frenchman, Luis Nee, who from 1789 to 1794 sailed with Malaspina on a voyage around the world. Not until 1831 was anything done about the orchids of the New World. At that time an Englishman living in Guatamala sent orchids to England, and in 1846 certain Danish, Polish, German and British orchid-collectors risked life and health to bring orchids from the jungles.

Some of these flowers when brought to Europe caused a furor in botanical centers. Some of the new orchids were too preposterous to be believed, and many of those who brought them often were actually accused of trickery. Many of the most beautiful and curious of the orchids, however, for lack of knowledge of their requirements, could not successfully be brought out of their native haunts. The Guaria Turrialba, a splendid, nankeen-yellow Cattleya with a purple trumpet veined with gold, was

One of the loveliest of American orchids, Calypso bulbosa, *from our cedar swamps, is easily comparable to the orchid beauties of the jungles. It is a delicate pink with a slipper-like lip fringed with gold hairs and veined with purple* discovered by a Dane named Oersted in 1846, but by some mishap it never reached Europe. The description of his greatest find was, therefore, discredited and laughed to scorn, and Oersted died unbelieved. Much later, on the slopes of the Turrialba volcano near the village of Guapiles in Costa Rica, the Guaria Turrialba again was found, and this time the irrefutable proof came to Europe and confounded the unbelievers.

In the early days of orchid-collecting, the prices set on single plants were high enough to induce many a man to risk his life. In 1855, when tropical orchids were first coming into favor, a plant of *Aerides Schroederi* brought $430 in England. In 1875 a Dendrobium plant sold at $500, and in 1879 a Blue Vanda or Moth Orchid from Burma was sold for $460.

Some orchids today have unbelievably high prices. Ten thousand dollars was the price put on a hybrid moth orchid *(Phaelanopsis Harriettae)* displayed in the New York Orchid Show in 1928. This costly plant had but two flowers, yet it had been produced and brought to its present state of perfection only after an American orchid-fancier

Lady's-slippers are all terrestrial orchids. The basal leaves are stiff, often mottled, and from them spring the slender stems with slippers of pink, pure green, white and green, or purple had spent 42 years in selection, hybridization, and care. Other orchids are almost as valuable as this one. Parent orchids used for hybridizing purposes often have a money value that runs into thousands of dollars.

Although the high prices set on orchids made them worthy of the searching, and although they were plentiful in their native jungles, it was no easy matter to bring the plants safely out of the tropics and convey them to the orchid-houses of Europe and America. A thousand difficulties beset the orchid-hunter. The weather was chronically bad for northerners. Native superstitions often prevented a fine orchid from being obtained. In addition there were all the snakes, jaguars, bats, spiders, scorpions, midges, gnats, flies, rats, and other tropic discomforts to hamper orchid collecting.

Orchid-hunters lived a risky life and the graves of not a few lie in the jungles they explored. Madagascar, Ecuador, Africa, Brazil, Siam—all have demanded a percentage of orchid-hunters' lives. They went to the jungle with a knowledge that death in the form of cobra, tiger, or enemy arrow might strike at any moment. When death did not strike, the hunters bequeathed to the world an increased orchid-heritage: Blue Vanda or Vanda cœrulea Orchids from Burma, Tiger Orchids from Siam, White Moths from the Philippines, Lady's Slippers from Honduras, Leopard Cymbidiums from China, Butterfly Orchids from Costa Rica—all these were made known to the world only through the trials and agonies of men who permitted no personal discomfort to sway them in their work.

When the Panama Canal was cut through wild, rocky, jungle territory rich in orchids, a great body of water called Gatun Lake formed as the canal was built, and miles of jungle were flooded. Thousands of huge old trees drowned, but on their unsubmerged tops flourished scores of unconquered orchids. Orchid-hunters no longer need to climb ant-infested trees, or dare the menace of the jungle. Now they had only to go out in rowboats and pick rare orchids from the tree tops.

The region of the canal was soon nearly barren of orchids, but there were yet others that hid in the forests of Panama. One day in 1924, a native found a flower which he brought to Charles W. Powell of Balboa, who had given up the profession of pharmacist to become an orchidologist and a collector. Here was an entirely new orchid. The flowers were two inches broad, and grew in pairs on a curving stem which sprang from a tight cluster of thick green leaves. The five parts of the individual blossom were chocolate color striped cross-wise with bright yellow. The center of the flower was shaped like a little yellow and brown dancing girl twirling on her toes. Yellow skirt spread, arms akimbo, head alert—here indeed was the first Dancing Girl of Panama. For centuries it had been hidden, and now it was found—but there was only one.

Powell dried the plant and sent it to Germany for classification. It was named *Oncidium Powellii* in his honor, but the name the Indian gave it re-

The Dancing Girl: a rare orchid from Panama whose center is shaped like a little yellow and brown dancing girl twirling on her toes. Only three plants have ever been found growing wild

mained uppermost in his mind. The native had disappeared into the jungle, and no one else seemed able to find another Dancing Girl Orchid. It was hidden somewhere in the Panamanian forests where only the ocelots and honey-birds could find so rare a thing. There, several years later, another sharp-eyed native found a second Dancing Girl, which was sent to America in 1927 when Powell died. One more plant was found in 1935, and this, together with the one in America, and four others grown from its seed, is the known total of Dancing Girl Orchids in existence today.

Although the demand for orchids is greater than ever before, in recent years commercial collecting

1

2

All photographs by courtesy of the G. E. Baldwin Nursery, Mamaroneck, N. Y.

3

The cultivation of orchids owes its fascination to the possibility of creating new types by crossing different species. A few years ago this method was exceedingly difficult, for orchid seed are so infinitesimal that they lack enough nourishment to survive without sustenance from a delicate fungus that grows around them in the natural state. The discovery that agar jelly could be used in place of this fungus has greatly facilitated the crossing of orchids, and a vast array of new creations are possible

(Above) Artificial pollination. The expert inserts a sterilized needle into the flower, pressing it against the glue gland, which instantly breaks. Adhering pollen masses are inserted into the other parent flower's stigmatic cavity. In about a year the latter gives forth as many as a million seeds. Hanging from the pod (Figure 1) is the shriveled flower, which withered a few hours after being pollinated. Using sterilized instruments the operator spreads some seeds on agar jelly in a flask, which is stoppered with antiseptic cotton and placed in a warm, even temperature. Figure 2 shows seeds at about two months.

The union of these two species is carefully recorded and later published in the orchid stud book,* where all new crosses periodically appear. Though all seeds at

*"Sander's List of Orchid Hybrids," St. Albans, England.

4

5

6

(Above) An exquisite hybrid produced by crossing a Laelia with a Cattleya *(Laeliacattleya hippolyta)*. Some cut orchids, notably Cymbidiums, will often last for six weeks or more, rewarding the grower for his pains and climaxing one of the most absorbing experiments in nature

left have the same parents, their hybrid flowers may vary amazingly in detail, giving interesting evidence of recessive characteristics.

In six to nine months the seedlings will have leaves one-half inch high (Figure 3) and in about a year the operator will withdraw the flask from the cabinet (Figure 4). The small orchid plants are then shaken out of the agar jelly onto a sheet of paper (Figure 5). Untouched by hands, about 20 plants are sorted out chopstick-fashion for each 2½-inch flower pot (Figure 6), and carefully planted in a special bedding of Oregon fibre (Figure 7). The potted orchids continue to require properly controlled temperature, humidity, sunlight and water, according to species. Oregon fibre is later replaced by Osmunda fibre, and the plants are re-potted approximately every year (Figure 8). As they grow, fewer are planted in the same pot (Figure 9), until each has its own. Some orchids are grown in baskets for better circulation of air. Orchids near maturity (Figure 10) are watched anxiously, for the first flowers will reveal the results of the crossing.

Popularly considered extremely fickle, orchids actually may be cultivated with great success if a few simple rules of their ecology are followed.

Some small creeping orchids are no larger than mosses, whereas the Grammatophyllum of Borneo grows leafy stems ten feet long and weighs hundreds of pounds.

7

8

9

10

of orchids in foreign lands has lessened. After some years of intensive search for orchids, all but the most elusive had been brought out, and there was danger of scarcity or extinction of many species. People in the American tropics, far from ignoring plants that were so common, were extraordinarily fond of orchids. Cattleyas, called Guarias, were the favorites, and even the poorest peon's adobe had its Guarias on wall or roof-top. Children in back-country villages knew the technical names of the commoner orchids. With possible extermination in sight, several Central and South American countries put heavy export duty on orchid plants, and the trade became less profitable both to hunters and to dealers.

Up to this time, to raise orchids from seed was considered very difficult and often impossible. At best it was a hit-and-miss procedure which might or

(Above) *A pink spray orchid* (Dendrobium superbiens), *thought to exist only as an artificially crossed hybrid until a collector brought the identical hybrid made by nature from Polynesia* might not turn out successfully. The procedure, also, was a lengthy one, and none but the most patient, painstaking, and skillful of the growers ever was successful in raising marketable orchids from seed. The difficulty in producing blossoms made their price prohibitive.

A few years ago a Belgian who had studied the intimate life of orchids in their native haunts, discovered the fungus jelly which surrounded the germinating orchid seed, and he deduced rightly that this fungus was necessary to the growth of the orchid. At home in his laboratory he experimented with orchid seeds, some infected with the fungus, some without. Those without the fungus sometimes germinated, but they invariably died, while the percentage of deaths was reduced to almost nothing in the fungus-infected seeds. He knew that most adult orchids have in their stems and roots this same fungus growth, so by taking a fungus-filled root and placing it in a sterilized jar in which were sterile peat moss and fresh orchid seeds, he was able to produce hardy seedlings. The fungus, however, was sometimes difficult to isolate; harmful sorts were not always excluded, so he hit upon the idea of using agar jelly, such as is used in bacteria cultures, instead of the fungus. Injected with nutrient salts, this jelly worked admirably. In glass test-tubes partly filled with agar, his orchid seeds germinated and grew until they were large enough to be carefully transplanted into peat moss.

This was the most revolutionary discovery ever made in the orchid world. It put a new light on an obscure and fumbling business. The collectors now had only to bring out of the jungle the choicest stock for parent plants. These could be pollinated by hand, the seeds grown in agar jelly, and quantities of orchids could now be raised in northern countries to keep up with the rapidly expanding orchid business.

Cultivated orchids are grown in a compost medium of peat moss and osmunda fibre, sometimes in hanging baskets made up of slats, in clay pots or in more modern glass receptacles so that root action can be observed. The process of hybridization takes place usually in a botantical laboratory. Here are brought the plants to be hybridized. The expert takes a sterilized dissection needle and presses it against the rostellum. There is at once a response, in which the glue gland is broken and the pod directly below the pollinia adheres to the needle. The pollinia are easily withdrawn and these are transferred to the stigmatic cavity of the other parent flower previously selected. Soon after being pollinated, this second flower withers. In a year the pod has ripened. Having sterilized the nutrient salts in agar contained in a flask or test tube, the operator proceeds to sterilize the seed in an antiseptic solution. He does likewise to his aluminum seed-spreading wire. From the receptacle containing the sterilized seed he quickly gathers what seed he can by a skimming of the surface and transfers them rapidly to the flask, which is stoppered with antiseptic cotton and kept at an even, warm temperature. Here the seed are grown until they are large enough to be transferred to individual pots.

Plant breeders like animal breeders never know exactly the result of their unions. Recessive characteristics show up constantly so that in a batch of 25,000 seedlings there may be just as many varieties. The breeder is constantly alert to find the "sport" or mutant, something new and finer which he is hoping to create. The weaklings and uninteresting plants are usually destroyed. Obviously the modern hybrid orchid is a man-made product with no actual equivalent in the forest, for it is possible to breed for scent, blooming season, color, size, in fact anything that the plant breeder sees fit to produce within the natural laws of the parents involved.

Nature, like man, can make new hybrids within closely related genus groups. Even relying on an external agent to bring pollen, foreign pollen grains are by chance sometimes introduced. From our native swamps *Habenaria lacera* and *H. psycodes* may be cited as examples. Quite a few tropical orchids do likewise, and this accounts for the duplication of the plant breeders' tricks. Thus, in the laboratory, the expert may make a new orchid—or rather one which he thinks is new—and then an explorer will come out of the jungle some fine day with a similar orchid which nature herself has hybridized. An example of this was seen a few years ago in the case of a spray orchid which was the occasion of much dispute and excitement in the orchid world. An American orchidologist had produced a pink Dendrobium with silver-backed flowers, and at almost the same time an English firm hybridized and raised a similar plant. Both were ready to accede to the other the credit for the discovery, when an explorer brought from the Polynesian Islands an identical pink Dendrobium which he had obtained from a native grave. This orchid was a hybrid which nature had produced long before there were human orchidologists.

Although orchids are usually produced from seed, they can also be perpetuated by vegetative parts, and thus they fall under the 1930 amendment to the United States Patent Laws. This amendment opened up a vast new field to the plant inventors, who, up to that time, had been unable to patent their inventions. Now a patent may be granted to anyone "who has invented or discovered and asexually reproduced any distinct and new variety of plant other than a tuber propagated plant, not known or used in this country before his invention thereof." To date no orchid has been patented. Perhaps it is the ever-present threat of nature which keeps orchids out of the class of hybrid roses and peach trees—plants which may be patented without fear of having identical hybrids produced in a wholesale manner by nature.

While the orchidologist seeks to learn the natural laws governing orchid hybridization and the evolution of the family, the commercial orchid-grower endeavors to produce new and exquisite blossoms for the adornment of woman. Many people when they see the honor and acclaim given by women to one of these exotic savages of the plant world, wonder half in resentment why it is so highly reverenced when to many a mind the rose, both in form and color, is far superior.

The answer lies in all these things which have come before—in the insect-infested jungles where men dared malaria and anaconda; in the superstitions of primitive lands; in the test-tube which is the incubator for modern orchids. The answer lies also in the luminous, deceptive fragileness, in the siren-like allure of the orchid. Yet, in addition to all this, there is a more elusive quality which is the secret of the mystery of orchids. It is the secret of that listening look, that silent gaze, that fierce splendor, of the orchid's flower. Its personality and history make it far more than a flower. It is a grail that lures strong men into jungle and laboratory in a life-long search for the orchid-mystery.

DO NOT MISS

Europe was at one time almost bled white by a small animal with triangular jaws and multiple stomachs. In **A LEECH AND HIS LEECHES** Mabel Lorenz Ives will tell the story of this strangest of man's "domesticated" animals—his influence on surgery and dress-design; his odd sex life.

If man were as successful in his schemes for cooperative social organization as some of the tiny hydroid colonies described by Dr. Roy Waldo Miner in **FRAGILE CREATURES OF THE DEEP**, tomorrow would dawn on a utopian world order. Their sexual and asexual breeding, "collective security," and ability to form happy partnerships with other creatures, distinguish this singularly well adapted under-water life.

American drug stores may sell histories of art, baseballs and stoves, but Chinese drug stores go them one better. They sell fossils—not for collectors but for sick people. In **A FOSSIL GAUR**, Dr. Walter Granger will tell how the Chinese faith in "dragon bones" is at once the boon and the bane of the scientific bone digger in China. From clues picked up in a "drug store," Doctor Granger was able to locate a fertile fossil field near a village of interior China where he was the first white man ever to spend the winter.

Stop! Look! and Listen! is Roy L. Abbott's injunction to all those who seek an understanding of Nature. In his article **LOOK! MAN**, readers new to the outdoors will find fascination, and veteran Nature trailers a thrill of reminiscence.

George G. Goodwin, seasoned Museum mammalogist and "graduate" of the North American game fields, has written so vigorously of his **FRESHMAN YEAR IN AFRICA** that many will consider it the best big game story to come out of that country since Hemingway's *Green Hills*. Here the true Africa, the jungle, its people, record elephant "bags," are recreated in a first person style as sharply in focus as the many accompanying photographs.

A native African tribe clad unaccountably in chain mail reminiscent of the Crusades was one of the unique sights encountered by Mr. and Mrs. Lawrence C. Thaw on their recent crossing of the dark continent. **BLACK KNIGHTS**, written jointly by them, will tell of this anachronistic experience soon in NATURAL HISTORY.

Surprising new exploration for the microscope hobbyist will be unfolded in **FUNGI—WONDER PLANTS**, by Harold J. Brodie, an article on the microscopic miracles displayed by one of the most beautiful groups of organisms.

FLAGPOLE SITTERS, by Henricks Hodge, will tell the story in text and chart of the never-ending struggle of the soilless jungle plants toward the sunlight of their treetop home.

THE FIRST AMERICANS, by C. Bertrand Schultz, will be one of the first authentic popular articles on the revolutionary discoveries which have pushed back man's known occupation of this continent many thousands of years and enabled scientists to reconstruct his struggles under climatic conditions differing radically from those of the present.

MARGARET MEAD, top-ranking woman ethnologist and insatiable explorer, will throw the spotlight on the neglected but charming theater festivals of romantic Bali.

The "social" background, genealogy and origin of that animal known to many as man's best friend will be brought out graphically in Dr. E. W. Colbert's **WILD DOGS AND TAME—PAST AND PRESENT.** No one with a love and understanding of dogs can afford to miss this panoramic history of canine life.

Creative Genius in Orchids

HOW NATURE CONTROLS BIRTH AMONG THE ORCHID DYNASTIES—

By the aid of insects Nature created the most refined and ingenious methods of reproduction to assure vitality in the world's noblest family of plants

By CARL T. RAMSEY

THE term aristocrat has been applied to many different kinds of flowers. Strictly speaking there is but one, the orchid. The reason for this will soon be obvious, for in no other class of flowers do we have the nicety of adjustment; the special servers of pollen; the long line of food and drink, varieties of scent, gamut of color, bizarre forms, and amazing adaptation to specialized fungal agents in the roots, called mycorrhiza. The marvel of all this centers itself in the mechanistic control of the various species of orchids, catering to individual insects with which they have produced a synchronized association in ages past. Obviously these specialized flowers became helpless in their so-called snobbishness, for once they had started their specialization, they were irrevocably tied to the various species.

With the establishment of all these particular habits and the carefully arranged flower structures, reproduction in most orchids has a fixed line of procedure, so that different species rarely breed outside their own kind. Thus their noble lineage has been kept pure through untold ages, each type evolving in its own way. So this is a true aristocracy of birth in which the anatomical specialization of the reproductive organs of the flower itself provides an absolute safeguard against intermingling of the clans.

However, under laboratory conditions this changes. By artificial pollination, closely related genus groups can be made to produce offspring by crossing or hybridization.

The object of every flower is to produce healthy seed. Once pollinated, the orchid will promptly signalize its success in life by withering within a few hours. In a single pod there may be as many as a million seed.

Naturally all along the line, individuals have died. Many seeds could not even send out roots. Myriads of failures were scrapped. Changes in environment involving temperature, moisture, and a thousand other factors, eliminated plants not able to cope with them because of the lack of congenial habitat conditions, especially fungal association to which the various orchid species have adjusted themselves. The poor relations, so to speak, are still with us, but evolution has proceeded in other directions. The successful features have become incorporated in more intricate forms which gradually evolved as the flowers coped with the habits of their insect sponsors and their environmental conditions. In this way the orchids have achieved their wide variety and unsurpassed botanical specialization. No fewer than 25,000 different species of orchids have been recorded, in some 600 genus groups.

To look at an orchid's beauty is sufficient for most flower lovers. Yet how many observers suspect that the simple wood lily and trillium hold the key to the ancestry of the Lady's-slipper, which represents the first family of orchids. The Lady's-slipper itself, however, is a simple affair compared with the nicety of a Fringed Orchis, the dainty Calypso, the Blue Vanda of India or the weird Catasetum and Coryanthes of Central America, where the orchid family finally reached its highest development from those lily-like or trillium-like ancestors.

These changes represent millions of years of gradual modification. From the simple beginnings we presuppose no miracle or sudden leap to complication. Once the intricacy had started, the manifold catering to the various forms of insects found all over the world proceeded in accordance with Nature's laws. New colors, delicate scents and violent odors were developed by the orchids, and the accumulation of astounding variety in the family was inevitable.

The connoisseur may turn up his nose at some of the "poor relations" which are tiny insignificant green and ill-scented flowers. But not so the morphologist, who follows thread by thread the vascular fifteen parts with their mutations and adaptations, and sees recorded in them the evolutionary progress in the piling up of genus groups and species.

When we look at a Blue Vanda or the snowy Phalaenopsis from the Philippines we have feelings similar to those evoked by a Beethoven symphony. So, too, when we look at a modern stream-lined car with all its delicate adjustments we sense a parallel to an orchid's intricate pollinating mechanism. True, the symphony and motor car are man-made while the orchid could have no conscious direction or exterior interference other than the laws to which the attending insect and the orchid's efforts toward reproduction were constantly focused. Yet in both cases we see a mechanical nicety which commands our deepest admiration.

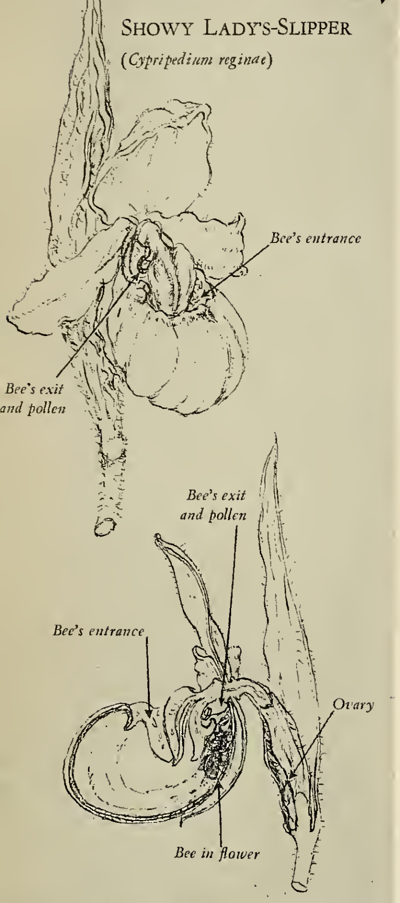
The 25,000 existing species of orchids are but a remnant of the countless forms that went into the production of the family, and give startling proof of the profound antiquity of the orchid and of our living planet. It is really a glorious wreath of beauty and fascination encircling the globe. With a geographic distribution ranging between the two polar circles and a habitat adjustment from two feet below the surface of the earth, growing in the dark sands of Australia *(Rhizanthella Gardneri* and *Cryptanthemis Slateri),* to altitudes of over 14,000 feet in South America where Masdevallia and Oncidium are found, we have evidence of a struggle for existence in both the roots and vegetative parts of an orchid that makes food for thought.

Obviously the orchid is the flower of science *par excellence*. The unsuspecting flower lover hardly thinks of the myriad of factors that went into the building of this regal family of flowers. The reproductive mechanisms of the orchid are at the very heart of this evolutionary story. The drawings and text which follow will acquaint the reader with a few of the striking and significant forms.

A One-Way Tunnel Mechanism

Showy Lady's-Slipper

(*Cypripedium reginae*)



Flower cut in half

Lady's-slippers

(Cypripediums)

The Lady's-slippers are literally the first family of the most exclusive and aristocratic line of flowers in the world. What a leap of imagination is required when we think of our tiny Ram's-head (*Cypripedium arietinum*) in cold Vermont swamps and in far-off Upper Burma and western China. Immediately the factors of seed distribution present themselves.

In fancy one sees a migratory bird back in pre-glacial days with a minute jewel-like orchid seed tucked in the callous crack of its foot, perchance a warbler or a woodcock, flying in the fall of the year to escape the cold. Where will he drop the seed? The adjustment to climate and soil are obviously no mean considerations, to say little of the associated special bee which must sip the nectar from the tiny hairs within the fleece-lined gnome's cap to perpetuate the species.

There is no doubt that the bees were the creators of our Lady's-slippers. The factors of color and fragrance, coupled with the mutating tendencies within the family, have a logical sequence in the Lady's-slippers' catering to a long line of special bees. These bees had reached their present-day perfection no less than 70 or more million years ago as their fossils in Baltic amber prove. To date, science has no record of a fossil orchid.

The accompanying drawings of the Showy Lady's-slipper (*Cypripedium reginae*) show the path which the bee follows in its pollen-taking visit, and serve as an example of the mechanism for this genus. The species of bee working on this flower is a tiny creature of iridescent gunmetal green less than 5/16th of an inch in length and not quite ⅛th of an inch in diameter. The fit of the bee to the exit is essentially a tight one. Flies and other unwelcome guests are frequently caught between the sticky anthers and held there until they die. The pollen masses are so hung over the rear hatches of the flower's exit that a smear of the simple pollen grains in the agglutinated mass is sure to cover the thorax and even the posterior of the gay green guest.

Of a bright June morning the bee enters the lovely mauve-pink lip as shown and it soon finds itself busy sipping the nectar from the tiny hairs leading along the converging deep mauve lines. Thus the way has been carefully marked, even windows have been provided in the rear to give light and tempt the insect along. Eventually the scant supply is exhausted and the bee pokes its head into the fresh air, slipping easily under one of the pollen masses where the seal of its office is administered. It proceeds promptly to another flower on another plant, for while the Showy Lady's-slipper sometimes produces three flowers on its stem, they bloom one by one from below. Within another flower the bee passes easily beneath the bristling stigmatic surface, presenting the token on its back, and the future generation of orchid queens has started.

A hundred odd species of Cypripedium exist today over a range extending from the polar circle in Alaska into the tropics of both the Old and New World, into New Guinea and the mountains of Colombia, Ecuador, and Peru. Botanists have subdivided the original genus into three main groups: (1) our native Cypripediums, which also extend into Europe and Asia; (2) the tropical Asiatic Paphiopedeliums; and (3) the South American Selenipediums. The latter two are sometimes terrestrial but they also go into the trees in search of sunlight. However, the chief distinction in which we are interested is the fused seven-part central organ known as the column. It is to be noted that the carpels of the lily's style are maintained in the tri-part stigmatic surface. Also that one of the anthers in the ancient lily became lost because it had no function, while the other became modified as a heart-shaped shield or staminode to prevent the guests from escaping by the front door. The tippling guests are strictly required to pass rearward to procure the parting token of fructification above the exit where the two functioning anthers hang. It is also arranged that they are not to have too large a drink and, having attended to the offerings of one flower, they are sure to carry the pollen to another plant.

Rothchild's extraordinary Lady's-slipper

Showy Lady's-slipper

Grass Pink

(Calopogon pulchellus)

Our native Calopogon or Grass Pink is an example of a dumping or jilting device. The bees get nothing for service rendered. Debonairly foraging for honey, the insect espies the gay colors which alone attract it, since there is no fragrance and nothing to eat. Its near-sighted compound eye centers on the yellow beard which fringes the extremity of the lip. The bee alights and instantaneously its weight plunges it down, causing its thorax to collide with the sticky glue gland, rupturing the membrane. Glue pops forth with the pollen masses at the same time, fastening them in a twinkling on the bee's back. In the ensuing scramble the defrauded insect very likely rolls off. Though its eyesight has led it on an unrewarding quest, it will try again. Away it goes, straight to the object of its desire. Once more it is jilted and in an instant has poked the pollen masses into the stigmatic cup, and the deed is done.

A few minutes afterward the hinged lip falls forward, and this is the gesture to the bee that Calopogon's love has been requited.

The flowers of this orchid, poised on a stem like gay mauve butterflies, open one by one from below a day or so apart. The position of the flower is rotated a half circle from the normal position of orchids. Hence the ovaries are straight and the lip occupies an upright position. All three of the sepals are free; the lower one serves as a base to the column; the two petals occupy an intermediate position between the sepals.

With all these special features the Grass Pink gives a striking illustration of the clever devices evolved by orchids in their manifold schemes of reproduction.

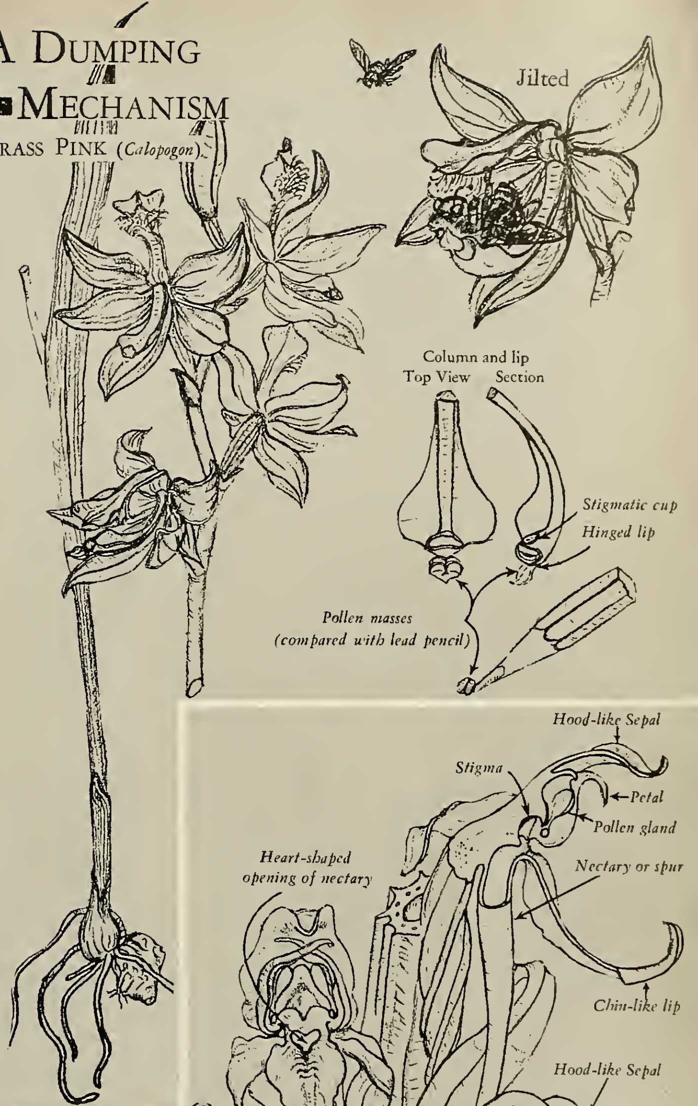
Hooker's Orchid

(Habenaria Hookeri)

Hooker's orchid would hardly fall in the category of pulchritude. The greenish flower suggests a gargoyle, mask-like, with the upper sepal forming a hood and the lip protruding like an elongated chin. The hook of the lip serves as a landing place for the moth. Approaching by this avenue the insect easily slips its tongue up the central groove of the lip and into the heart-shaped opening of the nectary (see figure). Then the pollen masses become attached to the tongue, but in a position in which they cannot possibly pollinate the same flower. After removal, however, a drying action causes them to fall forward to a functioning position, slightly diagonal to the center of the tongue (see drawing). Thus when the moth enters a second flower, all is ready. But another link is necessary in the finely evolved process. The insect might still retreat without depositing the pollen masses if it were not for a projecting beak-like nose, which obstructs its progress and obliges it to pass to one side. Thus the tongue is brought into proper alignment so that the pollen masses are sure to strike the stigmatic surface directly under the beak.

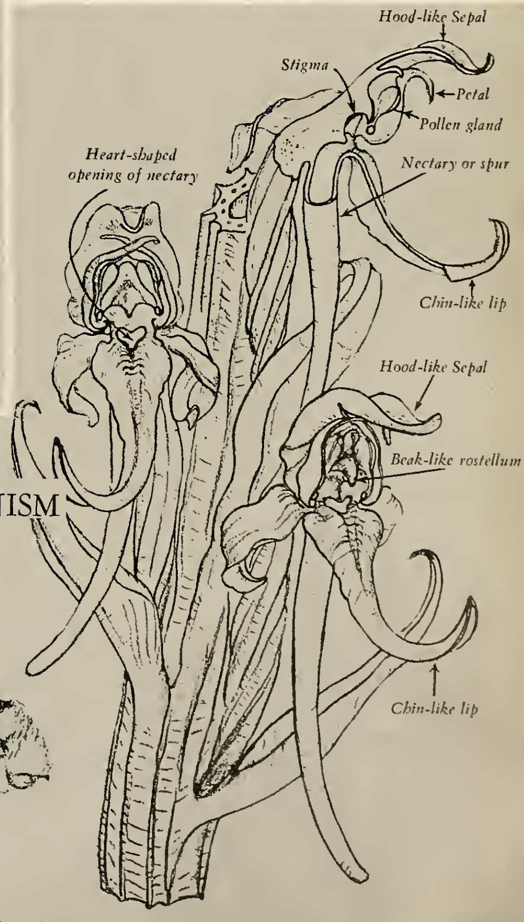
A Dumping Mechanism

Grass Pink (*Calopogon*)



A By-Pass Mechanism

Hooker's Orchid (*Habenaria Hookeri*)



Moth with pollen masses on tongue

This beak is actually that important member of orchid anatomy, the rostellum, which ordinarily serves as a sticky gland to fasten the pollen to the insect. Here it has lost some of its original function and become specialized to serve the purpose just described.

Geographically the genus Habenaria encircles the earth from the northern polar circle well into the tropics. These are ground-loving orchids as distinct from the epiphytic variety which require no soil in the tree top nooks they occupy. Catering almost exclusively to butterflies as their pollen bearers, they show an advanced development in their reproductive mechanism, including all sorts of elaborate provisions. Some hybrids occur in nature within the closely allied forms, but the many hundreds of species are fairly well distinguished by varied blooming periods, fragrance and construction of the throat and nectary, and the separation of the pollen masses from the central rostellum; and their existence is maintained to a synchronized nicety.

The Holy Dove Orchid

(Peristeria elata)

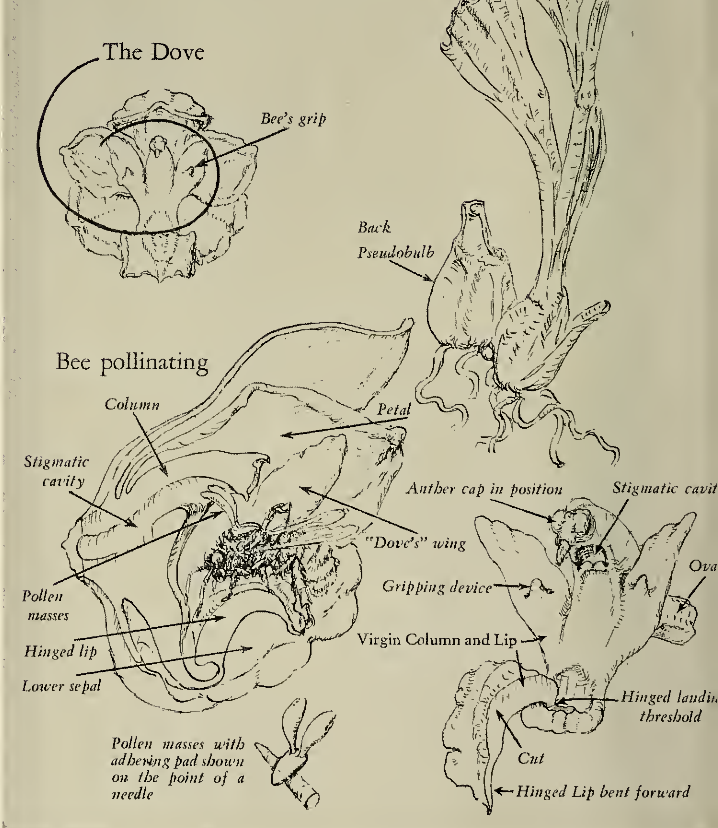
In the Holy Dove Orchid the special pollinating bee is subjected to an even more intricate seesaw mechanism than in the Grass Pink. A delicate fragrance calls the insect, and with instinctive accuracy it alights on the depressed lip to gnaw the succulent tissues. No nectar is secreted. Once the weight of the bee is on the lip and the feast progresses, there may be considerable swaying backward and forward on the fulcrum hinge. This will annoy the bee and in its effort to stop the swaying it will instinctively reach up to the gripping spurs conveniently provided in the bend of the "dove's" wings. In doing this it will be presented on its thorax with the pollen masses still enclosed in the anther cap. After a short interval a drying occurs in the elastic stalk of the pollen masses, and the bee, endeavoring to get rid of its encumbering bonnet by one grand swat, sends the anther cap flying, but the pollen masses stick fast. Feeling a bit more comfortable, the insect proceeds to fly to another flower to resume its repast. We may assume that this flower is in a receptive stage with its stigmatic cavity well agglutinated. The bee feeds as before, but during the process of acrobatic balancing, it is sure to make use of the gripping lugs and this will cause the insect to rise with an upward thrust, pushing the pollen masses into the stigmatic cavity.

Thus the Holy Dove Orchid, which has figured in picturesque religious legends owing to the dove-shaped formation of the virgin column, reveals to the morphologist an exceedingly interesting arrangement in the reproductive parts which has resulted, of course, through the normal processes of evolutionary development. The dove, with its mauve-tinted outspread wings, is merely a centralizing device to bring the bee to where it is wanted. The dove's head is formed by the anther with its cap. The beak of the dove

Hooker's Orchid

A Strap-Hanger ⬅ Mechanism

Holy Dove Orchid (*Peristeria elata*)

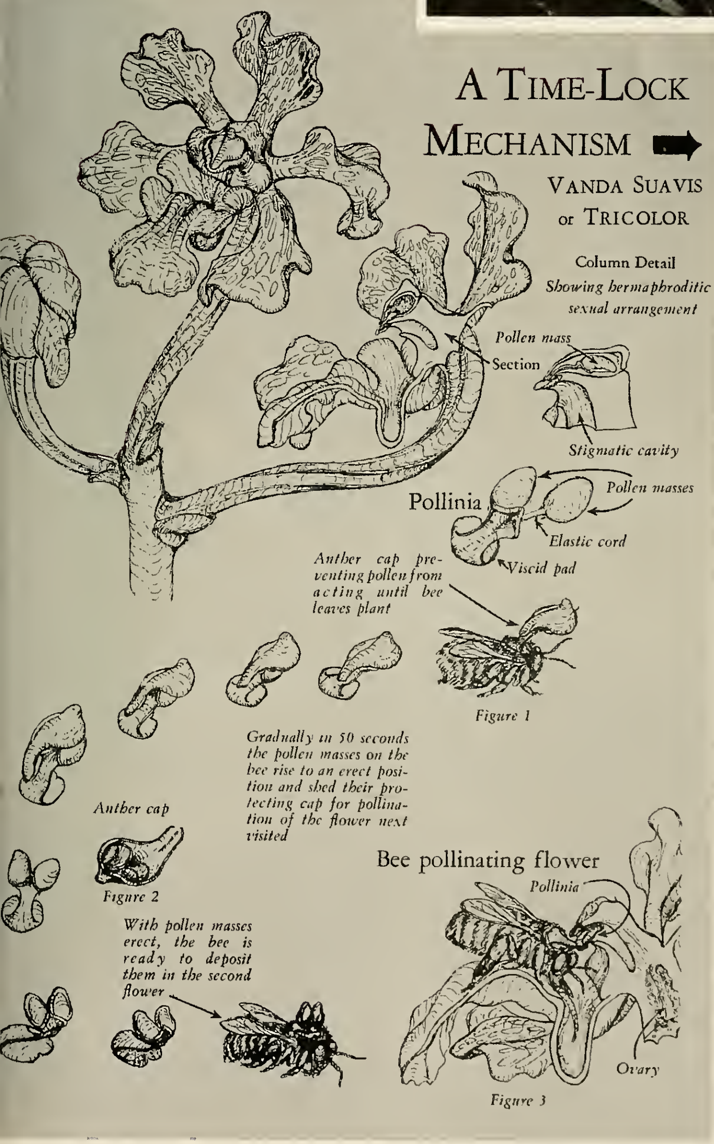


is a highly specialized, modified carpel and functions as an adhering pad for the pollen masses. The wings are the normal three-part arrangement of every orchid lip, two of the ancient lily anthers providing the gripping device, and the central third part or normal petal of the lily serving as the hinged landing threshold. The flower scape often attains a height of five feet or more and the flowers open one at a time at intervals of a day or two, so that they are assured of the required cross with another plant.

(Right) VANDA TRICOLOR

A TIME-LOCK MECHANISM ➡

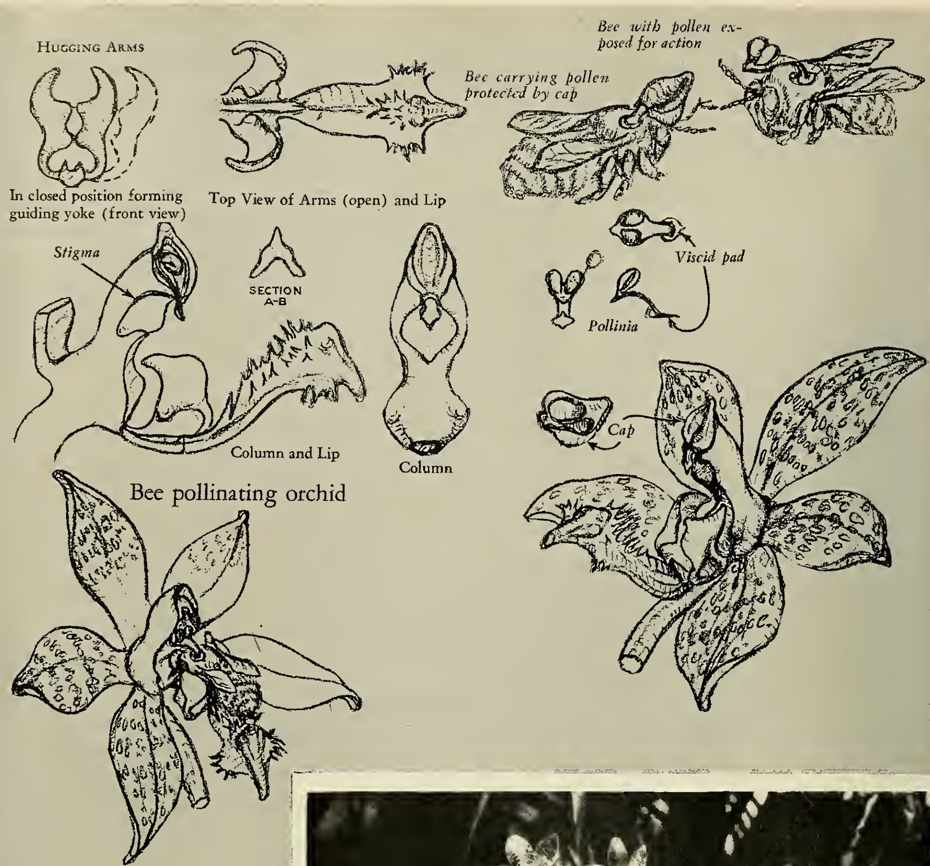
VANDA SUAVIS or TRICOLOR



VANDA TRICOLOR

VANDA TRICOLOR exhibits one of the most extraordinary mechanisms for preventing an insect sponsor from pollinating the same flower. Note the fine timing involved in the procedure. On entering the flower the bee gradually gets into the nectary where it moves about lapping up the nectar in an atmosphere fragrant with an aroma suggestive of our native locust or essence of grape. As it starts to back out it is presented with a bonnet containing the pollen masses as shown in Figure 1. Why the bonnet? This is to assure protection on the immediate plant in case the bee is rash enough to proceed to work on another flower of the same spike. The encumbrance is sure to make it fly from the plant to get rid of the load. But the elastic stalk or caudicle of the shielded pollen masses performs an automatic movement under the influence of drying, which heaves off the encumbering hat as shown in Figure 2. In approximately 50 seconds after the bee takes the pollen, this fascinating process causes the whalebone-like caudicle to assume an upright position, casting off the bonnet. By the time the pollen masses have thus been exposed the bee will have left the first plant and be ready for more nectar. But no harm is done if it does not find a flower in the immediate vicinity, for the pollen masses themselves are covered with a waxy surface which assures their protection from the intense tropical heat. An elastic cord attaches each pollen mass to the caudicle and the removal of the anther cap leaves a notch to guide these cords to a central position in the receptive flower. Upon entering the flower (Figure 3) the bee may temporarily be unable to rid itself of the pollen, but with one grand effort, using legs and wings, it will rush upward. The cords will reach their elastic limit, sever, and flip the pollen masses backward into the stigmatic cavity.

Vanda Tricolor hails from Java. This mechanistic example serves also for Vanda coerulea and allied species in the genus. The Vandas are evergreen epiphytes, showing a long struggle and specialized adjustment to the tropical factors which govern their existence. The petals and sepals of Tricolor are gay, mottled with a mauvish brown and yellow on a white field. The forepart of the lip is a rich mauve pink, and the throat is tinted with pale yellow.



PHALAENOPSIS
(*LUDDEMANNIA*)

A HUGGING MECHANISM

PHALAENOPSIS
(Luddemannia)

THIS Philippine Phalaenopsis is interesting for its novel hugging or lip-embracing feature. The ingenious devices seen in other orchids for guiding the insect to the reproductive parts are in this flower climaxed in a pair of arms which actually clasp about the victim, centering it in the act of pollination.

As the bee alights on the orchid's threshold, its weight simultaneously causes these arms to open; as it proceeds the arms close like a yoke. Once gripped the bee will struggle, and its weight and the push of its rear feet only make the grip tighter. In the ensuing struggle it will very likely force itself upward and be presented with the anther bonnet as illustrated. The little chapeau will be shed in due time. The insect will try once more on another plant to satisfy its appetite. In the subsequent feast it will present the message of love that came from the other flower.

The arms which hug the victim and so successfully serve the essential purpose of centering the insect in the process of pollination are modified anthers of the ancient lily.

• • •

These are only a few of the extraordinary pollinating mechanisms developed by this most aristocratic family of flowers. The pollen of the orchid, harboring within its microscopic dust millions of years of heritage in the most highly specialized family of flowers, is verily a golden miracle of Nature. Note well how Nature has guarded this treasure against mischance. Orchids do not permit their pollen to be eaten. They are forbidden to receive their own pollen. Tropical heat cannot injure the pollen grains if that is Nature's plan. Through the agency of specific insect sponsors the flowers are protected from contamination by pollen of another species. All this so that the precious mass, scarcely larger than a pinhead, will make fertile a million microscopic seeds and produce a new generation in the noblest lineage in the plant kingdom.

THE STORY OF THE LODESTONE—*Legends of ship-sundering magnetic mountains yield to the mariner's compass and later uses in modern electricity. Now a "time compass" may revolutionize archaeological dating as the latest boon of "the stone that loves iron"*

By WILLY LEY

NO COUNTRY has ever been so successful in building up a reputation for ancient wisdom as the Chinese. They have been accredited not only with the invention of gunpowder, porcelain, paper and paper money, but printing and the mariner's compass as well. We now know that many of these claims are either untrue or questionable.

We know that printing was invented in Europe independently and probably as early, if not earlier. Encyclopedias used to solemnly assert that the Chinese used sky rockets and firecrackers as early as 3000 B. C., but it has been shown that their discovery of gunpowder occurred when they tried to duplicate the famous "Greek fire," an inflammable mixture composed of resin, asphalt, sulphur, etc., used for firebrands. The Chinese never invented the art of shooting by means of gunpowder but used the explosive mixture only in firecrackers and bombs. Their claims to the invention of paper, paper money and porcelain are more firmly supported, but even here the oriental historians have left us less definite information than is desired.

Who invented the compass?

But one of the worst errors is the statement formerly accepted even by scientists that the first magnetic compass was made by the Emporer Hoo-ang-ti in 2634 B. C. In reality the Chinese records themselves admit that "foreigners" introduced the magnetic compass to China not earlier than A. D. 1086, if the author Choo-yue is to be believed and his writings are dated correctly.

Claims for an earlier knowledge of it, like many other errors, are the result either of misinterpretation of the records or of carefully planned changes and insertions. According to the historian of science Professor Edmund O. von Lippmann, such changes have been introduced into the entire Chinese literature for more than 2,000 years with the purpose of claiming for every invention mentioned a local origin as old as possible. Further, Lippmann writes: "We have learned that we have to receive all these traditions with utmost skepticism, since it is certain that no reliable historical data referring to events prior to 841 B. C. are in existence."

But as elsewhere in the world, the mysterious mineral that made the invention of the compass possible was known in China many centuries before the instrument itself. They knew the "thsoo-shi," the "stone that loves [iron]"; and, as their name for it proves, they had noticed that it attracts iron and things made of iron. In other words, they knew the lodestone.

A curiosity

If one wants to see a piece of lodestone nowadays one has to go to a museum that has a mineralogical department. The stone that had more influence not only on an individual fate but on the course of fleets and, therefore, on the course of history than any sparkling and highly priced gem has no place in modern civilization except as a scientific curiosity. If the brownish and heavy mineral that is chemically classified as one of the oxides of iron by the formula Fe_3O_4 is found in large quantities nowadays it is hailed as a rich iron ore. Although all of our civilization is based on electric machinery that would not work if there was not magnetism, nobody is interested any longer in the magnetic properties of lodestone, for we have learned to make much better, more lasting and more powerful magnets than lodestone.

The story goes that it was a Greek shepherd by the name of Magnes who discovered lodestone on Mount Ida when pieces of it clung to the ferrule of his shepherd's staff. Accordingly the ancients named the lodestone "magnet" or else they invented the story to justify this name, possibly after having coined the name from the city of Magnesia in Asia Minor. Their other names for it needed no justification: they were "siderit" from the Greek word *sideros* for iron, and "heraclion," after Heraclia, the place near which it was found. What "magnet" really means nobody knows for certain. It must have been applied to other minerals too, because it is certainly no lodestone which was described by Theophrastos when he mentioned the "magnetis lithos" shining like silver and easy to turn on the lathe.

The Greeks could not help but notice those properties we now call "magnetic." In about 54 B. C. Lucretius (in "De Natura Rerum") mentioned that a lodestone would attract small chips of iron through the thickness of a bronze bowl, and Alexander of Aphrodisias, one of the commentators of Aristotle, knew in about 200 A. D. that the magnetic force could even work through water. Such property must have a logical as well as a magical explanation, and both requirements were filled when these old philosophers remembered that astrology assigned iron to the planet Mars and consequently to the God of War and the masculine principle in general. Thus it came about that images of Mars were made of lodestone to attract images of Venus made of iron, symbolizing love. Naturally, once things had progressed as far as that, the principle was applied to love between humans too. Lovers' rings were made of lodestone, and lodestone charms were supposed to enhance natural love attraction. That lodestone, placed on the head, was believed to make the voice of gods speak to the owner of the stone, is understandable. But how it came about that lodestones were supposed to cure gout, rheumatism and cramps and—finely powdered and mixed with oil or grease —to cure or prevent baldness is hard to understand.

"Antidotes" for lodestone

It is even more mysterious how the belief arose that a diamond would counteract and prevent the lodestone's attractive power. If a diamond were lying nearby, it was said, lodestone would not attract iron; and if a diamond was brought near a lodestone that had attracted iron, the diamond would pull the iron away from the lodestone. Certainly many people must have observed that a diamond did not influence a lodestone at all, but the belief persisted. Another "antidote" for magnetism was the juice of an onion: if an onion were crushed over a lodestone the stone would lose all its power over iron. This belief even survived the discovery that any piece of steel could be magnetized permanently by means of a lodestone. As late as around the middle of the 17th century Sir John Pettus of Suffolk was tempted to test the power of onion juice to destroy magnetism. When he was a young man he had had the blade of his knife magnetized thus he had a magnet on hand and there were also some onions around. But after some hesitation he decided that it was preferable to accept the ancient belief than to risk losing his magnet. The onions were sliced with another knife that was not so valuable.

It was Cristobal Colòn, better known under the name of Christopher Columbus, who was the first to observe a phenomenon which is well known to us but which put him and his companions into a veritable frenzy of fear and astonishment. On September 13, 1492, during his first voyage Columbus observed in the dim light of the waning dusk that his highly valued magnetic needles in his primitive compasses began to deviate toward the northwest.

Columbus' forgotten discovery

After the first scare was overcome and after Columbus had probably made and discarded a dozen or more fantastic theories as to the probable cause of this strange behavior, he set out to correct the deviation. His description of how he did it is as confused and obscure as his methods probably were. Christopher Columbus, to whose name is attached the fame of having discovered America (although he was neither the first man of the white race to set foot on this continent nor could he ever be convinced that it was an unknown continent he had reached), was not a very good sailor. What knowledge he had was pieced together from omnivorous and indiscriminate reading; it was partly obsolete and partly wrong. His nautical knowledge in particular was incomplete and lacking in important details. But he was an excellent observer and possessed a mind that immediately perceived the useful side of things. Columbus had hardly observed that the magnetic needle deviated from true North when he thought that this deviation might be regular and, therefore, useful in determining the longitude of a ship at sea. That this method actually has no practical value, Columbus did not and could not know; but it was tried and suggested time and again before a practicable method was devised with the invention of a reliable marine chronometer.

Be that as it may, Columbus was the first man to discover that the magnetic poles of the earth are not exactly the same as the geographic poles, although many had used the compass before him. About 200 years before Columbus set out, the great Raymond Lully (1236-1315) had mentioned the magnetic needle among the instruments of a sailor.* Since then every sailor had trusted his needle faithfully, and one may imagine how they felt when they discovered that it was not absolutely reliable. Maybe they were really going to fall over the rim of the world, maybe they had already drawn so near India that the Mountain of Lodestone had begun to exert its influence.

*"*Et ad hoc instrumentus habent chartam, campasum, acum et stellam maris.*" "Compasum" means a pair of compasses while "acum" (needle) refers to the magnetic compass or rather its predecessor.

To those men the Mountain of Lodestone was a very tangible menace and the more they knew of the literature of their times the worse the menace appeared. Every one of them knew what to expect: if the ship came too close to this mountain it would attract all the iron on board so irresistibly that the course could not possibly be changed. Finally all loose pieces of iron would flow like swallows toward the dark, skeleton-strewn mountain, and in the end even the bolts and nails that held the planks together would be drawn out, so that the ship would fall apart even before actually touching the terrible mountain.

When we hear mention of the Mountain of Lodestone nowadays we usually think of the Arabian Nights and of the adventures of Sinbad the Sailor. Actually the legend is older; there is a vivid account of the shunned mountain in an anonymous Arabian work, "Book of the Wonders of India," which was written around the year 950 A. D., when there was much Arab trade with Indian Sea ports. The geographic location of the mountain was, of course, not definitely stated. It was expected to be somewhere in the vicinity of the Malay Peninsula, where it was also sought by the Chinese. One So-sung placed it there in an account written under the reign of the emperor Jin-tsung (1023-1063 A. D.), but So-sung did not believe it to be as destructive as the Arabs thought. He only related that there was a place in the seas so rich in lodestone that the large foreign vessels, built with much iron and even having a bottom sheathed with iron, would be so powerfully attracted that they could never pass the spot.

On an ancient map

The Mountain of Lodestone suddenly shifted its geographic location after the invention of the mariner's compass. Since the needle of this miraculous instrument always seemed to point toward the pole star, most authors believed that there was some mystic relation between the mineral and the star. But the geographer Johannes Ruysch had a better idea: most probably the compass pointed toward the Mountain of Lodestone, which was, therefore, situated near the pole and not in the East Indies as older authors had believed. Consequently Ruysch placed it far in the North on his map, finished and published in 1508.

His map is a very peculiar one indeed. At about 80 degrees north, where Greenland appears as an Asiatic peninsula, there is a string of 18 islands of the same shape and size. Between these islands and Greenland there is a legend, reading: "Here begins the amber sea, here the nautical compass grows uncertain and ships built with iron cannot return." North of this legend there are again four islands, one called Hyperborei, another Arumphei, and the remaining two "Insulae desertae." And north of these four islands there is another small island, marked: "Under the Arctic pole there is a rock of lodestone, 33 German miles in circumference, in the amber sea."*

On this map of the world the Mountain of Lodestone makes its last official appearance. The mariner's compass, coming increasingly into use, was allowed to sail the seven seas but it drew no ship to such a mountain.

The first compass

It is hard to say when and where the property of a magnetized needle to point north when allowed free movement was discovered for the first time.

When the Chinese claims of priority were still believed, it was generally thought that the Chinese "secret" became known in India in the fourth century and that about 400 years later the Arabs learned how to make magnetic compasses when their trade with India increased. It was thought that the invention entered Europe a few centuries later via southern Italy.

The magnetic needle, which later evolved into the mariner's compass, certainly did travel the way just described, only in the opposite direction. There can be no doubt that the earliest European sources mentioning it are the first sources in general. The magnetic needle was mentioned first in that period of history whose evil reputation is expressed in the name The Dark Ages, but it should be remembered that in this period several other important inventions were also made that were to change the face of the world.

The earliest definite statement yet known about the use of the compass in the Middle Ages is in the writings of Abbot Neckam (1157-1217), who twice mentioned it. The passage in his *De Utensilibus* reads:

> Among other stores of a ship, there must be a needle mounted on a dart (*habeat etiam acum jaculo superpositam*) which will oscillate and turn until the point looks to the north, and the sailors will thus know how to direct their course when the pole star is concealed through the troubled state of the atmosphere.

*On the map the inscriptions are in Latin. They read: "*Hic incipit mare sugenum* [*succinum*]. *his compassus navium non tenet, nec naves, que ferrum tenent, revertere valent.*" The other inscription reads: "*Sub palo arctico rupem esse excelsum ex lapide magnete, 33 milliarum germanicarum ambitu: hanc complectitur mare sugenum.*' This constant mention of the amber sea makes one wonder whether old Johannes Ruysch thought of a connection between the magnetic properties of lodestone and the electric properties of amber. Naturally Ruysch could not even guess how these two natural forces, magnetism and electricity, are interrelated.

The commoner form of the mariner's compass at the time of Abbot Neckam, however, was not a "needle on a dart" but a needle thrust crosswise through a piece of reed, which made it float. The needle was then "touched" with a lodestone—evidently the iron was too poor to stay magnetized for a long time and therefore needed frequent re-magnetization—and the whole affair placed in water in a wooden or brass vessel. It is probably to this type of compass that Alexander Neckam refers in his book *"De Naturis Rerum"*:

> Mariners at sea, when through cloudy weather in the day which hides the sun, or through the darkness of night, they lose the knowledge of the quarter of the world to which they are sailing, touch a needle with a magnet, which will turn round till, on its motion ceasing, its point will be directed towards the north.

Roger Bacon shows his familiarity with the principle in 1266-1267 (*Opus majus* and *Opus minus*) when, writing on the properties of lodestone, he states that if it is set so that it can turn freely (swimming on water) it points toward the poles. This, he says, is not due to the pole star, but to the northern region of the heavens.

In the works of Albertus Magnus (1193-1280) we find the following:

> It is the end of the lodestone which makes the iron that touched it turn to the north [*ad zoron*] and which is of use to mariners; but the other end of the needle turns toward the south [*ad aphron*].*

And the magnetic needle was already familiar enough in 1256 to be used figuratively:

> Just as mariners are guided during the night by the needle . . . in fair weather and foul, . . . so those who are called upon to advise the king must always be guided by a spirit of justice.†

Contemporary with Abbot Neckam is a famous satirical poem written in about 1208 by Guyot de Provins in which he commends the steadiness of the pole star as a lesson to the pope, and the faithfulness of the needle as an example for the lesser servants of the church.

Perpetual motion

Another very important document from the early times of the magnetic compass is the letter of Petrus Peregrinus. Petrus or Pierre, oftentimes called Pierre de Maricourt, was a man who visited the Holy Land with one of the Crusades, hence his decorative name Peregrinus, the Pilgrim. In 1269 Petrus was an army engineer of Charles of Anjou. Trying to devise a mechanism to keep the astronomical sphere of Archimedes in uniform rotation, Petrus fell for the dream that has made life miserable for so many mechanically inclined men—he tried to invent a perpetual motion machine. Being acquainted with the properties of the lodestone and having experimented with it seriously, he thought of accomplishing this by means of a lodestone. But however futile this may have been, his letter to a friend in France, completed on August 8, 1269, contains several interesting observations. It is a fairly long letter, consisting of two parts, the first ten chapters, the second only three chapters long. In the first part Petrus gave directions for selecting a good lodestone, for finding its two poles and for distinguishing them. Petrus deserves credit for being the first to prove the very fundamental principle that like poles repel each other and unlike poles attract. He was the first to prove that the polarity can be changed by means of a more powerful magnet, and he also proved experimentally that any part of a lodestone, no matter how small, is a complete magnet with both poles—a demonstration that is still used in the laboratory in the illustration of the molecular theory. Petrus was also the first to describe a real compass, with double pivoted needle and a scale of 360 degrees on the rim of the vessel. He emphasized that the container should be made of a non-magnetic metal or other material and covered by crystal or glass.

Discovered about 1200 A.D.

All of which proves that the mariner's compass was finished in Europe in about 1260 A. D., while the fundamental discovery, that a magnetized needle always assumes a certain position, was made in about 1200 A. D., probably earlier. Even the first source, Abbot Neckam, does not show the surprise one should expect in the case of an entirely new discovery.

It has been thought that the Europeans got the magnetic needle from the Mohammedans during the Crusades, but it seems that the Mohammedans were then acquainted with it only as a Christian invention. At any event there is no earlier Arabian description known than that contained in a book about valuable stones for merchants, written by one Bailak Kibdjaki in Cairo in 1282. Bailak told in this book that while traveling from Tripoli to Alexandria in 1242 he saw the sailors push a needle through a piece of reed and whirl it around with a lodestone. It is known that Bailak borrowed heavily from another book on stones by al-Tifashi, who died in 1253, but al-Tifashi mentions lodestone only as a mineral that attracts iron, from which we deduce that Bailak was referring to a relatively new invention.

There are also linguistic reasons to assume that

*De Mineralibus.

†From the introduction to the Spanish Code of Laws, *"Las Siete Partidas."*

the magnetic needle came from Europe to the Near Orient. While the Arabian author just mentioned asserts that the captains who sail the Indian seas are said to use a sort of fish made of hollow iron which points north and south, it is significant that words of European derivation are applied to the compass farther to the east than might be expected if the compass had not originated in the west. Dr. W. Robertson asserts* that the Arabs, Turks and Persians have no original name for the compass but call it *bossula*, the Italian name, which would indicate that the instrument itself was of European origin as well as the name.†

Named after reed grass

In southern Italy, where most of the fishermen spoke Greek, the magnetic needle was known under the name of *calamita*, evidently derived from the Greek word for reed grass *kàlamos*, which still lingers in the German *Kalmus* for a plant that, while not actually a reed from the botanical point of view always grows where reed and sedge can also be found. It is significant that *Kalmus* (its scientific name is *Acorus calamus*) which is now widely distributed in Europe came via Turkey, probably from East India. It is known that the body physician of Emperor Ferdinand I, the learned botanist P. A. Matthiolus, received in 1557 a *Kalmus* plant as a gift from Angerius Busbequius, who was then ambassador to the court at Constantinople. Whether the plant was widely known in Europe before Matthiolus described it is doubtful. True, the name is mentioned in earlier books, for example in Peter Schöffer's *Hortus Sanitatis* (1485) but it might have been *Iris pseudacorus*, which looks similar. At any event *Kalmus* might be used to keep a magnetized needle floating, at least for a short while. Maybe it was this plant that is the "reed" so often referred to in connection with early compasses.

A name for the compass created by the Arabs was *alkàlamos*, which came back to Europe distorted to *ascalamus*. Farther afield, the Italian *bossola* is seldom used in the Eastern seas—*Daïrah* and *Beit el-Ibrah* (The Circle or The House of the Needle) being the ordinary appellatives in the Red Sea, whilst in the Persian Gulf *Kiblah nāmeh* is in more general use.**

In East India, to give further evidence against an oriental origin, there seems to have been no magnetic needle even as late as 1450. Nicolo di Conti, who returned from India about 1454 after living there for 25 years reported of the East Indians: *"Non navigono col bussolo,"* "They don't navigate with the compass."

China, the alleged country of origin of the magnetic compass, presents a more difficult problem, not only on account of the changes and insertions denounced by the historian Lippmann but also because there did exist a few things in ancient Chinese literature that could be mistaken for a compass.

There was, for example, the *Sse-nan*, "Pointer to the South," a car bearing a statue of a man whose outstretched arm always pointed to the south. This car was to lead caravans on land, not ships at sea. It is very significant that the Chinese made this figure point south because in that direction lay the richer and more fertile parts of the country. The seafaring nations of Europe naturally spoke about a needle pointing north, because there was the pole star that had guided them before the invention of the compass, while there is no conspicuous star near the south pole of the heavens. The crucial question is whether the Chinese could have made a figure that would point south with the feeble magnetic force of a natural lodestone. Modern experiments have shown that it would not work; and the figure, if it existed at all, was probably only a protecting charm.

Conflicting dates

There is considerable discrepancy in Chinese literature itself as to the time when the *Sse-nan* was used. Some claim in 1100 B. C.; the encyclopedia of Suma-t's'am (around 80 B. C.) speaks about a "recent invention." The first picture was drawn in 700 A. D. All this and especially a passage in the annals of the Sung dynasty that speaks about south-pointing ships contrasts very strangely with a description the Buddhistic Chinese Fa-hian gave about his pilgrimage to India. When he returned in 413 (or 414) A. D. with a large vessel that carried several hundred people they got into considerable danger because sun and stars were hidden by a cloudy sky "and nobody could tell East or West."

Magnetized needles, suspended on cotton threads, were described in China for the first time by Keutsung-shi (in his encyclopedia "Pen-tsao-yan-ee") in about 1115 and by Shen-kua, who died in 1093 A. D. Neither, however, knew anything about the possible use of this needle in navigation and treated it only as an instrument for magical rites.The crucial passage is found in the writings of one Choo-yue (about 1105) who wrote that the needle was not used on sea-going vessels earlier than in the period from 1086-1099 A. D. when foreigners had it on their ships that traveled between Canton and Sumatra.

*Historical Disquisition concerning Ancient India, p. 227.

†*Bossula* is derived from the Greek *pixis* (latinized *buxus*) and is familiar in the French form *boussole*, meaning a mariner's compass.

**Rev. G. P. Badger *(Travels of Ludovico di Varthema*, trans. J. W. Jones, ed. G. P. Badger, Hakluyt Soc., 1813, note, pp. 31 and 32).

The Japanese historian Hashimoto, who carefully compared all available manuscripts from this time points out that the "foreigners" were in all probability Arabs, who reached Canton for the first time in 714, after the port had been opened for vessels other than Chinese in 700 A. D. Apparently the Chinese did not even take advantage of this "foreign" knowledge very quickly, because there were hardly any compasses in use when Marco Polo journeyed to Cathay. In his writings there is no mention of anything that might be usable as a compass, and the word *compas* itself is used only once (in chapter 186), and in this instance it pertains to some written matter encompassing his plans—a sketch—rather than an instrument.

The thorough analysis of all the Oriental writings is a task too great to be undertaken here, but to quote from the British authorities, Francis H. Butler and Silvanus Phillips Thompson, "There is now little doubt that the claim formerly advanced in favor of the Chinese is ill-founded." There seems to be no genuine record of a Chinese marine compass before A. D. 1297.

From northern Europe?

All this allows us to draw the following conclusions: The magnetized needle was invented around the year 1100 A. D. possibly a few decades earlier, somewhere in Europe. It became known very quickly all over Europe, the Arabs learned the art from the sailors living in or visiting southern Italy and carried it to the Far East themselves. Who was the first to make a magnetized needle float and direct the course of the ship? No one can yet say. It has been suggested that the Vikings are responsible for the invention. They had lodestone at their disposal in Scandinavia, they spent most of their lives on board their ships, and they occasionally built ships without iron for fear of the Mountain of Lodestone. Perhaps they took what they believed to be a sample of this mountain on board with them to warn them in some mysterious manner, and thus discovered its properties. This suggestion may point toward the truth, but proof is lacking and may be hard to furnish.

The story of the lodestone found its sudden end one day in 1819, when the Danish physicist H. C. Oerstedt discovered that a compass needle could be made to oscillate by placing it near to an electrically charged wire. This discovery proved that electric currents produce magnetic fields, a fact on which every electric motor and much of all other electric machinery is based.

This discovery made the lodestone superfluous, electric currents could produce much better and more powerful magnets. The first piece of iron magnetized by means of electricity was produced in 1820 by D. F. Arago, and the first actual electromagnet was exhibited in 1825 by W. Sturgeon. Meanwhile A. M. Ampère had published his hypothesis suggesting that magnetism is caused by molecular currents. In 1831 and 1832 Michael Faraday presented to the Royal Society his papers about magneto-electric induction and two decades later followed J. C. Maxwell's famous "Electricity and Magnetism."

Mysteries still unanswered

Shortly before Oerstedt made his discovery, the theory of ferromagnetism had progressed the first few steps since Petrus Peregrinus. Coulomb had in 1785 proposed the law that now bears his name—that poles attract or repel each other inversely as the square of their distances apart—and Poisson (1781-1840) had created the science of magnetostatics, based on this law. All of this gave fairly good insight into the laws governing the behavior of magnets, but it did not mean that there were no riddles left and that the possibility of surprises was eliminated. One of the biggest riddles still unexplained is the magnetism of earth itself. In a very recent book (1937), "Introduction to Ferromagnetism," the author, Dr. Francis Bitter, while discussing the various theories, was still compelled to admit: "The magnetization of the Earth's core, however, is not included [in these theories] and the theories in their present form do not account for its existence at the high temperatures of the Earth's interior."

One of the surprises of practical experimentation came in 1902-1903, when Dr. Friedrich Heusler discovered the alloys named after him. It had been known that manganese had a peculiar influence. An iron alloy with only 12.3% of manganese differed hardly from non-magnetic substances. Doctor Heusler alloyed manganese with copper and aluminum—and these alloys, composed entirely of non-ferromagnetic metals, were ferromagnetic! Best was the combination of 63% copper, 25% manganese and 12% aluminum, which represents about the chemical formula $(Cu, Mn)_3 Al$. It has been thought that manganese might actually be an additional ferromagnetic element beyond the three officially recognized—iron, nickel and cobalt—but one with so low a "critical temperature" that its magnetism is non-existent under ordinary conditions. Others sought the solution of the mystery in a peculiar molecular structure of the Heusler Alloys that show about the same magnetic properties as cast iron. But there is still room for better explanations.

Metallurgical science had learned, of course, to compound special alloys excellently suited either for electromagnets (where the metal must lose its magnetism as completely and as quickly as possible as soon as the current is switched off) or for permanent magnets. An especially good alloy for electromagnets is "Sendust," discovered by Hakar Masumoto in 1936, consisting of 8-11% silicon and 5-6½% aluminum with iron. It has the advantage of being very brittle, but it might be used in powdered form for loading coils. Other alloys have been developed having special characteristics. In short metallurgists have learned how to make powerful permanent magnets in a variety of ways, and some of the newer alloys exert a surprisingly great force, especially if one still remembers the weak steel magnets one played with a few decades ago.

There is one more surprise to be related. It takes only a few sentences to tell but it is as important as was the discovery of the magnetized needle.

Everybody knows that terrestrial magnetism varies not only with latitude and longitude but also through the years. There is a continual shifting of the direction of the earth's magnetic field, particularly its dip. Several years ago it was discovered that earthenware vessels acquire magnetic properties while being fired. These magnetic properties are faint, but detectable. And, what is more important, once the vessel is removed from the firing oven their direction remains constant. Therefore, if one knows the place of firing of a certain vessel, one can deduce its date, if the changes that occurred in the meantime are known. The importance of this in archaeology is obvious. Geologists, hearing about this new method, naturally thought of old and now cooled lava flows. They tried to apply the same method to them and met with success. It is a new tool of the scientist that is being forged by these experiments, a tool that may help to establish chronological orders in many circumstances where everything else would fail. Thus the good old lodestone, which once could serve only as a directional compass, acquires new importance as a time compass.

This is one of the latest discoveries connected with magnetism, the natural force that made the ancients wonder and fable about incredible dangers. They knew only one tiny manifestation of this force, as much as was shown to them by the lodestone. We now know almost a thousand times as much about this force as they did and we have lost the fear of unknown dangers that always accompanied ignorance. But we feel that everything we know is still only a beginning.

A NEW "TIME COMPASS"

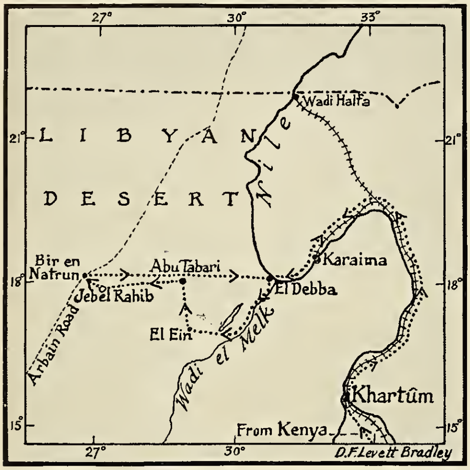
An unexpected and rather spectacular investigation along the lines discussed in the preceding article is being undertaken by the Department of Terrestrial Magnetism of the Carnegie Institution of Washington, involving the extraction of cores from the sea bottom. This extraction resembles the coring of an apple, performed, however, on a much larger scale and with the use of explosives. Thus removed from the ocean bed, these cores have been found helpful in the study of the changes in the orientation of the earth's magnetic field.

"Consider a minute particle of a magnetic mineral (and there are many such) settling slowly through the quiet water at the bottom of the ocean. Like a tiny compass needle it orients itself along the line of the magnetic force at that place and at that time. A multitude of such particles become buried in the sediment, and their orientation in these cores can be determined by delicate electrical apparatus. Therefore, as this orientation shifts back and forth throughout the length of the core, it reveals the cyclic changes of the lines of magnetic force throughout the past. Here is a record such as the non-magnetic ship *Carnegie* might have compiled had it been cruising the seas for several hundred thousand years or so." (From "Core Samples of the Ocean Bottom and Their Significance" by Charles Snowden Piggot, *Scientific Monthly*, March, 1938.)

Explorers in the Libyan Desert

By William D. Campbell

The accompanying photographic record of the trials and triumphs of the Campbell Expedition records a difficult journey across the Anglo-Egyptian Sudan in which Mr. William D. Campbell, F.R.G.S., Field Representative for the Department of Mammalogy, gathered material to complete the Libyan Desert Group in the American Museum. Exploring an area which had not been visited since Lord Edgerton of Tatton came there in 1929, Mr. Campbell describes his trip in the following letter to Natural History:



The white glare of sun and sand soon became familiar monotony to William Campbell and Major Dickinson as they set forth on the most difficult safari they ever made. The above map shows in dotted line their itinerary. Flying from Kenya in East Africa to Khartum, they continued their journey by train to Karaima, by boat to El Debba, thence on camel-back via El Ein to Bir en Natrun and back to El Debba. They covered 900 miles in 75 days

• • •

"Although we have traveled together for many years in the world's forgotten places, Major W. V. D. Dickinson, M.C., late of the King's African Rifles, second in command of the expedition, and I have never before encountered so many extreme disappointments and discomforts as on our ill-starred journey through the Libyan Desert. The game we sought was almost non-existent. With the exception of a few lizards slithering away among the stones and sparse grass, no animal life could be seen for days at a time. When we would finally locate a herd of addra or oryx, the lack of cover would rarely allow us to approach close enough for a shot. Coupled with this, the physical hardships became almost unbearable. Being thwarted in our purpose of collecting specimens, every irritation took on abnormally large proportions. As a result of the exercise and restricted rations, Dickinson contracted a stomach ailment and lost 25 pounds. I lost 20.

Our camels were fractious and often wandered away among the dunes. This necessitated dropping everything to look for them. One searching party took two weeks to round up a few strays. The cold was intense. So was the heat. But it was the sandstorms that were most galling. Many times it was necessary to stop the march in the middle of the day, set up our tents, and creep into them for shelter.

"When we were not battling with the elements, we were constantly gnawed by the fear that our water supply would give out before we could reach the next well. One instance will show the somewhat frivolous measures we had to adopt to keep our spirits up. After endless days of travel, in order to tear our eyes away from the unchanging skyline, Dickinson and I invented a game. We had noticed two queer customs of our Arab drivers. They talked constantly on a high pitch and at the top of their voices. And they punctuated every other sentence by clearing their throats and spitting. Our game consisted of selecting two men out of the lot and betting upon which one would spit most frequently in a given time.

"Of course, there were some compensations. A word should be said in praise of our men. Fortunately our gloom did not seem to affect them. They were in constant high spirits, laughing, singing, and joking among themselves throughout the expedition. Undoubtedly their friendliness and willingness to work was due largely to the very kind cooperation we received from the Sudan government officials. And if the government people or our men had been able to control the winds and the game supply, I'm sure they would have done so; and we would have had a more comfortable and far more profitable time."

(Above) A CONTRAST to the dry, hot wastes that engulfed the explorers, was this tree-shaded park surrounding the Mohammedan Mosque in Khartum, capital of Anglo-Egyptian Sudan

(Above) BABBLING CONFUSION prevailed among the white robed Arabs every time a train pulled in or out of Khartum's central railroad station. Trains, although air-cooled, lacked diners

(Right) STEAMER ON THE NILE: bound for El Debba, this small boat was almost hidden by the twin double-decked barges towed on either side. One carried a noisy horde of Sudanese women; the other men, donkeys, and chickens

(Left) AFRICAN SUNSET: a small sailing vessel anchored on the Nile is caught in silhouette against the evening sky by Campbell's camera. This peaceful moment was not echoed in the rest of the trip; for, once the Nile district was left behind, rigors of the desert excluded human habitations—only three human beings were encountered during the remainder of the expedition. Sand storms, heat, cold, and lack of game disheartened Campbell and Dickinson, seasoned explorers though they are

Mr. Campbell and Major Dickinson did get some fine specimens, in spite of their difficulties. Aside from the Barbary sheep shot for food, they took several oryx, addra and addax. The addax is a short-legged, heavy animal, an average adult standing about 42 inches at the shoulder and weighing 250 pounds. Its coat is white, with long brownish hairs on the neck shoulders and forehead. The hooves are broad and shallow, admirably adapted for going over deep sand. Its horns, closely ridged and twisting spirally backwards, are long—the longest on record being 39½ inches. During the heat of the day, these animals may gather under the sparse shade of an isolated thorn tree, with only their horns visible. At night they crouch in hollows which they have dug in the sand, primarily to get at the moist roots of shrubs, as a protection against the bitter cold winds, which are characteristic of this region.

The addra is the largest of all African gazelles, standing 36 to 37 inches at the shoulder. Its body is white with chestnut patches which may include most of the neck. The horns are about 15 inches long, and the tail, entirely out of proportion to the rest of the animal, only six inches. When browsing among the shoots of the desert trees, the addra rears up like a goat, often balancing itself straight upright on its hind feet. The white oryx, a frequent decoration on old bas reliefs and frescoes of Egypt, showing its one-time abundance in that country, is now limited in its scope to a few parts of the Libyan Desert. Similar to the addax in habits and migration, it also closely resembles that animal in form and color. The main differences lie in its horns, which curve back like a scimitar instead of in

(Left) PLACID ZOO GAZELLES: these animals were mild and friendly in the garden of the Khartum Zoo pictured here; but at home on the desert, they proved nervously timid

(Right) ANCIENT WELLS such as this, few and far between have served for generations as sole water supply for desert tribes. Largely unmarked on maps, their actual location has been handed down by word of mouth

(Left) A SWEET TOOTH hides behind these local sheiks' bushy mustachios. One, Abu Hassen, entertained the two explorers with saccharine fruit juice, tea and coffee in his spacious, multi-carpeted home

(Right) MAJOR DICKINSON with the expedition camel drivers and sheiks of El Debba. Twenty-six men and 50 camels were hired for the long desert trek

A SEA OF SAND was scrutinized by this Arab scout, looking for game. The scarcity of animal life in the Sudan is evidenced by the fact that less than 100 head of game were seen during the entire expedition. Vegetation was rare; only the short yellow African grass cropped up here and there to serve as food for the expedition camels. At that, the camels fared better than the men, who tasted little fresh food during the long trek and dined mostly out of cans. Any rock such as this, casting a shade in which halt could be made for lunch, was called a *verandah* by the natives the spiral shape of the addax, and in its tail. The tail of the addax measures only eight or nine inches, while the tail of the oryx is long and cow-like. Much prized by the Arabs for its hide and flesh, it is hard to capture, because its keen eyesight aids in detecting hunters before they can get close enough for a shot.

"But the worst blow was still to come," writes Mr. Campbell. "Perhaps the reader will remember that American papers carried the story in May of the sinking of the ship upon which our collection was sent to this country, in Boston harbor. Three-quarters of our specimens were lost. Out of the whole lot, we managed to save three white oryx, five addax, and two addra. These are being mounted and will soon be on exhibition in the African Hall of the Museum.

"Not entirely daunted, Dickinson and I leave this month to collect the chimpanzee and mandrill groups for African Hall. The mandrill is a large and spectacular member of the baboon family and the black-faced chimpanzee is a rare type which lives only in French Guinea. Our new course lies across the Sahara from French Equatorial Africa to Algiers. Abandoning the camel as a conveyance, we expect to start out from my ranch in Kenya Colony with a fleet of five motor trucks and go straight through the heart of Africa. Although this expedition will cover 20,000 miles and will last about six months, we hope to avoid the vexations of our Libyan safari, and trust that the Sahara will be both more friendly and more fruitful than her sister, the Libyan Desert."

(Left) Shoulders hunched against the cold, Campbell shows that desert morning temperatures necessitated thick protection against the bitter winds. Both men, saddle weary toward the close of their long trek, found it more comfortable to walk most of the day

(Right) Fierce sand storms forced frequent halts. Often twenty men were needed to set up the leaders' tent as shelter against the stinging sand and wind

(Left) White oryx: the result of a good day's hunting and a mad desert chase. Two of these animals were dropped in their tracks; the third, wounded, was pursued on camel-back for half an hour before he was finally taken

(Right) A Barbary sheep bagged by Campbell after a difficult stalk. These animals who make their home in the rocky desert hills, are much prized by the natives in eking out their meager food supply

Flying the union jack, the explorers set up their over-night camp. The camels graze; the natives take time out for their lengthy prayers, during which they lave themselves with sand; Campbell and Dickinson, if near a well, draw water for baths, for they may not have another for three weeks.

The first expedition in this territory in nine years, bad luck dogged their footsteps. Despite these hardships, the indefatigable explorers are even now starting a second desert journey—across the Sahara—to collect specimens for the chimpanzee and mandrill groups in Akeley African Hall of the American Museum

THE ROAD TO MAN

By ERICH M. SCHLAIKJER *Brooklyn College*

That man is the product of a continuous development from the earliest form of life that appeared eons of time ago, is by no means a new idea. This concept, with modification, was partly foreshadowed in the writings of some of the earliest naturalist-philosophers, and during the past one hundred and fifty years, many scientists in the biological, geological, and related fields have amassed a wealth of scientific data portraying with great accuracy the gradual transformation that has taken place from the earliest fish-like vertebrates to fishes, amphibians, reptiles, and to mammals leading eventually to man. Preëminent among the outstanding later contributors to the subject of man's place in relation to the lower vertebrates have been such men as Darwin, Haeckel and Huxley, and most notable at present is the work of Professor William King Gregory* whose many contributions, dealing with the stages of the evolution of man from the earliest fishes, are well known.

Likewise, the pictorial representation of stages in man's ancestry is not new. Several have done this, but they have not used as many forms and have employed, wholly or in part, living animals. The present attempt, however, is to portray, for the first time, a continuous series of restorations of thirty fossil forms in or near our ancestry from the earliest vertebrates of four hundred and fifty million years ago. These have been selected from the thousands of known fossil vertebrates because they best display the structural features necessary for giving rise to progressively higher forms, and have not been side-tracked by overspecialization from the road to man. It should be remembered that this road was a crowded one and that these chosen few represent only stages whose structural features characterize groups along the way. Evolution is not a matter of steps, nor is it a condition of change from one individual to another. It is a slow transformation from lower to higher types—new groups gradually emerging from old ones.

When vertebrates appeared, more than three-fourths of the earth's history had passed. Since then, however, much has happened to the ever-changing features of the earth's crust, and there have been many marked environmental changes. The first vertebrates were fresh water forms of a time when there were no land plants, and the continents were transgressed by extensive seas. By the close of Devonian times there had been marked restriction of the seas, forests of spore-bearing plants covered the landscape, and the first amphibians appeared. They found the warm, humid climate of the Carboniferous Period, with its extensive, heavily forested swamp-lands most acceptable and they developed abundantly. One group took to the land and from them evolved the reptiles which were already flourishing at the end of the Paleozoic Era. This great Era was brought to a close by the Appalachian Revolution. Mountain systems were built up where once there had been seas and marsh lands; moisture-laden winds were cut off from regions that were once humid, turning them into deserts; and, this universal diastrophism had much to do with bringing about rather extensive glaciation. These changes lasted on into the early Mesozoic and had profound effects on the animals and plants of the times. Amphibians were restricted and many diverse reptilian forms had developed. The mammal-like forms eventually gave rise to the mammals, which soon were to become varied but were for the next 140 million years to occupy an inconspicuous place in a world of reptiles. Among the plants, cycads and conifers (pines, etc.) were now dominant.

By late Mesozoic times the seas were once more widely transgressing the continents. Extensive sections were turned into swamp-lands, and flowering plants were widespread and abundant. Another great revolution brought this Era to a close, and the effects on life were as striking as before. This really marked the dawn of modern life. Mammals were established and such plants as grasses, cereals, and fruits began to flourish.

As early as the Miocene Period, uplifting began again and culminated in the Ice Age. Coincident with these severe conditions was the change from the man-like apes into man, and it was during the critical times of the Pleistocene, when nearly one-sixth of the land surface was periodically covered with ice, that man fought his way to a higher evolutionary plane.

These are the main environmental changes, which during the last 450 million years, have marked the way of vertebrate evolution along the road to man.

* See especially, "The Origin and Evolution of Human Dentition," Williams and Wilkins, 1922, and "The New Anthropogeny: Twenty-five Stages of Vertebrate Evolution from Silurian Chordate to Man." Scien. 77: 29-40, 1933.

ed,
a
ion
of
mi-

in
on-
ent
eat
er-
at-

vas
vas
ct-
nes
na-
ent
ere
f a
ian

pes

ms
the
ire
ed,
on-
ver
re-
tes

iod
ent
uf-

3

SILURIAN began
375 MILLION YEARS AGO

SILURIAN ended | DEVONIAN began
MILLION YEARS AGO

DEVONIAN ended | CARBONIFEROUS began
275 MILLION YEARS AGO

1

Man's oldest vertebrate ancestor, ASTRASPIS (1) was one of the small ostracoderms ("shell-skinned" fishes) that had the front of the body encased in plates of armor. Only the plates, from delta deposits of fresh water origin at Canon City, Colorado, are known.

2

Of wide distribution over Europe and North America was a later archaic tribe of these jawless ostracoderms represented by ANGLASPIS (2). They have a single dorsal shield. Excellent preservation of some of these shields shows a network of sensory canals, gill

3

pouches, and even semicircular canals. In all these features these fishes point the way to our first jawed relatives. The ANCESTRAL APHETOHYOIDS (3) form a shark-like group unique in having a hyoid gill slit that corresponds to our eustacean tube. They are for the

4

most part primitive and foreshadow the oldest known ray-finned fish CHEIROLEPIS (4). This progressive type has started on the road to higher ray-finned fishes, but has retained many structures, especially in the dimensions and positions of the skull bones, of our

5

early lobe-finned Devonian ancestors. The most primitive of these was OSTEOLEPIS (5). Their lobe-like fins, fringed with dermal rays, were differentiated internally into elements that were to become the bones of our limbs. Nostrils opened into the roof of the

6

mouth showing the probable presence of lungs.
One of the most advanced of these fresh-water, medium-sized, carnivorous forms was EUSTHENOPTERON (6) of Canada. He could paddle his way out of the water and was far on the way to be-

7

coming an amphibian. The early fish-like amphibians spent most of their life in water yet had many characters necessary for success on land. Such were the ICHTHYOSTEGALIANS (7) from East Greenland—the first tetrapods, or four-legged vertebrates. Bones between

8

the skull and shoulder covering the gills were lost and the first neck appeared. In the specialized yet primitive EOGYRINUS (8) the shoulder-girdle is still attached to the skull. Having to hear through air, the first major step in the development of our refined hearing ap-

NATURAL HISTORY MAGAZINE,

By ERICH M. SCHLAI...
Drawn by GEORGE F. ...

The transition from reptile to mammal was a gradual one and the rare ICTIDOSAURIANS (16) from South Africa bridge the gap perfectly. Though still on the reptile side, known parts of the skeleton are unbelievably mammalian. The dentary bone of the jaw has

16

nearly joined the skull. When this happened, the two much reduced bones of the old jaw-skull joint were taken over into the middle ear. Mammals were born, and our hearing apparatus established. AMPHITHERIUM (17) of the English Middle Jurassic represents

17

the Pantotheria (all-mammal), an order of mammals ancestral to all the later higher forms. Only jaws are known but they show no specializations and much can be inferred concerning the rest of the animal. ADVANCED PANTOTHERES (18) known by teeth and

18

jaws of *Melanodon* and others of these pre-placentals, by the close of the Jurassic foretell the earliest known placentals, or insectivores, of the later Cretaceous. A half dozen skulls from Mongolia represent the first of these. DELTATHERIDIUM (19), the most archaic,

19

whose restoration is based on two skulls, is much like later fossil and primitive living forms. It typifies the ancestor of a tree-living line that gave rise to our first immediate ancestor. We know this INSECTIVORE-PRIMATE (20) stage in our evolution through fossil teeth and

20

jaws, and especially by their very primitive living descendants, the tree shrews of the Far East. ANCESTRAL LEMUROIDS (21) were the first true primates. Their remains are found in early Paleocene rocks in the Rocky Mountain States. Though specialized, they reveal

21

many of the structures and habits of the lemur ancestry, portraying in general our earliest primate tree-living ancestors. By Eocene times true lemurs were well established in the Old and New Worlds. PELYCODUS (22) was a small primitive form with teeth that re-

22

call an early lemuroid ancestry. More progressive was the American *Notharctus*. PARAPITHECUS (23) of the Oligocene of Egypt had advanced more in the direction of the ancestral anthropoids, possessing the features of the teeth necessary for giving rise to monkeys

23

AGO

JURASSIC ended | CRETACEOUS began
120 MILLION YEARS AGO

CRETACEOUS ended | PALEOCENE began
60 MILLION YEARS AGO
END OF MESOZOIC ERA | BEGINNING OF CENOZOIC ERA

55 MILLION YEARS AGO

EOCENE ended | OLIGOCENE began
35 MILLION YEARS AGO

CARBONIFEROUS ended | PERMIAN began
225 MILLION YEARS AGO

END OF PALEOZOIC ERA | BEGINNING OF MESOZOIC ERA
PERMIAN ended | TRIASSIC began
200 MILLION YEARS AGO

TRIASSIC ended
155 MILLION YEARS AGO

9 — paratus was taken when the upper bony support of the old hyoid gill was transformed into a little bar (stapes) connecting the inner ear with an external drum. One group of amphibians, represented by DIPLOVERTEBRON (9) from the Carboniferous of Bohemia,

10 — took to the land more and more, became quite lizard-like, and had well developed limbs. Eventually they changed into reptiles—the next higher group of vertebrates. SEYMOURIA (10), the amphibian-reptile from Texas, shows this transformation—a change that meant,

11 — among other things, a better developed brain, costal (rib) breathing, and that eggs could be laid on land. This change was the product of trying conditions at the close of the Paleozoic. ROMERIA (11), also from Texas, was a more advanced member of this stock. Known

12 — only by the skull, this form seems to stand at the cross-roads that lead in one direction to many of the highly specialized and later reptiles, and in the other to CAPTORHINUS (12) and the mammal-like reptiles. This small form had rather slender limbs. The skull had

13 — most of the primitive elements but the teeth were rather specialized possibly for eating molluscs along the shores of Permian seas. More advanced, however, was MYCTEROSAURUS (13), which belonged to an order of the more common Texas Permian reptiles.

14 — Characterized by its large eyes, and fairly deep, long face, it foreshadows many of the features of the mammal-like cynodont (dog-toothed) reptiles of South Africa. CYNOGNATHUS (14), the dog-jawed reptile, has progressed towards the mammals in such

15 — features as reduction of the posterior jaw elements, differentiation of the teeth, limbs under the body, and a shoulder-girdle that closely resembles and has the same elements as the egg-laying mammals of today. TRINAXODON (15) was even a more mammal-like cynodont.

and apes. Egypt was also the home of the earliest known ape. From deposits there, a single lower jaw named PROPLIOPITHECUS (24) has been described. Its form and tooth characters show that this progenitor of ours was decidedly like living apes though far — 24

more primitive, as are all ancestral forms. More ape-like, yet more primitive than any of the chimpanzee-gorilla group was DRYOPITHECUS (25). Fragmentary remains of this stock have been recovered from parts of Western Europe and India. Unquestionably these — 25

display, especially in the form of the teeth and in the number and arrangement of the tooth-cusps, an ancestral stage common to the orang, gorilla, chimpanzee, and to man. AUSTRALOPITHECUS (26) of the Pleistocene of South Africa combined in a — 26

unique way ape-like and man-like characters. It was a structural connecting link between the two families. The oldest and most primitive of fossil man is the Peking SINANTHROPUS (27). Several skulls, jaws, teeth, skeletal fragments, stone implements, and charcoal — 27

unearthed in an early Ice-Age cave deposit tell the story of this cannibalistic forefather of all modern races. Towards the close of this Period *Homo sapiens,* the species to which we belong, had appeared. An early generalized member is the WADJAK MAN (28) of Java. In — 28

his many primitive skull characters, this lantern-jawed individual closely resembles the Australian and could be the ancestor of all later forms including the advanced CRO-MAGNON MAN (29). This cave-dweller possessed a few primitive features, but had a superior — 29

brain volume, averaged six feet tall and had a high degree of artistic ability as is shown by paintings, carvings, etc. This European was contemporaneous with the extinct mammoth of pre-Recent glacial times, and may have been ancestral to some of the white race of HOMO SAPIENS (30) of today. — 30

OLIGOCENE ended | MIOCENE began
20 MILLION YEARS AGO

MIOCENE-PLIOCENE ended | PLEISTOCENE began
1 MILLION YEARS AGO

PLEISTOCENE ended | RECENT began
10,000 YEARS AGO

Information Test for This Issue

A few informational high spots that may be gleaned from this month's NATURAL HISTORY

Score 5 points for each correct answer. Correct answers on page 231

1. Is the Dancing Girl: *the popular name for a mirage seen by Mr. Campbell recently in the Libyan Desert, a rare variety of orchid,* or *a fairy believed even today to visit Scottish homes every Hallowe'en?*

2. Was the first man to discover that the magnetic poles of the earth differ from the geographic poles: *Albertus Magnus, Christopher Columbus, Roger Bacon,* or *Marco Polo?*

3. Sequoyah is the name of: *a type of orchid, an edible plant recently grown without use of soil,* or *the only man known to have created unaided the entire written language of a people?*

4. A certain variety of central American orchid is found in association with: *oil wells, soy-beans, bee hives,* or *vanilla?*

5. Are trilobites still living? Yes—No.

6. The orchid is: *a self-sustaining plant,* or *a parasite?*

7. The addax is: *an instrument used by mariners before the compass, a hoofed animal with spirally twisted horns,* or *a two-bladed adz?*

8. The Holy Dove was: *a bird which reassured Columbus when his compass failed, an orchid given significance by the Spanish priests in teaching the Indians,* or *a bird of good omen supposed to appear at early Hallowe'en festivals?*

9. A sea-lily is: *a type of orchid, a mythological river spirit,* or *a prehistoric animal?*

10. Certain orchids avoid pollinating a flower on the same plant by: *temporarily paralyzing the visiting insect, enclosing the pollen in a cap which springs off about 50 seconds after the insect leaves,* or *by emitting a repellant odor from the neighboring blossoms?*

11. In 1928 a single orchid which had taken 42 years to produce was valued at *$450, $800, $10,000,* or *$15,750?*

12. *Australopithecus* is the scientific term for: *an "ape" living in South Africa during the Pleistocene, thought to be the "granduncle" of man, an Australian aborigine,* or *the southern counterpart of the magnetic North Pole?*

13. "Greek Fire" was: *a ceremonial bonfire to light the way of ancestral spirits returning from the grave, a clay-baking process important in the classification of ancient Greek pottery,* or *a fuel for firebrands which influenced the invention of gunpowder?*

14. Cristóbal Colón was: *the first scientist to realize that the magnetic property of lodestone was an electrical phenomenon, a Brazilian orchid hunter,* or *the discoverer of America?*

15. The most revolutionary discovery in orchid culture was: *that agar jelly could be used in place of the natural fungus to nourish the seed, that orchids could be bred with a fraction of the labor in association with bee farms,* or *that the color of the flowers could be controlled chemically?*

16. Orchids rarely cross-breed in Nature because: *specific insect sponsors are required for the different species, they do not let the insects eat their pollen,* or *all the 25,000 different species are genetically incompatible?*

17. When the Panama Canal was cut through wild jungles: *a lake was formed which facilitated the collecting of rare orchids, ancient shorelines were uncovered giving much information about the area of our continent 300 million years ago,* or *tombs were unearthed proving the existence of a death festival among pre-Colombian Indians?*

18. On what continent did the apes originate?

19. Archaeological dating systems may be revolutionized through the discovery: *that clay vessels acquire magnetic properties while being fired, that pottery can be located in "ironized" deposits by the drawing power of lodestone,* or *by careful measurement of the depths at which trilobites are found?*

20. In the Lower Silurian Period would you rather live on the present site of: *New Orleans, Tampa, Buffalo,* or *Greenland?*

THE INDOOR EXPLORER

•

Halloween: Ancient Festival of the Dead

TO say that the celebration of Halloween is one of our outstanding social atavisms will cause little commotion in informed circles. Most of us know that this festival is deeply rooted in the past. But few of us know just how deeply, and since the vitality of the celebration remains undiminished in this streamlined age its roots ought to be well worth exploring.

Glancing out our windows late in the October of 1938, we see school children tracking townward across frosty morning lawns and we know that they will soon stop to ogle in the store windows at gaudy splashes of orange and black, jack-o'-lanterns, broom-riding witches, spitting cats and sepulchral paper costumes. What little chance they might otherwise have had to escape another annual celebration of Halloween is thereby blasted, for the costumes, standardized though they may be, are lurid, cheap, and fetching enough to stimulate violently an acquisitive desire ever bubbling near the surface in those so young.

This flood-tide of costumes, seasonal gimcracks, and all the other familiar properties for staging bigger and better Halloween parties throughout America might conceivably be described by the learned as empirical evidence of an ancient rite in its modern, mass-production phase. Is it then the powerful modern adrenalin of show-window display that keeps Halloween alive from year to year? This certainly seems the major factor. What of the old traditions? There is much room for doubt that Peter Pan's heart-wringing appeal for belief in fairies would draw more than a polite ripple of applause from war-threatened audiences of 1938. Though some bucolic folk still live in fear of being "hexed," it is doubtful too if there is a very widespread belief in witches. Nearly every town, even in these times, has its haunted house, yet there is a discernible tongue-in-cheekishness when we talk about ghosts. The church, broadly speaking, does not contrive any extraordinary solemnities in honor of the event. And still Halloween goes on.

Why? Well, it's profitable for one thing, and it's fun for another. Reason enough in this day and age. Yet at the beginning there must have been more to it than that. Some strongly established precedent, some emotional basis deeply affecting the whole people; something of the sort must be at the bottom because it has been going on for a very long time. How long? Let's take it up piecemeal.

New plague, old precedent

Does your little boy join crowds of children in the streets and, masked by Woolworth, go about from door to door? On the Isle of Man, from time immemorial almost to our own day, masked choristers used to go the rounds on Halloween singing an old Gaelic song to the inhabitants of this last stronghold of Celtism. Worse still, does your little boy's gang incessantly ring yours and the neighbors' doorbells to demand tasty handouts? There is precedent aplenty for both actions although they were not so closely connected in the days before electric doorbells. From a church warden's accounts for the year 1517 at Heybridge, England, we have a record that one Andrew Elyott of Maldon received a fee for mending the bell rope "agenste Hallowmass." Another entry reveals that they had to get "a new bell-rope agenste Hallowmass." From these and other clues we gather that the brand of nervous torture produced by a pin stuck in your doorbell is nothing new. It was evidently the custom, then, to ring bells constantly, night and day, on this holiday, until finally in the time of Henry VIII, that lusty, short-tempered man of action, a law was passed forbidding the people to ring the bells all night. Nor was good Queen Bess so long suffering as you and your neighbors. An injunction early in Elizabeth's reign states: "That the superfluous ringing of bels, (sic) and the superstitious ringing of bells at Allhallowtide and at All Soul's Day, with the two nights next before and after, be prohibited."

Threats, sins and bruises

As to the handouts your little boy and his masked friends demand, it's no secret that in giving them you are "paying for protection." Refuse, and a pinned doorbell or an upset ash barrel will be the mildest retaliation. Many parents have been alarmed by this practice in recent years, regarding it as incipient gangsterism, but it goes all the way back at least to early feudal times. In those days, harvests all being home, it was convenient to pay tithes and other debts on the day of the festival. Landlords often passed out a sort of dole of apples, cider and cake to their gathering tenants who, probably to encourage the custom, developed the idea of praying for the landlord's soul and those of his family. Hence this medieval handout received the name of "soul cake." The advantages of trading prayers for cakes soon became evident to all. It was no time before the poor from every fief in the region were lustily praying at the door. If the landlord grew stingy, they threatened to change their prayers to curses. Yes, even the feudal lord had to pay for protection. But he had one weapon which for better or worse seems unavailable to the modern householder. He invented an alms-cake differing from the soul-cake in little else than name. But at the time that difference meant a great deal. It was called a "sin-cake," the understanding being that whoever ate one immediately took upon his own head the sins of the landlord, the landlord's family, or both. While this acted as a check on the less needy beggars, many remained willing to mortgage their immortal souls for the infrequent pleasure of a full belly.

Do you look out with consternation at the open lot next door where your little boy is running about twirling a perforated tin can filled with burning coals gathered from the nearby bonfire? Don't fret. Practically speaking, it's in his blood. Torch bearing was a feature of English, Scotch and Irish Halloweens from long before the time of the Saxon invasion. Perhaps the greatest mass demonstration of torch bearing was at Balmoral castle during the reign of Victoria when the royal family gazed on a torch-light parade of unprecedented proportions from a balcony of that celebrated Scottish landmark. But the torch-light parade was simply a formalized version of a very hoary Celtic custom. Throughout Ireland in the time of the Druids all local fires were extinguished on Halloween and then relighted by torch carriers from a central fire kindled by the Druid priests on a high hill, whence its glow was visible for miles around.

Perhaps your little boy comes home with several minor contusions inflicted by the flour-filled stockings of toughies from across the tracks who are not above adulterating their flour with foreign and weightier bodies like the legendary horseshoe in the prize fighter's glove. This, too, seems inevitable. Halloween street brawls among adolescents are of a haphazard nature today, but time was in the Scottish highlands when scattering the coals after the traditional Halloween bonfire had died down was considered so great an honor that youthful bands vied with one another for the privilege. Many a young Highlander hiked up his kilts for a battle royal to defend his coal-scattering rights and came home scuffed and bloodied after the inroads of his marauding neighbors.

In your own youth you may remember dashing about in the moonlight upsetting neighboring out-houses, stealing gates and removing barn doors. The first activity seems to be without ceremonial precedent and stems from the armory of early American vandalism, surviving still in some rural districts. But the barn door episode echoes from the past. Robert Burns in a scholarly footnote, from which his tongue-twisting Gaelicism is mercifully absent, gives us an account of a most curious Scottish custom. The Scotch and their young womanhood in particular were, it seems, forever contriving games of prophecy to foretell future marriages. Many of these games in which the person, personality, and profession of the future husband were revealed took place in stables, barns and dark gardens to which the young maiden was obliged to retire alone. One is moved to ponder on the temerity of the lone lassie venturing into such secluded spots on ghost-ridden Halloween nights. But that was the rule. The barn game, according to Burns, provides that the maiden must remove the doors of the barn in order to release any harmful spirits who might remain to her detriment if she kept it locked up. Whether this is the precaution that made the undertaking a safe one, or whether any girl physically able to dismantle barn doors might not wander anywhere with impunity, this writer cannot say. At any rate once she had taken down the doors she must stand inside the barn and pretend to be winnowing corn. Then, at the stroke of midnight, the image of her future husband would pass directly through the barn, dressed in the costume and making motions characteristic of his trade.

"Mirror, mirror . . "

Although this is the most athletic of the Gaelic prophecy games, there are many others, some of which, probably without their former significance, will be played at your daughter's party. It is hardly likely that any of the guests will dig up a three-legged stool and carry it out at midnight to a place where three roads meet. But if you care to try, tradition has it that voices will come from nowhere telling the names of those doomed to die within the year. Most of the prophecies are more cheerful, however, and, like the barn door episode, in the matrimonial vein. A lovesick swain and maiden may each place a nut in the fire, the nuts being given the name of the boy or girl who put them there. If the paired nuts catch fire and burn steadily an omen for future marriage and felicity is read. But if the nuts crack and sputter and jump apart, the two whose names they bear may not wed for fear of a life of unending squabbles.

Bobbing for apples amused the ancient Celts quite as much as it will your daughter's guests, but its portentous significance, if it ever had any, seems to have been lost. Paring an apple, however, without breaking the peel and then tossing the paring over your shoulder will give you an inkling of your future husband, the clue being that the paring should fall in the shape of his first initial. This same and additional prognoses may be made through the formation of candle drippings when dropped in cold water. While you've got the candle lighted you might have your daughter hold it in one hand and stand in front of a mirror combing her hair with the other. Presently the face of her future betrothed will appear over her shoulder reflected in the mirror.

Lest you may have misgivings about investing witches, fairies, brownies and other supernatural agencies with sole power to select future intimates, it should be remembered that these

canny Scots had a way of securing the desired augury by tipping off the right party to appear at the right time. Your daughter will doubtless reach this solution independently, even if you don't suggest it. But if the thirst for prophecy remains unslaked even after the party is over, there is always the injunction of an old Irish rhyme:

"Turn your boots toward the street,
Leave your garters on your feet,
Put your stockings on your head,
You'll dream of the one you're going to wed."

A unanimous desire to peer into the future characterized Halloween-time activities among both Celtic and Teutonic peoples. District bonfires lit the scene of many community games of prophecy similar in procedure to those mentioned above but almost entirely concerned to foretell whether particular individuals would live out the year. The crystal gazing idea permeated the whole festival and a child born on Halloween was thought to be a seer, mystically equipped to consult the spirits while asleep.

The Church, the soul and the New Year

The festival was officially inserted in the holy church calendar during the 7th century when the old pagan Pantheon at Rome was dedicated to the worship of Christ by Pope Boniface IV, the day being set aside for the veneration of the Virgin and all martyrs. By the close of the 9th century, All Souls' Day (November 2nd) was an established holy day of the Catholic Church, a time of prayer for the souls in purgatory. People wore black and the streets were filled with the dismal ringing of deep-toned bells to remind the population of their duties to the dead. In Naples it is recorded that the charnal houses were invaded by friends and relatives of the recently deceased. Corpses and skeletons of the latter were arrayed in robes and flowers, then fixed in niches along the wall. Thus ensconced they conducted a ghastly reception for their visitors.

Long before the Pantheon was rededicated to Christianity, the Romans had a festival for Pomona, the goddess of the harvest, which also made much of auguries and portents of the future. We perceive, then, that two phenomena seem inextricably bound up with this autumn festival which had come down to the Scots by way of their Druidic forebears and to the Latin people through pagan Rome. The first is prophecy and the second a highly emotional exaltation of the dead. Perhaps it strikes you as odd that this ceremony should have become, over so wide an area, a time marked off for divination and omens? But wait. Do you recall that among the historical antecedents of your little boy's Halloween activities was the record of masked choristers who went about singing on this eve in the Isle of Man? Their song was the Hogmanay song, which has nothing to do with the celebration of All Saints' or All Souls' Day, but with the earliest Celtic New Year's. This explains why the Druid priests caused all the fires of Ireland to be put out and then relighted from a central fire on this particular night. It was a ceremony signifying the birth of a new year, and fire is common among many primitive people as a symbol of continued life as well as the immortality of the spirit. Lacking the doughty self-confidence of our own so-called rational civilization, the superstitious Celts made no New Year's resolutions, but rather sought some inkling of what the natural forces they feared and misunderstood were going to do to them. The old year was over and done with. Ahead lay new tasks and new hopes. What better time could they have chosen for seeking knowledge of the future?

Days of death

But when we turn to the second significant characteristic of the festival, that is to say, The Dead, we find our explorations taking us even deeper into the antiquity of mankind. So far we've seen that the festival at Halloween-time existed long before Christianity became the great organizer of our North European folklore.

But even after the Church had consolidated its position the Isle of Lewis was the scene of a surviving custom which persisted despite the frantic wheedlings of the local minister. A special cup of ale was brewed from materials contributed by the inhabitants. On Halloween one of the group took the cup, strode waist-deep into the sea and pouring the brew on the waves, addressed a propitiatory allocution to a sea god called Shony, who was believed to influence their crops. This done, everyone returned to church and observed a moment's dead silence. Then, at a given signal, the altar candle was snuffed out and the crowd ran out into the fields, where the rest of the night was given over to revelry.

Pressing our quest into other lands we come up with the astonishing fact that the period just before and after our "modern" Halloween (roughly from late October through early November) has been marked off for festivals of the dead among most primitive races for thousands of years. And, almost everywhere, the festival seems to have lasted for three days. This tallies perfectly with the three days comprising the original Church festival, that is to say, All Hallows-eve, All Saints' and All Souls' Days, the last of which was, you will remember, observed in medieval Europe by a gloomy bewailment of lost souls.

The quasi-universality of the death festival is unassailable. Nearly all outstanding peoples practiced the three-day rites of the dead, from the Egyptians who possessed perhaps the most elaborate of ancient cultures to the Australian aborigines, generally considered the low-brows of world society. The latter, incidentally, were accustomed to outline their ribs, arms, and legs in white paint and, thus adorned, to dance around their "Halloween" fire. In the flickering light they resembled not only animated skeletons but your little boy and his friends, tricked out in those familiar black paper costumes, on which bones of white paper are pasted.

Bushy-haired Fiji Islanders declared a moratorium on all work, war, and play during this period, giving themselves over to prayer for their departed ancestors, while a crop-fostering god was believed to visit the islands. When the latter finished his work he was bathed in effigy by the priests and then sped on his way back to Bulu, Land of the Dead. In ancient Persia, November was the month of Agriculture and Death, during which bonfires were lit much after the manner of the Druid priests. At the same period in Egypt, Isis, Goddess of the Dead and wife of Osiris, had her feast days, on the third of which Osiris was said to have been placed in an ark by a priest, washed with water, and symbolically, at least, sent back to the land of the spirits. This ritual is reflected in the Hindu festivals as well as those of Ceylon. And there are well-nigh identical steps in the Japanese three-day Feast of Lanthorns. On the erstwhile pleasant land of Cherry Blossoms, bonfires were lighted in all the graveyards as guiding beacons for spirits returning to their former homes. Private feasts were then held in every home elaborately welcoming the unseen ancestral guests, while, probably on the same day, an identical performance was going on in Salerno, Italy, on the other side of the world. At the close of the Japanese festival a straw boat was carried to a river bank, set on fire and launched; the passenger lists containing only non-inflammable ancestor-spirits, making their annual voyage back to the land of the dead.

Crossing the bar

Surely by this time the reader has noticed something familiar about these spiritual river-fordings. Remember the Styx? The Greeks' Charon and his boat are certainly linked with this Polynesian - cum - Asiatic ceremonial. Then there is the Swing Low Sweet Chariot and the River Jordan of our own Negro spirituals, and on it goes. The reader can undoubtedly fit in many kindred myths from sundry folktales the world over. And "the world over" is said advisedly, for the Festival of the Dead was not unknown to this hemisphere despite our having thus far cited examples only from the eastern half of the globe.

Long before the seemingly supernatural Spanish cavalry had come to ride rough-shod over their horseless civilization, the Peruvians practiced a three-day ritual called Ayamarca, or the time for carrying corpses. These were cheerless days in the highest of the pre-Columbian cultures. Dead friends and relatives were disinterred and at approximately the same time that medieval Christians flocked to the charnal houses of faraway Naples, or the spirit-attended banquets of Salerno, richly decorated Inca corpses were paraded in funeral processions through the streets of adobe cities. Among the Aztecs to the north, a Festival of the Dead was held a little later in the month. Here the less common phenomenon of human sacrifice was a feature of the rites.

It seems probable that there is a definite time correlation between the Feast of the Dead among people geographically prohibited from contact with one another and the rising of the particular constellation known as the Pleiades. This group of stars is generally conceded to have widely influenced primitive thought and some of the most far-reaching theories concerning Man's origin have been built around its vagaries. But a more tenable explanation of the world-wide coincidence of the festival springs from the fact that it is almost everywhere held at harvest time.

You will remember that in Persia, November was the month of Agriculture as well as Death, and while we are retracing our steps, we note that during the same month the fruit had ripened in the Fiji and nearby islands, where a sumptuous banquet was held as a thanksgiving to the gods for their bountiful harvest. It was after this feast that prayers were offered to the dead. Our own Harvest festival (Thanksgiving) is celebrated as distinct from the far older Halloween. But this division seems to have been brought about as much through the desire of the pilgrim fathers to give a fresh significance to their new life as to the probable differences in harvest time between the old and new England. Nevertheless, the hollowed pumpkin, its jagged mouth and round eyes ablaze with candlelight, is America's native contribution to Halloween paraphernalia and seems even here and now to link harvest time to the Festival of the Dead.

Harvest's end, Year's end

But what of the ancient Celts? From all our information, they appear to have been not an agricultural people, but pastoral. This, however, merely strengthens the suspicion that the festival had an economic basis. Two seasonal events deeply affected the Celts economically and hence spiritually. The first came in May when their cattle were turned into the fields. The second came at the end of October when the flocks were reinstalled in winter quarters. Small wonder then that the ancient Druidic calendar was not determined by the permutations of our solar year, but had its central divisions in these two events which most profoundly affected the lives of all. Thus the Celtic year began at the end of October, which was a time of prophecy and of mourning for the dead because it represented the close of a logical cycle, the end of one seasonal way of living and the beginning of a new.

Of course, this ancient New Year's day dates from a time before the adoption of our year based on the revolution of the earth around the sun. But this serves as further proof that the Halloween-New Year goes back to the dimmest recesses of Northern man's history, since the pagan feast of the summer solstice, a phenomenon of the solar year, is demonstrably far older than Christianity. So in the earliest times, the Celts do not appear to have been interested in the sky but in the earth, on which their livelihood depended. In this light their inclination to divide the year terrestrially rather than celestially becomes perfectly clear.

Much can be said for their wisdom in such a time division. The rigidity of our own year, a static product of mathematicians, makes us conform to a fixed pattern which remains immutable despite the changing conditions of our own life. This state of affairs has led to much talk lately of revising the calendar, more elesticity being the catchword of those who would

Continued on page 231

YOUR NEW BOOKS

PLANTS WITHOUT SOIL • SEQUOYAH, THE MAKER OF AN ALPHABET • OUR AMAZING EARTH • STARCRAFT • FABRE ON INSECT MARVELS • BEEBE'S VENTURES • OUR SHADE TREES

SOILLESS GROWTH OF PLANTS

by Carleton Ellis and Miller W. Swaney

Reinhold Publishing Corporation, $2.75

During the past year or two there have been many articles in magazines and newspapers concerning the possibility of growing flowering plants and vegetables without the use of soil. Some of these have been quite fantastic, visualizing the housewife opening a closet door and picking fresh vegetables for dinner. This is unbelievable, yet the authors of *Soilless Growth of Plants* state that it is not impossible but that it is scarcely practical. The vegetables we eat, and the plants that we grow in our homes and in our gardens, will not grow without sunlight, so, if we are to grow vegetables in a closet we must provide either sunlight or its equivalent. The equivalent of sunlight is obviously obtained by artificial lighting and we fear that the cost of this would be considerably more than the cost of vegetables obtained at the nearest store.

This business of growing vegetables without soil has always been of the greatest interest to us. The idea is a fascinating one but it is also perfectly logical and the wonder is that it has not been developed long before now. It is a perfectly simple process. All that one needs is the chemicals that are consumed by a plant during its natural growth, a system by which the plant can acquire these chemicals, sufficient space for the growth of a plant and the means of furnishing the growing object with the proper food. The proper food is, of course, the essential feature. Scientists have determined what the essential foods of plants are and as a result it is possible to buy a few chemicals, dissolve them in water, mix them together, place them in contact with the roots of the plants to be grown, and await the results. They may be good or bad. By this we mean that the grower may have either good or bad luck in his first attempt since he will not be familiar with the care of the plants, nor familiar with the symptoms indicating a deficiency of one or more of the chemicals so necessary for their growth.

There are several different methods of growing plants in the house or in the garden and each method requires a certain amount of care. The plants must receive care, just as a growing child or household pet needs constant supervision. It is not possible to give the plant one feeding, and leave it alone. It must receive regular meals, it must have the proper amount of sunlight and the proper amount of darkness in order to prosper. Too much sunlight is as bad as too little. Either one results in a sick plant. The proper amount is the same as the plant requires during its normal season out-of-doors. If one is growing plants in the open there is no need to worry about this, but if the household is being used as a garden it is necessary, in winter, to be certain that the plants receive as much sunlight as possible in order to secure perfect results. The use of artificial light will increase the growth of the plants and this may be used to supplement the shortened hours of daylight in winter.

One of the greatest advantages of soilless culture is that the equivalent of an acre of plants—soil-grown—can be grown on a very small area. Then, too, there are no weeds, no fungous or bacterial diseases and no—or very few—insect pests. Perhaps these advantages may not be entirely real. There are some plants that require bacteria of certain types in order to produce best results. There are others that thrive upon decaying matter. There are others that require elements that occur in the soil in such small quantities that their presence is not always detected in normal soil samples.

Since this method of growing plants is in the first stages of its infancy the devotee will find many opportunities to experiment with the chemical solutions used.

To be perfectly frank there are many ifs and buts in connection with the soilless culture of plants. It has taken us hundreds of years to learn how to feed plants with a modicum of intelligence and it may take us another hundred or more in order to learn how to feed them so that they may produce fruits or flowers possessing the finest qualities. We do know that soil fertilization will produce large crops and that much larger crops, per acre, can be grown by the soilless method but we wonder whether the fruits and vegetables resulting from this method of growing contain all the elements so necessary to human welfare?

Regardless of any disadvantages of soilless growing of vegetables we venture to say that this process is destined to become one of the greatest hobbies the world has ever known. It will far surpass tropical fish, stamp collecting, or any other pastime of which we are aware because, when the end is in sight, the hobby will provide us with food. We shall be able to say to our guests—we grew this ourselves, on the window sill, on the roof, in the back yard, or wherever we might have grown it. And our guest might reasonably reply—"I grow sweet peas in my living-room."

Soilless Growth of Plants tells how to grow plants without soil. It answers all the questions that the amateur might ask. It tells of the difficulties and discusses the various methods. Anyone interested in plant life will find the answers to his questions about the food requirements of plants, grown either with or without soil. With this book the veriest tyro should be able to grow plants without soil.

C. H. CURRAN.

Our amazing earth

- - - - - by Carroll Lane Fenton

Doubleday-Doran, $4.50

CARROLL LANE FENTON has written in the past few years a number of popular books on different phases of geology, but this is his first general geological book. He has done an excellent job of popularizing a science which has lagged in popular interest, partly because of need for an interpreter. A number of books have attempted to cover the general field discussed by Doctor Fenton in *Our Amazing Earth*, but this is easily the best of recent years.

The book is intended for the general reader who has or who might develop an interest in the science of Geology. Geology is a broad subject which may be treated from many viewpoints and which contains much unrelated material. The general geologist must be familiar with all of the sciences today; and this is probably more necessary for a geologist than for any other scientist. Mineralogy and paleontology have little in common, though both are grouped under the geology omnibus. Consequently, it is a difficult task to write a single book which will cover the entire field adequately.

Our Amazing Earth is written in a style which excites and maintains the interest of the reader. The author commences with a general view of the Earth, its origin, its interior and the materials of which it is composed. The cause and structure of various surface features of the earth; the mountains, earthquakes and crustal movement, volcanoes and glaciers are discussed in turn, but in a logical and connected sequence, and in their proper relationships.

The specific localities, to which reference is made, are largely places in the United States where they lie, potentially at least, within the reader's own experience and may, very likely, have stimulated a consciousness of geology as a science. The photographs, of which the book has some 66, are new to the field of geological books, and while many of the places shown are hackneyed they are all the more convincing for it. The quality of the pictures, many supplied by tourist bureaus, is far higher than those usually seen in such works. Artistically good, they also bring out the points Dr. Fenton wishes to emphasize.

The most serious criticism which can be made of the book is that some of the data is incorrect (as in the case of the mineral descriptions, specifically, and these could easily have been given correctly by the briefest of references to the standard mineralogical work) and some theories, theories resting on the feeblest of legs, are given as undisputed fact. The book contains so much that is good, that one can overlook these minor faults.

The excellent bibliography, wherein is acknowledged the source material and where suggestions for further reading may be found, makes it a useful first book for amateurs whose interest and desire to learn more is aroused. It is the best of the popular geology books, from the standpoint of readability and ground covered, available today.

F. H. Pough.

Sequoyah

- - - - - - - - by Grant Foreman

University of Oklahoma Press, $1.50

THE University of Oklahoma Press has during the last few years published some of the best Indian material available anywhere. Included in this so-called Civilization of the American Indian Series are attractive books of high merit by a number of well known authors, and one of the best equipped of these is Grant Foreman, whose writing and research concerning the Five Civilized Tribes (Chickasaw, Choctaw, Cherokee, Creek, Seminole) extends over a period of a quarter of a century. He is the author of *Indians and Pioneers, Indian Removal, Advancing the Frontier*, 1830-1860, and *The Five Civilized Tribes*, as well as the volume under consideration.

Sequoyah, the subject of his new biography, was a recognized genius of the Cherokee Nation. He was of mixed blood, his mother being a Cherokee and his father a white man. He could not speak or write the English language—at least, he did not or would not speak it—although his wife spoke English fluently. He was born in the Cherokee village of Tuskegee in Tennessee, near Fort Loudon on the Tennessee River. He enlisted in the War of 1812 and fought against the hostile Creek Indians. After the war he became lame, and led a quieter life.

He had observed, at an early age, that the white man had a method of conveying thoughts on paper by a series of signs or marks and he conceived the idea of inventing characters intelligible to the Red Man. One day he heard some of the young men of the tribe talking of the superior talents of the white man, because they could "talk" on a piece of paper and send it to distant places and have it understood by the one who received it. Sequoyah said "you are all fools; why the thing is very easy; I can do it myself." This started him on his invention.

He was laughed at and ridiculed but he became increasingly interested in the idea and devoted more and more of his time and energy to it, neglecting his fields and his home. Finally after several attempts he stumbled upon the right trail and invented 86 characters. In a remarkably short time the Cherokee Indians became a literate people. "The Cherokee Phoenix" the first Indian newspaper in history was a direct result of Sequoyah's contribution to Cherokee culture.

The story of Sequoyah, "the only man in history to conceive and perfect in its entirety an alphabet or syllabary," the man for whom the California Big Tree and Giant Redwood were named, is told with directness and simplicity. The illustrations, which include the Cherokee Alphabet, add to the interest of the book.

In fact this is a fascinating story, better done than any previous attempt to set forth the life of this famous Indian.

Te Ata.

Marvels of the insect world

by Jean-Henri Fabre, translated by Percy F. Bicknell

D. Appleton-Century Co., $2.50

THE writings of Fabre need no introduction to the reading public. For many years his *Souvenirs of Entomology* have held a place of their own among the writings on insects. Their beauty lies in the fact that they are written in what one might describe as the simplicity of a child but with all the reserve and accuracy of the master scientist. Fabre does not give us the bare results of his experiments and the dull notations of his countless observations—he carries us with him from the meager beginnings to the final results and takes us along with him through success and disappointment until the whole plan of nature, as it concerns the creature in question, is unfolded before our eyes.

Marvels of the Insect World differs only in subject matter from the other books in the series. Fabre tells us how insects live, how they are constituted, how they live together in colonies and the changes that take place between the various stages in an insect's life. One might well say that he here gives us an introduction to entomology plus many observations on some of the amazing habits of insects.

In the chapters dealing with "Butterfly Courtship" and "A Lucky Find" Fabre recounts many experiments conducted with the object of determining how the males are attracted to the females, and the question receives what is, to us, a satisfactory answer. However, the translator apparently feels that the question still remains open, and that the secretions given off by the female do not wholly solve the problem. Our own experience indicates that it does, at least insofar as the silkworm moths are concerned. One could never criticize Fabre but one may offer an academic correction to the terms used in these two chapters—the insects considered are consistently called butterflies, whereas they are both moths. We know, of course, that most people look upon all large moths as butterflies and for this reason the use of the latter word might be excused. But, as Fabre explains, among other things, butterflies fly in the daytime and moths at night.

No one who has become acquainted with the writings of Fabre will want to be without this book. Anyone who is not yet acquainted with him would do well to gain an acquaintance through *Marvels of the Insect World.*

C. H. CURRAN.

ZACA VENTURE

- - - - - - - - - by William Beebe

Harcourt, Brace and Company, $3.00

NOT long ago Templeton Crocker in his yacht, the *Zaca,* took William Beebe and his associates on a cruise about Lower California to observe, collect, and study the fauna of the region. This is a picture of these shores and waters, their teeming life large and small, fishes, birds, turtles, down to barnacles, as seen on the expedition. To those who are familiar with Doctor Beebe's writings it is really unnecessary to say more.

There was unusual opportunity to observe great whale sharks off Cape San Lucas, and egg-laying sea turtles at Clarion Island were studied and are discussed in detail, the chapters devoted to each of these beasts respectively, perhaps being of most interest to the naturalist. The emphasis on isolated phenomena—the changing colors of a bonito, the flight of cormorants when in company with pelicans—even when they do not tell us anything new, are constantly introducing new and stimulating perspectives. The discussion is more or less strung on philosophic concepts of time and space, with a friendly human undertone. It never focuses long on a given point, a single form of life, and thus brings out interrelationships to illuminate the hazy science of ecology.

Perhaps it is as a writer that Beebe is outstanding, and this book is another example of his artistry. Any friendly naturalist may read it with interest, pleasure and profit, though realizing that the desired emphasis is at times brought about by use of somewhat artificially colored backgrounds. It is written for a larger audience for whom the marvelous in nature has a strong appeal, and occasional mazes of esoteric words a fascination—while they share the author's adventures on unknown seas in the quest for virgin truth.

J. T. N.

STARCRAFT

by William H. Barton, Jr., and Joseph Maron Joseph

Whittlesey House, McGraw-Hill Book Company, Inc., $2.50

IN this book, written by the Executive Curator of the Hayden Planetarium and the Head of the Science Department of the Smedley Junior High School in Chester, Pennsylvania, the boy or girl who is interested in the stars will find a valuable handbook. Here we find combined such varied but essential phases of astronomy as star-gazing (the oldest practised astronomy), construction of instruments and models to make the young observer's work more interesting and more worth-while, and general reading concerning various types of astronomical bodies and about famous astronomers themselves. The section of the book entitled "Pointing to the Stars" introduces a clever innovation in constellation study which should make it possible for even the most star-bewildered beginner to find his way about the heavens. Clear and accurate directions point the way to construction of such useful astronomical tools as sundials which actually tell time, and a real reflecting telescope. Other interesting features of the book are the stereoscopic pictures which show many of the most beautiful sky views in the third dimension, and the "Truth Trailers," brief biographies of outstanding figures in astronomical history, with their various contributions to their great science clearly stated. For children who are already interested in the stars this book will prove a godsend; for those who are not, it will open up a whole new field of hitherto unguessed fun and inspiration.

MARIAN LOCKWOOD.

OUR SHADE TREES

- - - - - by Ephraim Porter Felt

Orange Judd Publishing Co., $2.00

HERE is a practical book on the care of shade trees written by a leading authority out of his wide practical experience. Doctor Felt is now Director and Chief Entomologist of the Bartlett Tree Research Laboratories. For thirty years he was State Entomologist of New York, and for more than a quarter of a century he was Editor of the *Journal of Economic Entomology.* He is widely known as the leading authority in America on insect-galls.

For the last decade he has been devoting his time to the problems in the field, which are covered in this compact and attractive volume. Less than 200 pages in length; printed in large, legible type; and illustrated with more than thirty excellent photographs, each of which tells a story, the book is most inviting, especially to the dwellers in the suburbs of our cities.

All phases of the subject are included. In the chapter "Shade Trees and Men," are discussed the recreational and aesthetic values, historic and noteworthy trees, the development of expert shade tree work. In the chapter "General Shade Tree Care," pruning and cabling, cavity filling, banding, roots and the soil, and feeding trees are treated with clear instructions.

In the chapter entitled "The Language of Shade Trees," the author interprets the significance of twig growth, bud indications, the story of tree rings, the dropping or browning of leaves, and the meaning of dead or dying branches. The multitude of troubles of shade trees, too numerous to mention here, are discussed in the light of the latest knowledge, with practical instructions for prevention or cure.

In short the book is useful, the treatment clear, brief, and non-technical. It contains valuable information on the selection, planting, pruning and feeding of trees, as well as on tree-surgery and the control of destructive insects and diseases.

CLYDE FISHER.

NORTHERNMOST LABRADOR MAPPED FROM THE AIR

- - - - - - - by Alexander Forbes

American Geographical Society

Special Publication No. 22

ONLY a few years ago so prosaic, and, one might almost say, so scientific an enterprise as a survey of a country just because it would make safer the lives of men who "go down to the sea," would hardly have been considered. To many would come the question as to the reason for traveling so far in order to map such a barren, untenanted and, to most people, useless land. The answers to these questions and innumerable others are found among these pages. With unlimited interest to all who are arm-chair explorers and useful beyond mere money to those who sail these waters, Doctor Forbes' work traces the exact location and boundaries of the many fiords, winding lakes, mountains and lingering glaciers that abound in this little known land. In dealing also with the geological and botanical aspects of the country he is ably supported by Noel E. Odell, famous climber of Mount Everest, and Ernst C. Abbe. Of the actual mapping of northernmost Labrador, O. E. Miller of the American Geological Society was in charge and the process of high-oblique air surveying has resulted in photographs of a country rich in scenic beauty.

Beginning with the earlier explorations in Northern Labrador, Doctor Forbes takes the reader on the three expeditions of 1931, 1932 and 1935. One sees through his eyes the fiords, waterfalls, salmon rivers, icebergs, Eskimos and auroras which promise in the future a lure to many who would find such beauty near at home.

Starting at the Straits of Belle Isle and ending at Cape Chidley we move over great ranges of the loftiest mountains on our Atlantic seaboard and a tempting and untrodden ground for topographical and geographical investigation is opened before us. Sailing north on the *Ramah* on the first expedition of 1931 the group covered the ground from Indian Harbor to Ekortiarsuk Fiord making survey flights and taking soundings all along the coast. The second expedition of 1932 in the *Zavorah* covered the region between Gulch Cape, just south of Nachvak, and the Kiglapait Mountains. A gap of less than 150 miles of coast line was photographed by plane. The last expedition of 1925, the flight to Cape Chidley, was completed successfully and so the remaining area between Nachvak and the Cape became navigable with a margin of safety to the sailor.

Containing besides, in an accompanying slip case, Navigational notes on the Labrador Coast and a series of six maps giving the contours and height of this section it leads us to believe with Doctor Forbes, that in looking at the future of Labrador, one is struck by the partial analogy with Norway. One wonders whether similar enterprise and ingenuity could produce similar results in Labrador.

RUDOLF FREUND.

THE BOOK OF INSECT ODDITIES

by Raymond L. Ditmars, illustrated by Helene Carter

J. B. Lippincott Co., $2.00

DURING the past few years the public has shown an increasing interest in insects and with this has come a demand for publications of a popular nature. Owing to the large numbers of insects, it is uterly impossible to include in a single book more than a few of the unusual types that are known to man. Doctor Ditmars has made a selection of some of the bizarre forms and tells about them in this book.

The arrangement is different from anything of a popular nature that has yet appeared. The first chapter deals with North America and, among other things, gives the characteristics of the main groups of insects. Following this each of the various continents are treated separately. There is something unusual about each of the insects mentioned, in regard to size, shape or strange habits, and every page contains facts that are sure to surprise the reader. Dr. Ditmars does not describe the little animals with any trace of the sensational. Indeed, in many cases he might be considered to be ultra-conservative.

If the book is revised it is to be hoped that the author will not advise people to collect flies in alcohol. Since these are among the more fragile of the insects, and their colors are easily destroyed in alcohol, they should, if possible, be pinned in the field. It is unfortunate that the color reproductions are none too acurate in some instances, certain of the butterflies in particular being away off color, although the form and color pattern is most excellent.

The book is well arranged and well written and anyone desiring to know something about insect oddities will find plenty of information in its pages. Apart from the color reproduction, Helene Carter is to be congratulated on the accuracy and skill of her drawings.

C. H. CURRAN.

PRACTICAL SEISMOLOGY AND SEISMIC PROSPECTING

- - - - - - by L. Don Leet, Ph. D.

D. Appleton Century Company, $6.00

ON the jacket of this book the publishers proclaim that it "provides a readily understood introduction to the scientific study of earthquakes" and is "written in a manner that requires on the part of the reader no more than an elementary knowledge of mathematics." Nevertheless I am of the opinion that the really "popular" exposition of this science is yet to appear. The interest and curiosity shown by the public in the operation of the visibly recording seismograph at the American Museum dramatizes the need for a treatise wholly intelligible to the average reader.

This book is rather unevenly written. The sections on the cause, distribution and descriptive observation of earthquakes, while not "popular" in their treatment, are of sufficient color and clarity to hold the interest of the non-scientific reader, while the sections on Elasticity and Elastic Waves, Instrumental Methods and Seismic Prospecting are more involved and technical. The discussions in these sections make it seem quite possible that Doctor Leet was not attempting to produce a treatise for the layman. In general, the stylė and presentation is that of a textbook for an introductory course in seismology and it seems to be excellently adapted to this purpose. It is to be regretted that the publishers are claiming for this book a field that it does not fill.

H. E. VOKES.

THE INDOOR EXPLORER

Continued from page 227

like to make it adaptable to our way of life. One of the most interesting recent suggestions is particularly provocative in the light of our foregoing investigation of the Celtic Halloween. I quote from an editorial in the *New York Times* (September 6, 1938):

"WHY NOT CELEBRATE NOW?

"It has not occurred to any of the calendar reformers, so far as one can recall, to suggest that we begin our new years at about the middle of September instead of on the first of January. Yet something might be said for this change. Our celebrations of the present New Year's Day are at best neurotic. We are tired out by the preceding holidays. The bills are coming in. The weather is bad. The seasonal slump in business is at hand. We have colds. There is little to celebrate, except the misfortunes that have not befallen us, individually or collectively, during the preceding twelve months. No wonder many of us drink too much and wake up with a headache on January 2.

A New Year's Day falling on September 15, on the other hand, would find us full of vim and vigor. Many of us have returned refreshed from our summer vacations. Our minds as well as our bodies are, so to speak, tanned and invigorated. The weather is often lovely. Business is picking up. As it is the middle of the month, there are no bills. We are full of plans and hopes. Thanksgiving and Christmas are ahead instead of behind. Manufacturers are in a mood to bring out new models, merchants to enlarge and redecorate their stores, families to move into new homes, producers to put on new plays. Father will buy a new suit; mother a new dress and the children will be reattired for school. This is fine. It is something to celebrate. It provides the proper mood in which to begin a new year."

Perhaps, then, after all is said and done —after all the sages and astronomers and mathematicians have for centuries prescribed our methods of reckoning the seasons, we will in the end return to the terrestrial year and, like our ancient Celtic forebears, celebrate our New Year's festival, if not on the same day as Halloween, at least during a season logically most suited to our vastly more complex economic life.

—D. R. BARTON.

Correct Answers to Questions on page 223

1. A rare variety of orchid. See page 189
2. Christopher Columbus. See page 202
3. The only man known to have created unaided the entire written language of a people. See page 230
4. Vanilla. See page 187
5. No. See page 175
6. A self-sustaining plant. See page 186
7. A hoofed animal with spirally twisted horns. See page 209
8. An orchid given significance by the Spanish priests in teaching the Indians. See page 185
9. A pre-historic animal related to the starfish. See page 175
10. Enclosing the pollen in a cap which springs off about 50 seconds after the insect leaves. See page 199
11. $10,000. See page 188
12. An "ape" living in South Africa during the Pleistocene, thought to be the "granduncle" of man. See page 232
13. A fuel for firebrands which influenced the invention of gunpowder. See page 201
14. The discoverer of America. See page 202
15. That agar jelly could be used in place of the natural fungus to nourish the seed. See page 190
16. Specific insect sponsors are required for the different species. See page 195
17. A lake was formed which facilitated the collecting of rare orchids. See page 189
18. Africa. See page 232
19. That clay vessels acquire magnetic properties while being fired. See page 207
20. Greenland. The other sites were all under water. See page 172

SCIENCE IN THE FIELD AND IN THE LABORATORY—*Skull of Child Links Man and Ape—North American Expedition—Prehistoric Mysteries of South America—Museum Joins School of Air—New Courses*

Africa's "Missing Link" Skulls

Arriving at Pretoria, Africa, early in July, Doctors William K. Gregory and Milo Hellman of the American Museum spent several weeks studying, measuring and taking notes on the specimens of the fossil "ape" *Australopithecus africus* Dart, recently discovered by Doctor Broom of the Transvaal Museum. During the investigation Doctor Hellman made a fine series of moulds and casts of the jaws and teeth some of which are now on exhibition in the foyer of the Museum. After careful study, Doctor Gregory endorses Doctor Broom's view that these forms possess both ape and human characters and represent connecting links between the two families, although they may well be "granduncles" rather than "grandfathers" of man.

At Johannesburg the child *Australopithecus* skull described by Doctor Dart in 1925 was studied by the scientists and compared with the later discoveries. Endorsement was made of Doctor Dart's conclusion that this form tends to connect the ape and human families. The result of all these studies will be published in a joint paper by Doctors Gregory and Hellman.

Doctor Gregory delivered six lectures before various South African societies bearing on the significance of South Africa's records of the evolution of life. Doctor Hellman gave a number of lectures on orthodontia before dental societies. He also took many interesting motion pictures in zoological gardens illustrating methods of animal feeding and locomotion.

Shortly before they sailed for home, the degree of Doctor of Science was conferred upon both Doctor Gregory and Doctor Hellman by the University of the Witwatersrand at Johannesburg for their contributions to the science of anthropology and to dental science. In presenting the diploma to Doctor Gregory, the Dean of the University said: "The University desires by the conferment of an honorary degree to do honor to one of the most outstanding scientists of our time; at the same time by enrolling Professor Gregory among its alumni it brings honor to itself. We earnestly hope that the bonds brought into being at this congregation will strengthen and fructify the cooperation between our University here and the American Museum of Natural History and Columbia University in New York."

In conferring the degree upon Doctor Hellman, the Dean said: "This University has a special interest in research and teaching in the field of dentistry, and we are happy to have this opportunity of paying tribute to a distinguished dentist who has not only contributed in large measure to our knowledge of the evolution of human dentition but has also laid the foundation of the modern teaching and practice of orthodontia."

The Odontological Society of the Union of South Africa also bestowed honorary fellowships upon Doctors Gregory and Hellman.

Report from Archbold Expedition

Some idea of the great success being achieved by the Archbold Expedition to Dutch New Guinea can be had from a recent letter, received from Richard Archbold.

Some ten specimens of the exceedingly rare giant quail, *Anurophasis monorthonyx,* have been secured in the neighborhood of Lake Habbema, which is nearly 11,000 feet above sea level. Also, several specimens of a kind of bird, probably representing a new genus, have been taken. Large general collections of birds, mammals and plants have been secured, among which may be mentioned a probable new species of the water rat, *Hydromys,* some forty kind of orchids and twenty forms of rhododendrons.

The Archbold Expedition is thought to have formed a semi-permanent camp near the Lake where a large population of natives, hitherto unacquainted with white men, exists. Friendly relations with these people have been established from the first. Connections with the base at Hollandia are maintained, both by radio and by means of the giant Amphibian airplane in which Archbold and some of his associates crossed the Pacific last Spring. The party is expected to remain in the Highlands of Dutch New Guinea between one and two years.

Material for North American Hall

According to an announcement made by Dr. Harold E. Anthony, Curator of the Department of Mammals of the American Museum of Natural History, the new Hall of North American Mammals will have material for ten habitat groups by the end of this year. Under the active leadership of Mr. Robert E. McConnell, chairman of the North American Hall Committee, the case construction in this hall is moving rapidly ahead so that the groups can be installed.

An expedition to collect specimens, accessories and paintings for the Grizzly bear group was sent to the Yellowstone National Park. Mr. George E. Petersen, Mr. A. Perry Wilson and Mr. Gardell D. Christensen of the Museum's department of Arts and Preparation are members of the party. Mr. Petersen is gathering accessories, such as plants, soil and rocks for the group; Mr. Wilson making the background paintings, and Mr. Christensen preparing the skins of the bears obtained in cooperation with the Park authorities. It is planned to depict this habitat group against the background of the famous Yellowstone Falls. The expedition is financed by Mr. Beverley R. Robinson.

After completing their work in the Yellowstone, these men will proceed to Trappers Lake Basin in the Horseshoe range of Colorado to make background paintings and gather accessories for the Elk group, which is donated by Mr. William L. Honnold.

The Mellon-Yukon Expedition is now collecting White sheep in the Donjek Valley of the Yukon for the North American Hall. The expedition is led by Mr. Richard K. Mellon of Pittsburgh, who is accompanied by Mrs. Mellon, Mr. Robert S. Waters, President of the National Radiator Corporation of Johnstown, Pa.; and Mr. Robert H. Rockwell, preparator of the department of Arts and Preparation.

An expedition to collect Alaskan moose and Grant caribou in the Kenai peninsula is led by Mr. Wilton Lloyd-Smith, Trustee of the American Museum, who is accompanied by Mr. G. Frederick Mason and later will be joined by Mr. Rockwell after he has completed his work in the Yukon.

Mr. Joseph Guerry of the department of Arts and Preparation, and Mr. Harry Davison are collecting material for the Bighorn sheep group in the Jasper National Park region, Alberta, Canada.

Late this fall the Museum will collect accessories and background material for the White-tailed deer group in Bear Mountain Interstate Park region. This group is donated by Mr. E. Rolland Harriman, Trustee of the Museum.

Prehistoric Mysteries of South America

The country of Venezuela, especially that part near the southern end of the Panama Isthmus, is ideally situated to answer many questions of animal history. Were the extinct Patagonian animals, found in the extreme southern portion of South America, typical of all of South America or only of an isolated southern region? Just when and where did the North American animals enter the continent? How did the Caribbean Sea and its islands develop? Where were the South American monkeys and rodents before their relatively late appearance in Patagonia? These and dozens of other important problems are among those to be solved by an extensive expedition to this region sponsored by H. S. Scarritt and headed by George Gaylord Simpson, Associate Curator of Vertebrate Palaeontology.

This expedition to collect fossils in the rich and heretofore almost untouched prehistoric beds of northern Venezuela was organized by the American Museum upon the invitation of the Venezuelan Government.

All collections will be divided between the Venezuelan Government Museum in Caracas and the American Museum of Natural History. It is expected that ultimately these investigations will lead to a more thorough understanding of the distribution of prehistoric animal life during the Miocene and Pleistocene ages, both before and after North and South America became connected by land bridges.

Doctor Simpson, who has uncovered the remains of strange prehistoric animals which once inhabited Patagonia, on several previous expeditions, is assisted by men assigned by the Government of Venezuela and by Dr. Anne Roe Simpson (Mrs. G. G. Simpson), who accompanied the party to collect recent mammals and assist in the field work.

The principal objective is a region around the town of Barquisimeto in northwestern Venezuela where traces of prehistoric animals have several times been reported. Local amateurs and passing oil geologists have picked up fragments of fossil bones and teeth that show that mastodons, ground sloths and other strange extinct animals once existed there. Other regions where fossils have been reported or are likely to occur will also be investigated.

The history of animals in South America has been known almost entirely from discoveries in the extreme south, in Patagonia. Latest of a series of explorations there were the first two Scarritt Expeditions, 1930-31 and 1933-34. Discoveries there have shown that during most of the long Age of Mammals the animals of Patagonia were remarkably different from those of North America. Then, toward the end of the Age of Mammals and not long before the great Ice Age, there appeared many mammals from North America, and at the same time typically South American animals like armadillos and ground sloths appeared in the northern continent. Probably these migrants followed the Isthmus of Panama, then newly risen from the sea.

In order to obtain as complete a picture as possible of the evolution of life in northern South America during the last few millions of years, the expedition is collecting recent animals for comparison with their extinct ancestors and relatives and with the animals of other parts of the world.

This work continues a long series of explorations by the Museum, revealing the past and present life of the two western continents and the relationships between the two. The collaboration of the Venezuelan Government is testimony not only of Pan-American friendship, but also of the progress of that country and its ever-increasing interest in the solution of scientific problems.

Museum Joins School of Air

The American Museum of Natural History will take a prominent and active part in the American School of the Air presented by the Columbia Broadcasting System, in its effort to make available to the nations radio-equipped class rooms a correlated and progressive treatment of a wide range of general cultural subjects. Every school year for the last decade, teachers in all parts of America have found a valuable supplement to class room instruction in this series of daily, afternoon, week-day programs. The presentation by the American Museum on this series will be known as "New Horizons." It will be on the air Thursday afternoons at 2:30 p. m. eastern standard time and represents an original departure in educational technique on the air.

The series presents Roy Chapman Andrews, the noted explorer and Director of the American Museum, as commentator. Doctor Andrews will take the microphone to various prominent exhibits on the American Museum's floors to discuss their bearing on contemporary life in America.

Sponsored by various well-known educational institutions, the other programs include Wednseday afternoon presentations of significant current events under the title "This Living World"; Monday talks on "Frontiers of Democracy" outlining the career possibilities in Science, Health, Community Planning, Education and other fields of endeavor; Friday discussions of books entitled "Lives Between the Lines"; and on Tuesdays a program of "Music of America" tracing the development of native American music.

Astronomers' Activity

The Amateur Astronomers Association and the Junior Astronomy Club resume their full schedule of fall activities this month. On October 19th the first meeting of the Amateur Astronomers Association will be addressed by Dr. Maud W. Makemson, of Vassar College. Her unusual subject is the "Astronomy of the Polynesians," on which she is a leading authority. On October 22nd Dr. Clyde Fisher, Curator-in-Chief of the Hayden Planetarium, will address the opening meeting of the Junior Astronomy Club on his favorite topic—"Mars, the Ruddy Wanderer of the Sky." Each of these meetings is open to members of the Museum and their friends.

It is not too late to join the classes conducted by the Amateur Astronomers Association in astronomy and mathematics. For complete details write to the Secretary of the Amateur Astronomers Association at the Hayden Planetarium, in New York City. Annual members of the American Museum of Natural History may attend these courses without charge.

Museum Courses

In preparation for a new free course for teachers entitled "Primitive Peoples and Their Cultures," which she will give at the Museum this autumn in cooperation with Hunter College and the College of the City of New York, Doctor Grace Fisher Ramsey, Museum's Associate Curator of Education in the American Museum made a study this summer of the archaeological ruins in Yucatan, Mitla, and Monte Alban, Mexico. Her course will be based upon a study of the noteworthy collections in the anthropological halls of the Museum and therefore offers a unique opportunity for teachers to study original objects from the material cultures of many primitive peoples of the world. The first session is on Thursday, September 29th.

Other free Museum courses offered this autumn for the teachers of the public schools of New York City are:

Methods of Teaching Geography in an Activity Program—Doctor Ramsey. First session Tuesday, September 27th.

Nature Study—Miss Wiley. First session Wednesday, September 28th.

How to Know Natural Objects—Miss Wiley. First session Thursday, September 29th.

Miniature Habitat Group Techniques for Teachers of New York City Public Schools—Mr. Orth. This is a course of five double sessions which covers techniques in making miniature habitat groups in nature study and geography. Each teacher will have the opportunity to "Learn by Doing" and the instructor will emphasize the use of simple tools and materials. Two sections of this course are planned for this autumn. The first session will be on October 6th with enrollment limited to twenty students.

A Hunter College course in "Descriptive Astronomy" will also be given at the Museum by Mr. William H. Barton, Executive Curator of Astronomy and the Hayden Planetarium, and another course for the Division of General Education, New York University, "Astronomy for Teachers" by Dr. Clyde Fisher, Curator-in-Chief of the Hayden Planetarium.

Also in cooperation with New York University is the course on telescope making given by the Planetarium. This is primarily a workshop course in which the student has an opportunity to learn the technique of telescope mirror making and is expected to complete a telescope mirror which becomes his own property at the end of the course. The fee for the course is $35.00, including all supplies and the necessary glass for a 6″ mirror. Students may choose either Tuesday or Thursday evening as their regular night for attendance. The place of registration is in the Optical Workshop of the Hayden Planetarium at 81st Street and Central Park West on any Tuesday or Thursday evening during October.

Beginning Wednesday evening, October 12th, the famous Weems system of navigation will be taught as follows:

Dead Reckoning (Air or Marine)
11 Lessons......................$25.00
Celestial Navigation (Air or Marine)
12 Lessons......................$35.00

Both courses may be taken for a total of $50.00. For these courses, just as in the course in telescope making, no mathematical or special training is necessary.

Entomology Note

Returning from a recent trip to Eastern Canada, Doctor C. H. Curran of the Museum's Entomology Department reports a very poor season for insects in general although he brought back with him much valuable material. Several weeks' collecting in the Muskoka District in Central Ontario followed his attendance of the American Association for the Advancement of Science meetings and his speech before the Entomological Society of America on "Increasing Demands upon Entomology." Doctor Curran also spent some time studying the collections of the Entomological Branch at Ottawa, the Royal Ontario Museum, Toronto, and the Ontario Agricultural College at Guelph.

Audubon Society Meets

The National Association of Audubon Societies will hold its annual conference at the American Museum from October 21 to 25. Its various sessions have all been thrown open to the public. The program is as follows (for further information call the National Association of Audubon Societies):

FRIDAY NIGHT, OCTOBER 21, AT 8:00 P. M.

A dinner and motion pictures. Admission $1.50.

•

SATURDAY THROUGH SUNDAY, OCTOBER 22 AND 23

An overnight field trip to Cape May, N. J.

•

SUNDAY MORNING, OCTOBER 23

An all day field trip to Montauk Point.

•

MONDAY NOON, OCTOBER 24

Luncheon to members of Affiliated Clubs in the Bird Hall of the American Museum.

•

MONDAY AFTERNOON, OCTOBER 24

Color motion pictures taken by Miss M. L. Bodine.

An address by Mr. Bayard H. Christie of Pittsburgh on "The Artistic Talent of James Audubon."

An address by Mr. James Tanner of Cornell University, Audubon Research Fellow, reporting on the first of a two-year study on the Ivory-billed Woodpecker.

An address by Mr. A. A. Nichol of the University of Arizona on Desert Bighorn Sheep.

An address by Mr. Alex Sprunt, Jr., Supervisor of Southern Sanctuaries of Audubon Societies on the present status of the Roseate Spoonbill in the United States.

An address by Robert D. Allen, Director of Audubon Sanctuaries, on the present status of the Florida Crane.

•

TUESDAY MORNING, OCTOBER 25 AT 9:30 A. M.

Annual Business Meeting of the Audubon Association.

An address by Professor Dymond of the Royal Museum of Canada on conservation in Canada.

•

TUESDAY AFTERNOON, OCTOBER 25

Color motion pictures taken by Miss M. L. Bodine.

An address by Mr. J. R. Pemberton of Los Angeles on the California Condor (color motion pictures).

An address by Dr. Ralph King, Director of the Roosevelt Experimental Station at Syracuse University on What's Wrong with Introducing Exotic Game Birds into the United States.

L E T T E R S

Sirs:

An article in the June issue of the NATURAL HISTORY Magazine has caused no small amount of comment among my friends, so I am writing in the hope that you can help us in our quandary.

I refer to the story by Myron Gordon titled "Sargasso Merry Go Round," in which he states that all fresh water eels originate in the Sargasso Sea and then find their way back to the former haunts of the parent eels.

My friends claim that some eels must breed in the waters in and around New York because they have caught baby eels on occasions, even finding them under rocks and in concealed places at low tide.

Any information will be greatly appreciated.

JOSEPH P. DUFFY.

New York City.

* * *

Dear Mr. Duffy:

The eel is a strange animal.

The story as written in NATURAL HISTORY, of course, is perfectly true. The fresh water eels do breed in the Sargasso Sea.

The fact that eels, one to two inches long have been found around New York City is not evidence that they breed there. I have caught them that size in this state near the mouths of the rivers too. This is a case of Believe It or Not but those baby eels have travelled over 1000 miles before your friends have caught them.

For a complete story of the fascinating eels I suggest to your friends that they go to the 42nd Street Library or to the library of Natural History at the American Museum and ask for *History of Fishes* by J. R. Norman. There the marvelous story is told completely and illustrated. You will all appreciate what I meant when I said in NATURAL HISTORY that baby eels look like cellophane cigar wrappers. Later they shrink somewhat and become opaque.

Thank you for writing us.

MYRON GORDON.

Fish and Game Department,
State of New Hampshire.

* * *

Sirs:

I have just seen an account of the magazine NATURAL HISTORY which makes me wish that our boys and girls might have the advantage of it. How helpful it would be in their science classes and in the library where they could all share its use.

Hindman Settlement School is one of the earliest of all the mountain Settlements, and it has always been a pioneer in the field. Being so, we should like especially as challenging a magazine as NATURAL HISTORY, and I wonder if either the Museum or some individual in the Museum would be willing to share the copies with us. All of the magazines which we have are the gifts of our friends, for we have no fund with which to subscribe direct; and we should certainly appreciate being able in some way to enjoy and use the material in NATURAL HISTORY.

ELIZABETH WATTS.

Hindman Settlement School,
Hindman, Knott County, Ky.

* * *

SIRS:

Thanks for your kind letter of the 16th and for the shipment of five copies of your very fine magazine.

Your publication fills a real want in prison administration and is exactly what the men incarcerated need and want. If any of your readers could send us copies when they are finished with them, they would be put to good use.

Again thank you.

CURTIS E. SHIELDS,
Chaplain.

London Prison Farm,
London, Ohio.

A YOUNG ROBIN sits for an unusual nature-portrait at Camp Wigwam.
Submitted by A. Mandelstam.

NOTICE:

Readers are encouraged to submit their own photographs of natural history subjects. Those selected for publication on this page will be paid for at $1.00 each, with full credit to the photographer. Return postage must be included.

Who • *When* • *Where*

OCTOBER CALENDAR OF ENTERTAINMENT

On these pages will be found a calendar of museum events in metropolitan New York for October. It is hoped that this list will enable those at a distance who contemplate a visit to New York to plan more efficiently, and that those who live in or near the city may be able to choose lectures and other activities that fit their needs or interests.

CHARLES RUSSELL,
Curator of the Department of Education, American Museum of Natural History

General Information

AMERICAN MUSEUM OF NATURAL HISTORY
Central Park West at 79th Street, New York City
Hours: Daily 9:00 a. m. to 5:00 p. m. Sunday 1:00 p. m. to 5:00 p. m. Open holidays 9:00 a. m. to 5:00 p. m. Admission Free.
Exhibitions of gems, human and animal habitat groups, prehistoric creatures, and fossil arrangements showing evolution.

AQUARIUM
Battery Park, New York City
Hours: Daily 9:00 a. m. to 5:00 p. m. Admission Free.
Collections of living aquatic animals; fresh-water and marine, principally fishes but including other groups.

BROOKLYN BOTANIC GARDEN
1000 Washington Avenue, Brooklyn
Hours: Daily from 9:00 a. m. until dark. Sundays from 10:00 a. m. Conservatories open from 10:00 a. m. until 4:00 p. m. Admission Free.
Rose garden; wild flower, Japanese rock, and wall gardens; horticultural displays; conservatories.

BROOKLYN MUSEUM
Eastern Parkway and Washington Avenue, Brooklyn
Hours: Daily 10:00 a. m. to 5:00 p. m. Saturdays and holidays 10:00 a. m. to 6:00 p. m. Sundays 2:00 p. m. to 6:00 p. m.
Admission Free except Mondays and Fridays, when charge is 25¢ for adults and 10¢ for children.
Arts of the world arranged in chronological and geographical order to illustrate the history of cultures.

THE CLOISTERS
Fort Tryon Park (190th Street Subway Station) New York City
Hours: Daily 10:00 a. m. to 5:00 p. m. Saturdays and holidays 10:00 a. m. to 5:00 p. m. Sundays 1:00 p. m. to 5:00 p. m.
Admission Free, except Mondays and Fridays, when charge is 25¢.
Branch of the Metropolitan Museum of Art devoted to European medieval art.

FRICK COLLECTION
1 East 70th Street, New York City
Hours: Weekdays 10:00 a. m. to 5:00 p. m. Sundays 1:00 p. m. to 5:00 p. m. Admission Free.
14th-19th century paintings, Renaissance bronzes, Limoges enamels, Chinese and French porcelains, period furniture.

METROPOLITAN MUSEUM OF ART
Fifth Avenue and 82nd Street New York City
Hours: Daily 10:00 a. m. to 5:00 p. m. Saturdays and holidays 10:00 a. m. to 5:00 p. m. Sundays 1:00 p. m. to 5:00 p. m.
Admission Free, except Mondays and Fridays, when charge is 25¢.
Collections of Egyptian, Classical, Oriental, European, and American art—paintings, prints, sculpture and decorative arts.

MUSEUM OF THE AMERICAN INDIAN
Broadway and 155th Street New York City
Hours: Daily 2:00 p. m. to 5:00 p. m. Sunday 1:00 p. m. to 5:00 p. m. Admission Free.
Anthropological collections from the aboriginal inhabitants of North, Central, and South Americas, and West Indies.

MUSEUM OF THE CITY OF NEW YORK
Fifth Avenue and 103rd Street New York City
Hours: Daily 10:00 a. m. to 5:00 p. m. Saturdays and holidays 10:00 a. m. to 6:00 p. m. Sundays 1:00 p. m. to 6:00 p. m. Closed Tuesdays. Admission Free, except Monday, when charge is 25¢.
Exhibits of the chronological development of New York City life from earliest times to the present.

MUSEUM OF MODERN ART
11 West 53rd Street, New York City
Hours: Daily 10:00 a. m. to 6:00 p. m. Sundays 12:00 m. to 6:00 p. m.
Admission Free on Monday, other days 25¢.
Art of today—showing American and European painting, sculpture, architecture, industrial art, photography, motion pictures.

MUSEUM OF SCIENCE AND INDUSTRY
RCA Building, Radio City, New York City
Hours: Daily 10:00 a. m. to 5:00 p. m. Sundays 2:00 p. m. to 5:00 p. m. Admission 25¢. (Free to teachers with classes.)
Exhibits in transportation, communications, power, food, housing, electro-technology and other scientific and industrial fields.

NEW YORK BOTANICAL GARDEN
Bronx Park, Bronx, N. Y.
Hours: Museum and Conservatories open daily 10:00 a. m. to 4:30 p. m. Admission Free.
Extensive greenhouses, outdoor plantings, floral displays and museum collections of economic, drug and fossil plants.

STATEN ISLAND MUSEUM
Stuyvesant Place and Wall Street St. George, Staten Island
Hours: Daily 10:00 a. m. to 5:00 p. m. Sunday 2:00 p. m. to 5:00 p. m. Admission Free.
Collections in science, art and history, especially relating to Staten Island.

WHITNEY MUSEUM OF AMERICAN ART
8-12 West 8th Street, New York City
Hours: Daily 10:00 a. m. to 6:00 p. m. Sunday 2:00 p. m. to 6:00 p. m. Closed Monday. Admission Free.
Collection of sculpture, painting, watercolors, drawing and prints by American artists. (The Museum is closed from June 1st to September 15th.)

OCTOBER 1

AMERICAN MUSEUM OF NATURAL HISTORY
2:00 p. m.—Motion picture and lecture—"World of the Spineless," by John R. Saunders—Museum Auditorium—Open to public.

BROOKLYN MUSEUM
2:00 p. m.—Lecture—"History of Music and Its Parallels in Visual Art," by David LeVita—Classroom A—Open to public.
3:00 p. m.—Swedish Festival—Sculpture Court—Open to public.

FRICK COLLECTION
3:00 p. m.—Lecture—"Italian Painting in the Collection," by Mr. Arnason—Open to public.

METROPOLITAN MUSEUM OF ART
11:00 a. m.—Lecture—"Early European Prints," by Miss Abbot—Lecture Hall—Open to public.
2:00 p. m.—Lecture—"Chinese and Japanese Painting," by Miss Duncan—Main Hall—Open to public.
2:30 p. m.—Motion picture—"The Etcher's Art; Drypoint—a Demonstration"—Lecture Hall—Open to public.

GUIDE SERVICE

The following institutions offer free lecture tours of their collections:

AMERICAN MUSEUM OF NATURAL HISTORY
Wednesdays, Fridays and Saturdays at 11:00 a. m. and 3:00 p. m. Meeting Place: 2nd Floor, Roosevelt Memorial.

METROPOLITAN MUSEUM OF ART
Tuesday at 12:00 m., Wednesday and Thursday at 2:00 p. m. Meeting Place: Main Hall.

MUSEUM OF MODERN ART
Daily at 11:00 a. m., 1:30 p. m., 3:00 p. m., and 4:30 p. m.

MUSEUM OF THE CITY OF NEW YORK
1:15 and 3:30 p. m.—Motion picture (2 showings)—"Electrifying New York"—Open to public.

NEW YORK BOTANICAL GARDEN
3:00 p. m.—Lecture—"Rock Garden Construction," by A. C. Pfander—Open to public.

OCTOBER 2

BROOKLYN MUSEUM
2:30 p. m.—Organ Recital by Robert Bedell—Sculpture Court—Open to public.
3:00 p. m.—Motion pictures—Classroom A—Open to public.
4:00 p. m.—Concert—Gramercy Chamber Trio—Sculpture Court—Open to public.

FRICK COLLECTION
3:00 p. m.—Lecture—"Italian Sculpture in the Collection," by Mr. Arnason—Open to public.

METROPOLITAN MUSEUM OF ART
2:00 p. m.—Lecture—"Chinese and Japanese Painting," by Miss Duncan—Main Hall—Open to public.

2:30 p. m.—Motion picture—"A Visit to the Armor Galleries; The Making of a Bronze Statue"—Lecture Hall—Open to public.

2:30 p. m.—Lecture—"Glass: Ancient and Modern," by Miss Bradish—Main Hall—Open to public.

3:00 p. m.—Lecture—"Design in Architecture," by Joseph Hudnut—Classroom K—Open to public.

OCTOBER 4

American Museum of Natural History

3:00 p. m.—Lecture and motion picture—"Sequoia," by John Saunders—Museum Auditorium—Open to public.

Brooklyn Botanic Garden

4:00 p. m.—Lecture—"Walks and Talks in the Botanic Garden," by Arthur Harmount Graves—Open to public.

Metropolitan Museum of Art

11:00 a. m.—Lecture—"Color Schemes: Red and Orange," by Miss Cornell—Classroom K—Open to public.

2:30 p. m.—Motion picture—"The American Wing; Firearms of Our Forefathers"—Lecture Hall—Open to public.

3:00 p. m.—Lecture—"Italian Furniture," by Miss Cornell—Classroom K—Open to public.

OCTOBER 5

Frick Collection

3:00 p. m.—Lecture—"Dutch Painting in the Collection," by Mr. Arnason—Open to public.

Metropolitan Museum of Art

11:00 a. m.—Lecture—"The Early Art of the Hebrews," by Miss Duncan—Main Hall—Open to public.

4:00 p. m.—Lecture—"Thomas Dennis of Ipswich," by Mr. Busselle—Main Hall—Open to public.

Museum of the City of New York

3:30 p. m.—Motion picture—"The Port of New York"—Open to public.

OCTOBER 6

Frick Collection

3:00 p. m.—Lecture—"English Painting in the Collection," by Doctor Ritchie—Open to public.

Metropolitan Museum of Art

11:00 a. m.—Lecture—"Classic Myths and Their Persistence in Later Art: Introduction to the Gods," by Mr. Shaw—Classroom D—Open to public.

OCTOBER 7

American Museum of Natural History

10:30 a. m.—Lecture—"Redmen and White in Early New York," by Almeda Johnson—Museum Auditorium—Open to public.

Frick Collection

3:00 p. m.—Lecture—"Chinese Porcelains in the Collection," by Mr. Arnason—Open to public.

OCTOBER 8

American Museum of Natural History

2:00 p. m.—Motion picture and lecture—"World of Fishes," by Marguerite Newgarden—Museum Auditorium—Open to public.

Brooklyn Museum

2:00 p. m.—Lecture—"History of Music and Its Parallels in Visual Art," by David LeVita—Classroom A—Open to public.

Frick Collection

3:00 p. m.—Lecture—"French Painting, 18th Century, in the Collection," by Doctor Ritchie—Open to public.

Metropolitan Museum of Art

11:00 a. m.—Lecture—"German Masters of the XV Century," by Miss Abbot—Lecture Hall—Open to public.

2:00 p. m.—Lecture—"Miniatures of Persia and India: a Contrast," by Miss Duncan—Main Hall—Open to public.

2:30 p. m.—Motion picture—"Digging into the Past; The Daily Life of the Egyptians—Ancient and Modern"—Lecture Hall—Open to public.

Museum of the City of New York

1:15 and 3:30 p. m.—Motion picture (2 showings)—"Peter Stuyvesant"—Open to public.

New York Botanical Garden

3:00 p. m.—Lecture—"Humoring the Garden Soil," by T. H. Everett—Open to public.

OCTOBER 9

Brooklyn Museum

2:30 p. m.—Organ recital by Robert Bedell—Sculpture Court—Open to public.

3:00 p. m.—Motion pictures—Classroom A—Open to public.

4:00 p. m.—Concert—Gramercy Chamber Trio—Sculpture Court—Open to public.

Frick Collection

3:00 p. m.—Lecture—"French Painting, 19th Century, in the Collection," by Doctor Ritchie—Open to public.

Metropolitan Museum of Art

2:00 p. m.—Lecture—"Miniatures of Persia and India: a Contrast," by Miss Duncan—Main Hall—Open to public.

2:30 p. m.—Motion picture—"The Making of Wrought Iron; The Making of a Stained-Glass Window"—Lecture Hall—Open to public.

2:30 p. m.—Lecture—"Francisco Goya," by Miss Abbot—Main Hall—Open to public.

3:00 p. m.—Lecture—"Design in Tall Buildings," by Harvey W. Corbett—Classroom K—Open to public.

PLANETARIUM

Schedule for October

★

"The Sun's Planetary Family"

Weekdays—2:00, 3:30, and 8:30 P. M.

Saturdays—11:00 A. M., 1:00, 2:00, 3:00, 4:00, 5:00 and 8:30 P. M.

Sundays and Holidays—2:00, 3:00, 4:00, 5:00 and 8:30 P. M.

General Admission Afternoons	25¢
Reserved Seat "	50¢
General Admission Evenings	35¢
Reserved Seat "	60¢

General Admission for Children under 17, accompanied by adults, 15¢ at all times. (No reduced price for reserved seats occupied by children.) Children under 5 not admitted. Doors close on the hour. Special facilities for the hard of hearing.

OCTOBER 11

American Museum of Natural History

3:00 p. m. Lecture and motion picture—"Mealtime in the Animal Kingdom," by John Saunders—Museum Auditorium—Open to public.

Metropolitan Museum of Art

11:00 a. m.—Lecture—"Color Schemes: Green and Yellow," by Miss Cornell—Classroom K—Open to public.

2:30 p. m.—Motion picture—"Columbus (Yale Chronicles of America Photoplay)"—Lecture Hall—Open to public.

3:00 p. m.—Lecture—"French Furniture," by Miss Cornell—Classroom K—Open to public.

OCTOBER 12

Frick Collection

3:00 p. m.—Lecture—"El Greco and the Spanish Temperament," by Doctor Ritchie—Open to public.

OCTOBER 13

Frick Collection

3:00 p. m.—Lecture—"Limoges Enamels in the Collection," by Doctor Ritchie—Open to public.

Metropolitan Museum of Art

11:00 a. m.—Lecture—"Classic Myths and Their Persistence in Later Art: Causes of the Trojan War," by Mr. Shaw—Classroom D—Open to public.

OCTOBER 14

American Museum of Natural History

10:30 a. m.—Lecture—"Desert Life," by Farida Wiley—Museum Auditorium—Open to public.

Frick Collection

3:00 p. m.—Lecture—"English Painting in the Collection," by Doctor Ritchie—Open to public.

OCTOBER 15

American Museum of Natural History

2:00 p. m.—Motion picture and lecture—"World of Birds," by John Orth—Museum Auditorium—Open to public.

Brooklyn Museum

2:00 p. m.—Lecture—"History of Music and Its Parallels in Visual Art," by David LeVita—Classroom A—Open to public.

Frick Collection

3:00 p. m.—Lecture—"Dutch Painting in the Collection," by Mr. Arnason—Open to public.

Metropolitan Museum of Art

11:00 a. m.—Lecture—"Italian XV Century Prints," by Miss Abbot—Lecture Hall—Open to public.

2:00 p. m.—Lecture—"Painting in Crete and Greece," by Mr. Shaw—Main Hall—Open to public.

2:30 p. m.—Motion picture—"Behind the Scenes in the Metropolitan Museum; The Temples and Tombs of Ancient Egypt"—Lecture Hall—Open to public.

Museum of the City of New York

1:15 and 3:30 p. m.—Motion picture (2 showings)—"Alexander Hamilton"—Open to public.

New York Botanical Garden

3:00 p. m.—Lecture—"Botanists and Human Progress," by J. H. Barnhart—Open to public.

Staten Island Museum

8:30 p. m.—Lecture—"Color Photography," by Frederic N. Adams—Open to public.

OCTOBER 16

Brooklyn Museum

2:30 p. m.—Organ Recital by Robert Bedell—Sculpture Court—Open to public.

3:00 p. m.—Motion pictures—Classroom A—Open to public.

4:00 p. m.—Concert—Gramercy Chamber Trio—Sculpture Court—Open to public.

Frick Collection

3:00 p. m.—Lecture—"Italian Painting in the Collection," by Mr. Arnason—Open to public.

Metropolitan Museum of Art

2:00 p. m.—Lecture—"Painting in Crete and Greece," by Mr. Shaw—Main Hall—Open to public.

2:30 p. m.—Motion picture—"The Pottery Maker; The American Wing"—Lecture Hall—Open to public.

2:30 p. m.—Lecture—"The Exhibition of Photographs of American Architecture," by Mr. Busselle—Main Hall—Open to public.

3:00 p. m.—Lecture—"American Small House Design: English Types," by Talbot F. Hamlin—Classroom K—Open to public.

OCTOBER 18

American Museum of Natural History

3:00 p. m.—Lecture and motion picture—"Economic Insects," by C. Howard Curran—Museum Auditorium—Open to public.

Brooklyn Botanic Garden

4:00 p. m.—Lecture—"Walks and Talks in the Botanic Garden," by Arthur Harmount Graves—Open to public.

Metropolitan Museum of Art

11:00 a. m.—Lecture—"Color Schemes: Blue and Purple," by Miss Cornell—Classroom K—Open to public.

2:30 p. m.—Motion picture—"Firearms of Our Forefathers; Peter Stuyvesant (Yale Chronicles of America Photoplay)"—Lecture Hall—Open to public.

3:00 p. m.—Lecture—"English Furniture," by Miss Cornell—Classroom K—Open to public.

OCTOBER 19

Frick Collection

3:00 p. m.—Lecture—"The Christian Theme in Italian Painting," by Mr. Arnason—Open to public.

Metropolitan Museum of Art

11:00 a. m.—Lecture—"The Art of Ancient Assyria and Babylonia," by Miss Duncan—Main Hall—Open to public.

4:00 p. m.—Lecture—"Nicholas Disbrowe of Hartford," by Mr. Busselle—Main Hall—Open to public.

MUSEUM OF THE CITY OF NEW YORK

3:30 p. m.—Motion picture—"A Trip on a Revenue Cutter"—Open to public.

OCTOBER 20

FRICK COLLECTION

3:00 p. m.—Lecture—"Furniture in the Collection," by Mr. Arnason—Open to public.

METROPOLITAN MUSEUM OF ART

11:00 a. m.—Lecture—"Classic Myths and Their Persistence in Later Art: The Destruction of Troy," by Mr. Shaw Classroom D—Open to public.

3:00 p. m.—Lecture—"Italian Decorative Art," by Miss Cornell—Classroom K—Open to public.

OCTOBER 21

AMERICAN MUSEUM OF NATURAL HISTORY

10:30 a. m.—Lecture—"Big Game Animals of Africa," by William Smith—Museum Auditorium—Open to public.

FRICK COLLECTION

3:00 p. m.—Lecture—"Italian Sculpture in the Collection," by Mr. Arnason—Open to public.

OCTOBER 22

AMERICAN MUSEUM OF NATURAL HISTORY

2:00 p. m.—Motion picture and lecture—"World of Primates," by Grace F. Ramsey—Museum Auditorium—Open to public.

4:00 p. m.—Lecture—"Jade: the Many-Colored Jewel of Heaven," by Herbert P. Whitlock—Room 319, Roosevelt Memorial—Open to public.

BROOKLYN MUSEUM

2:00 p. m.—Lecture—"History of Music and Its Parallels in Visual Art," by David LeVita—Classroom A—Open to public.

FRICK COLLECTION

3:00 p. m.—Lecture—"El Greco and the Spanish Temperament," by Doctor Ritchie—Open to public.

METROPOLITAN MUSEUM OF ART

11:00 a. m.—Lecture—"The Origins of Medieval Sculpture," by Mr. Grier—Main Hall—Open to public.

11:00 a. m.—Lecture—"The Raphaelesque Tradition and Its Development," by Miss Abbot—Lecture Hall—Open to public.

2:00 p. m.—Lecture—"Roman Painting," by Mr. Shaw—Main Hall—Open to public.

2:30 p. m.—Motion picture—"A Visit to the Armor Galleries; The Etcher's Art"—Lecture Hall—Open to public.

3:00 p. m.—Lecture (for the deafened who read the lips)—"Chinese Jade," by Jane B. Walker—Classroom B—Open to public.

MUSEUM OF THE CITY OF NEW YORK

1:15 and 3:30 p. m.—Motion picture (2 showings)—"Eve of the Revolution"—Open to public.

NEW YORK BOTANICAL GARDEN

3:00 p. m.—Lecture—"Winter in Oaxaca," by W. H. Camp—Open to public.

OCTOBER 23

BROOKLYN MUSEUM

2:30 p. m.—Organ Recital by Robert Bedell—Sculpture Court—Open to public.

3:00 p. m.—Motion pictures—Classroom A—Open to public.

3:00 p. m.—American Indian Day Festival—Sculpture Court—Open to public.

4:00 p. m.—Concert—Gramercy Chamber Trio—Sculpture Court—Open to public.

FRICK COLLECTION

3:00 p. m.—Lecture—"English Painting in the Collection," by Doctor Ritchie—Open to public.

METROPOLITAN MUSEUM OF ART

2:00 p. m.—Lecture—"Roman Painting," by Mr. Grier—Main Hall—Open to public.

2:30 p. m.—Motion picture—"Digging into the Past; The Daily Life of the Egyptians—Ancient and Modern"—Lecture Hall—Open to public.

2:30 p. m.—Lecture—"The Art of the Cabinetmaker: Early Types in Italy and France," by Miss Bradish—Main Hall—Open to the public.

3:00 p. m.—Lecture—"American Small House Design: French, Italian and Spanish Types," by Talbot F. Hamlin—Classroom K—Open to public.

OCTOBER 25

AMERICAN MUSEUM OF NATURAL HISTORY

3:00 p. m.—Lecture and motion picture—"Nature Photography Throughout the Year," by Charles Coles—Museum Auditorium—Open to public.

METROPOLITAN MUSEUM OF ART

11:00 a. m.—Lecture—"Color Schemes: Area and Texture," by Miss Cornell—Classroom K—Open to public.

SPECIAL EXHIBITS

MISSING LINK SKULLS—Showing a remarkable mingling of human and ape characteristics, models of the skull and teeth of the child *Australopithecus africus* Dart (who lived probably over 50,000 years ago) are compared with the skull and teeth of a baby chimpanzee and a human child. Declared to connect the ape and human families, these models are on exhibit in the foyer of the American Museum of Natural History.

•

"FACES OF THE CITY"—A series of photographs by John Albok, whose candid camera hobby has enabled him to document life in New York, are on view in the Small Special Exhibitions Gallery of the Museum of the City of New York.

•

ESKIMO ART—A collection presented by Mrs. Ruth Bryan Owen Rohde showing the richness of modern Eskimo wood, ivory carvings and bead work, as well as ceremonial objects and utensils is exhibited in the foyer of the American Museum of Natural History.

•

AMERICAN SCULPTURE—Ranging from humorous political satire to conventional figure pieces; a showing of contemporary American sculpture by members of the Sculptors Guild will be held from October 22 to November 27 at the Brooklyn Museum.

2:30 p. m.—Motion picture—"The Pottery Maker; Alexander Hamilton (Yale Chronicles of America Photoplay)"—Lecture Hall—Open to public.

3:00 p. m.—Lecture—"American Furniture," by Miss Cornell—Classroom K—Open to public.

OCTOBER 26

FRICK COLLECTION

3:00 p. m.—Lecture—"Velasquez, Court Portrait Painter," by Doctor Ritchie—Open to public.

METROPOLITAN MUSEUM OF ART

11:00 a. m.—Lecture—"The Art of Ancient Persia," by Miss Duncan—Main Hall—Open to public.

4:00 p. m.—Lecture—"Transition in Architecture in 1700," by Mr. Busselle—Main Hall—Open to public.

MUSEUM OF THE CITY OF NEW YORK

3:30 p. m.—Motion picture—"To Serve New York"—Open to public.

OCTOBER 27

FRICK COLLECTION

3:00 p. m.—Lecture—"Chinese Porcelains in the Collection," by Mr. Arnason—Open to public.

METROPOLITAN MUSEUM OF ART

11:00 a. m.—Lecture—"Classic Myths and Their Persistence in Later Art: The Wanderings of Odysseus," by Mr. Shaw—Classroom D—Open to public.

3:00 p. m.—Lecture—"Italian Decorative Art," by Miss Cornell—Classroom K—Open to public.

OCTOBER 28

AMERICAN MUSEUM OF NATURAL HISTORY

10:30 a. m.—Lecture—"Indian Crafts," by Gladys Pratt—Museum Auditorium—Open to public.

FRICK COLLECTION

3:00 p. m.—Lecture—"French Painting, 18th Century, in the Collection," by Doctor Ritchie—Open to public.

OCTOBER 29

AMERICAN MUSEUM OF NATURAL HISTORY

2:00 p. m.—Motion picture and lecture—"Theodore Roosevelt," by William L. Smith—Museum Auditorium—Open to public.

4:00 p. m.—Lecture—"Antique Jade," by Herbert P. Whitlock—Room 319, Roosevelt Memorial—Open to public.

BROOKLYN MUSEUM

2:00 p. m.—Lecture—"History of Music and Its Parallels in Visual Art," by David LeVita—Classroom A—Open to public.

FRICK COLLECTION

3:00 p. m.—Lecture—"The Christian Theme in Italian Painting," by Mr. Arnason—Open to public.

METROPOLITAN MUSEUM OF ART

11:00 a. m.—Lecture—"Durer's Woodcuts and Engravings," by Miss Abbot—Lecture Hall—Open to public.

11:00 a. m. Lecture—"The Dark Ages," by Mr. Grier—Main Hall—Open to public.

2:00 p. m.—Lecture—"Mediaeval Painting," by Mr. Grier—Main Hall—Open to public.

2:30 p. m.—Motion picture—"Tapestries and How They Are Made; The Making of a Stained-Glass Window"—Lecture Hall—Open to public.

MUSEUM OF THE CITY OF NEW YORK

1:15 and 3:30 p. m.—Motion picture (2 showings)—"New Frontiers"—Open to public.

NEW YORK BOTANICAL GARDEN

3:00 p. m.—Lecture—"Garden Work with Shrubs," by P. M. Koster—Open to public.

OCTOBER 30

BROOKLYN MUSEUM

2:30 p. m.—Organ Recital by Robert Bedell—Sculpture Court—Open to public.

3:00 p. m.—Motion pictures—Classroom A—Open to public.

4:00 p. m.—Concert—Gramercy Chamber Trio—Sculpture Court—Open to public.

FRICK COLLECTION

3:00 p. m.—Lecture—"The Attainment of Creative Expression in an Art," by Olin Downes—Open to public.

METROPOLITAN MUSEUM OF ART

2:00 p. m.—Lecture "Mediaeval Painting," by Mr. Grier—Main Hall Open to public.

2:30 p. m.—Motion picture—"Behind the Scenes in the Metropolitan Museum; Drypoint—a Demonstration"—Lecture Hall—Open to public.

2:30 p. m. Lecture—"Lathe-turned, Carved, and Marquetry Furniture," by Miss Bradish—Main Hall—Open to public.

3:00 p. m.—Lecture "Early American: English Types," by Aymar Embury—Classroom K—Open to public.

See Next Page for Radio Guide

OCTOBER RADIO PROGRAMS

OCTOBER 1

10:00 a. m.—Organ Recital—Station WNYC—BROOKLYN MUSEUM.

12:00 m.—"This Wonderful World" (Question and Answer Program)—Station WOR—HAYDEN PLANETARIUM.

OCTOBER 3

5:15 p. m.—"New Horizons"—Station WABC—AMERICAN MUSEUM OF NATURAL HISTORY.

OCTOBER 4

1:05 p. m.—Organ Recital—Station WNYC—BROOKLYN MUSEUM.

OCTOBER 5

5:15 p. m.—"Exploring Space"—Station WABC—HAYDEN PLANETARIUM.

OCTOBER 6

1:05 p. m.—Organ Recital—Station WNYC—BROOKLYN MUSEUM.

OCTOBER 7

1:05 p. m.—Organ Recital—Station WNYC—BROOKLYN MUSEUM.

OCTOBER 8

10:00 a. m.—Organ Recital—Station WNYC—BROOKLYN MUSEUM.

12:00 m.—"This Wonderful World" (Question and Answer Program)—Station WOR—HAYDEN PLANETARIUM.

OCTOBER 11

1:05 p. m.—Organ Recital—Station WNYC—BROOKLYN MUSEUM.

OCTOBER 13

1:05 p. m.—Organ Recital—Station WNYC—BROOKLYN MUSEUM.

2:30 p. m.—"New Horizons" (Sponsored by American School of the Air)—Station WABC—AMERICAN MUSEUM OF NATURAL HISTORY.

OCTOBER 14

1:05 p. m.—Organ Recital—Station WNYC—BROOKLYN MUSEUM.

5:15 p. m.—"Men Behind the Stars"—Station WABC—HAYDEN PLANETARIUM.

OCTOBER 15

10:00 a. m.—Organ Recital—Station WNYC—BROOKLYN MUSEUM.

12:00 m.—"This Wonderful World," (Question and Answer Program)—Station WOR—HAYDEN PLANETARIUM.

OCTOBER 18

1:05 p. m.—Organ Recital—Station WNYC—BROOKLYN MUSEUM.

OCTOBER 20

1:05 p. m.—Organ Recital—Station WNYC—BROOKLYN MUSEUM.

2:30 p. m.—"New Horizons" (Sponsored by American School of the Air)—Station WABC—AMERICAN MUSEUM OF NATURAL HISTORY.

OCTOBER 21

1:05 p. m.—Organ Recital—Station WNYC—BROOKLYN MUSEUM.

5:15 p. m.—"Men Behind the Stars"—Station WABC—HAYDEN PLANETARIUM.

OCTOBER 22

10:00 a. m.—Organ Recital—Station WNYC—BROOKLYN MUSEUM.

12:00 m.—"This Wonderful World," (Question and Answer Program)—Station WOR—HAYDEN PLANETARIUM.

OCTOBER 25

1:05 p. m.—Organ Recital—Station WNYC—BROOKLYN MUSEUM.

OCTOBER 27

1:05 p. m.—Organ Recital—Station WNYC—BROOKLYN MUSEUM.

2:30 p. m.—"New Horizons" (Sponsored by American School of the Air)—Station WABC—AMERICAN MUSEUM OF NATURAL HISTORY.

OCTOBER 28

1:05 p. m.—Organ Recital—Station WNYC—BROOKLYN MUSEUM.

5:15 p. m.—"Men Behind the Stars"—Station WABC—HAYDEN PLANETARIUM.

OCTOBER 29

10:00 a. m.—Organ Recital—Station WNYC—BROOKLYN MUSEUM.

12:00 m.—"This Wonderful World," (Question and Answer Program)—Station WOR—HAYDEN PLANETARIUM.

WHAT SIZE CAMERA?

By CHARLES H. COLES

Chief Photographer, American Museum

THAT glorious feeling of unhampered freedom that the miniature camera user knows when he is taking pictures is just one of the delights of using a tiny precision camera of modern design. Its light weight, speedy manipulation, and inconspicuousness all add to the ease of using one of these latest products of the camera maker's art. But it is not all as simple as the camera manufacturers would have you believe. There has yet to be made a camera that is truly universal and satisfactory for all kinds of picture making. Let us review the advantages and drawbacks of the modern miniature camera, considering, for the moment, only those cameras that use short strips of perforated motion picture film. The Contax and the Leica are the most famous members of this camera group.

Portability

When it comes to compactness and portability, the miniature camera leaves little to be desired. Being small and light, it may be worn with no inconvenience. On expeditions where weight and bulk must be kept to an absolute minimum, the miniature camera is the only choice of photographic equipment that can be made. The mechanism of these instruments is arranged in such a simple way that after a short while the owner can operate the controls with as much ease as he drives his car.

For candid photography and work under extremely poor light conditions, a miniature camera equipped with one of the large aperture lenses is supreme in its field. No other camera can approach its performance in dimly illuminated interiors and for night photography. These cameras are still amazingly slow compared to the human eye, and require time exposures when the artificial lighting is not of the brightest, but they represent the ultimate that it has been possible to construct.

Enlargement

Slight camera movement during exposure will impair the sharpness of a miniature picture much more seriously than the same movement in a larger camera. Certain aspects of the developing of miniature film must also be considered, especially if you plan to do this work yourself. Inasmuch as all pictures made with a small camera must be enlarged to an effective size, the negative must have a perfection very much higher than larger negatives. This demands that the negatives be developed in such a way that a minimum of grain is produced. The emulsion on film can record only certain fineness of detail. It is obvious that when you enlarge beyond the limit no more detail can be brought out and the picture becomes "fuzzy." This limit of resolving power is the same for films of similar types and restricts the amount of enlargement the picture will stand, provided focusing and exposure were correct. Meticulous care is further required if the negatives are to be free from blemishs, scratches, and unevenness. And this applies not only during the development but in handling the film afterwards. After all this loving care has been expended on the pictures, the vast majority will still fail to compare in cleanness and detail with pictures made with a larger camera properly operated. On the other hand you will get many pictures you would not take at all if dependent on a large camera.

If you want convenience in shooting, a miniature camera is what you want. With it you must develop a higher technical perfection in every stage of making a photograph than if you are using a camera taking a larger negative size. You must focus more critically, hold the camera more rigidly, expose more accurately, and process the negative more carefully, if you want good results. You must be prepared to wait until three dozen exposures have been made until you see the result of your work. Regardless of the kind of photograph you want to take, you must use the type of film you happen to have in your camera. Retouching portraits or removing objectionable spots on the negative is practically impossible. Finally, you will have a serious problem in filing the small negatives. They must be kept in strips of several pictures or even in complete rolls for ease in handling. This means that each strip will contain a variety of subjects all of which must be entered and cross-indexed in some manner.

Color Pictures

One of the most exciting and satisfying fields in which the miniature camera excels is that of color photography. The beautiful transparencies made by the Kodachrome process and projected upon a screen are a joy to everyone who sees them. The reality of the colored scenes, their apparent depth, and brilliancy have indeed caused many miniature camera fans to decide to use nothing but color film for all their snap-shooting.

Unusual Services

With primitive tools the Navajos produce their silver and turquoise jewelry. At **FRED LEIGHTON'S** shop, 15 East 8 St. you will find a choice selection of their art. Massive Squash Blossom necklaces, rings and bracelets. Strings of wampum from almost a pure white to soft tones of grey, objects of genuine beauty, worthy of being imprisoned in a Museum glass case. There is no sign: "Please do not touch" in the shop. Drop in and find delight in things Indian. . . .

•

The worst menace to a traveler is disease. The early **EXPLORERS** left for the jungle with little more than quinine, castor oil, and a roll of bandages. Other drugs deteriorated and were too bulky. Burroughs Wellcome & Co. impressed by the need of proper equipment to combat disease began a program of scientific research. This resulted in the compact medicine kits and the advice given to the intending traveler. As a result from Stanley to modern explorers Burroughs Wellcome & Co. has supplied many important expeditions. The name of Burroughs Wellcome has become internationally famous. Today not only explorers carry their kits but they can be found in homes, mines, factories, boats, in fact wherever there is a possibility of the need for first aid. Special kits are made for specific needs. Write Burroughs Wellcome & Co., 9 and 11 East 40th Street, New York for their catalogue and further information.

•

FRUITNUTS are a tasty and different confection. Consisting of freshly ground fruit made into rolls and then filled with English walnuts, they are distinctly different. There are 3 kinds of **FRUITNUTS:** Fignuts which are made of white figs and filled with walnuts; Nectarnuts made of Nectarines and four other fruits ground together, and Datenuts which are filled with dates. This confection makes an ideal gift for birthday and holiday. All the fruit and nuts are entirely uncooked. Here is a tasty sweet that can be eaten freely. A 5-lb. box of assorted kinds costs $2.75 (express prepaid). Write to The Canoga Farms whose advertisement appears on this page.

•

So many readers have spoken enthusiastically of the beauty of NATURAL HISTORY that we felt they'd like a **NEW BINDER** this year. We had the staff design a binder characteristic of the magazine. It is a very attractive addition to the library, following the same general scheme as the covers of NATURAL HISTORY. Copies are easily inserted, resulting in a permanent file of magazines which is not bulky. In imitation green leather with the characteristic bands in gold on the cover. Look for the ad next month.

THE VOICE WITH A *Smile*

NORTH

SOUTH

It may carry the salty twang of New England or the soft accents of the South.

It may be swift and crisp in the New York manner or full of the pleasant rolling r's in the style of the West.

But wherever you hear it, it will be friendly, courteous, and efficient.

It's the all-American voice of the Bell Telephone operator—"The Voice with a Smile."

The entire Bell System seeks to serve you quickly, capably and in the spirit of a friend.

EAST

WEST

BELL TELEPHONE SYSTEM

NATURAL HISTORY

The Magazine of the American Museum of Natural History

Frederick Trubee Davison, President — Roy Chapman Andrews, Sc.D., Director

VOLUME XLII—No. 4 ★ ★ ★ ★ ★ **NOVEMBER, 1938**

Publication Office: American Museum of Natural History, Seventy-ninth Street at Central Park West, New York, N. Y.

Editor: Edward M. Weyer, Jr., Ph.D.

Associate: D. R. Barton.

Production: Frederick L. Hahn.

Art: Charles Curtis Hulling.

Manuscripts should be sent to the Editor, The American Museum of Natural History, N. Y.

Subscriptions: Natural History is sent to all members of the American Museum as one of the privileges of membership. Membership Secretary, Charles J. O'Connor.

Advertising Department: Sherman P. Voorhees, Manager. W. Ware Lynch.

Representatives:
Frank S. Whitman, Chicago, Ill.
Warwick S. Carpenter, Santa Barbara, Calif.

The American Museum of Natural History wishes to express gratitude for the assistance in the promotion of the interests of Natural History that has been rendered by the Works Progress Administration.

Natural History is published monthly (except July and August) at New York, N. Y., by The American Museum of Natural History, Seventy-ninth Street and Central Park West. Subscription price $3 a year, single copies fifty cents. These rates also apply to Canada, Newfoundland, and all foreign countries. Entered as second class matter March 9, 1936, at the Post Office at New York, New York, under the Act of August 24, 1912.

Figure 1. *Greatly enlarged model of the original scallop-shell described in the text, now on exhibition in the Darwin Hall of the American Museum. The inset in the upper left-hand corner shows the natural size of the shell.*

A colony of Carnation Worms (Hydroides dianthus) *has encrusted the shell with their dwellings,—a series of coiling limestone tubes from which the heads of the worms have extended their flower-like circlets of breathing-plumes varying in color from bright orange and white to pink, blue and gray. Covering these tubes are colonies of moss-animals, hydroids and protozoa as shown in greater detail in Figure 2*

FRAGILE CREATURES OF THE DEEP—*The story of the hydroids and their kind, whose schemes for coöperative social organization, specialized labor, and collective security set a Utopian example man would find hard to equal*

By ROY WALDO MINER
Curator of Living Invertebrates, American Museum of Natural History

A DEAD scallop-shell lodged between two stones in the swift current attracted my attention. It was covered over with irregular growths of a reddish color, with dots of blue and orange scattered here and there. I reached down to dislodge it from its anchorage in the tidal stream, placed it in a glass jar of sea-water partly filled with other specimens, and brought it back with me to the laboratory.

The scallop-shell was then transferred to a glass dish beneath a stream of gently running sea-water, and some time later I examined it under the low power of a binocular microscope. Immediately I was held spellbound, transported into a world of delicate beauty. My dead shell had sprung to life!

A colony of serpulid seaworms *(Hydroides dianthus)* had built their tiny limestone tubes in a coiled cluster over the fluted scallop-shell, each with a little round opening at the end about an eighth of an inch in diameter but magnified by my instrument to a sizable cavern *(Figure 1, opposite)*. Feathery tufts of orange, purple, and rose slid into view from each opening and expanded into petal-like crowns of gorgeous plumes, flaunting bands of crimson, blue and gold, set off by translucent collars of green and yellow.

The terminal portions of the tubes projected from beneath a brick-red calcareous crust, which completely covered the intertwined coils of the stony dwellings. This crust resolved itself into thousands of tiny vases with perforated walls. From the mouth of each vase a graceful, golden lily-like head protruded *(Figure 2)*. I recognized a species of moss-animal or sea-mat *(Schizoporella unicornis)*, so-called because of its spreading habit. Within my field of view thousands of these little creatures reared their delicate heads in regular ranks and as a shadow passed above them instantaneously disappeared within their shells. Soon they slowly emerged, unfolding their circlets covered with moving hairs to ensnare still tinier creatures and engulf them within their gaping central mouths.

This microcosmic world was so complex, and each detail so interesting, that only after an interval did I perceive hundreds of other fairy creatures standing erect between the shells of the moss-animals. Some were club-shaped, being expanded at the top, and all were translucent, disclosing within their elongate bodies an interior lining of rose-color. Their sides were adorned with stiff, outstanding tentacles, each terminating in a ball-like knob. As I watched, a tiny protozoan came blundering through the forest of fingers. It touched one of the knobs and after a twitch or two, suddenly ceased to move. It had been stung to death by the battery of sting-cells with which each knob was equipped and soon was drawn into the mouth which now expanded to receive it.

These creatures, of such fragile beauty, apparently so innocent, are in reality voracious hydroids of the species *Zanclea gemmosa*, extending their death-dealing weapons in all directions to slay small swimming animals that may come in contact with them. As I gazed through their crowded ranks, I noticed that many had a small ball-like projection on one side. In others, this had grown to a considerable size and was becoming indented to resemble a saucer. In one individual directly beneath my eye, the saucer had expanded to a transparent bell with a tiny clapper hanging down within it. Tentacles with knobbed branches extended in opposite directions from the margin of the bell. As I watched, the stem by which it was attached narrowed to a tenuous thread. Suddenly, struggling with vigorous spasmodic contractions and expansions of its transparent umbrella, it gave a quick pull, separated from the parent stem, and swam off to lead an independent life as a tiny medusa or jelly-fish *(Figure 3)*.

The hydroid polyps are among the simplest forms of animal life, and represent the stock from which all higher groups sprang. They are one grade above the Protozoa, the bodies of which are composed of but a single cell or particle of protoplasm, the basic living substance.

The hydroids also at the beginning of their life-history, start out from a single-celled egg, comparable to a protozoan, but they then go through a process of cell-division which results, first, in a mulberry-like cluster of cells; second, a stage in which these form a single layer of cells arranged like a hollow ball; and, third, the final essential phase, in which some of the cells push inward and line the cavity with a second but internal layer. The forming of this layer is shown in Figure 4, a-c. The embryo then elongates to form a tube *(4d)*, which attaches itself *(4e)*. A circular mouth appears at one end, around which a series of hollow arms or tentacles develops, and thus the adult polyp is produced *(4f, g)*. The cells of the layer lining the cavity of the tube remain large and secrete digestive ferments, while the outer layer becomes composed of smaller cells which are compact for protection, and sensitive so as to react to impulses from the environment.

Some of the cells, located in the tentacles, are unusually sensitive, and become quite complex, forming thread-cells. These are bulb-like and contain a turgid fluid, within which a delicate hollow

Fig. 2

A populous community of hydroids, moss-animals and protozoa has covered the worm-tubes on our scallop-shell. The hydroids (Zanclea gemmosa, *Inset A*), *project between the crowded moss-animal shells* (Schizoporella unicornis, *Inset C*). *Forked lappets of the swallow-tail Protozoan* (Folliculina hirundo, *Inset B*) *show between*

Figure 4. *Free-swimming embryo of hydroid. Formation of inner layer, cells produced from outer layer pushing inward to fill cavity* (a and b), *and splitting apart to produce a two layered embryo* (c), *which elongates to form a*

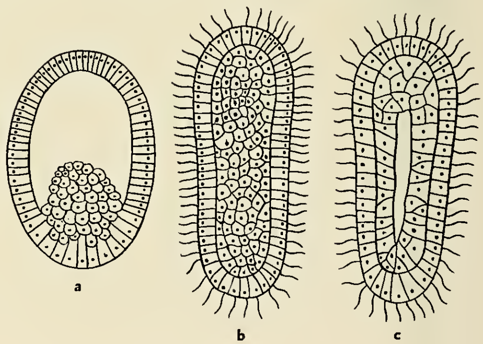
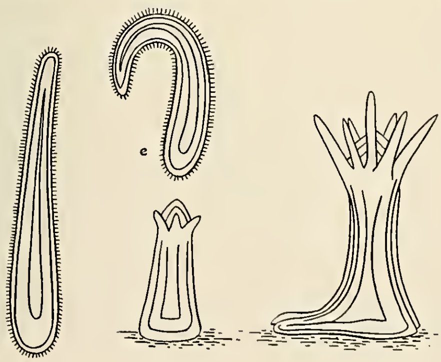


Fig. 3

Above, at left: the head of the sand-mason worm projects from its home of cemented sand-grains. To the right small medusae with bubble-like umbrellas are seen newly budded from their stationary hydroid-parents to form a free-swimming generation. They, in turn, hatch larvae to produce stationary hydroids.

free-swimming planula (d). *This soon settles down* (e), *its blunt end resting on sea-bottom and flattening, while mouth and tentacles appear at free end* (f, g)



thread is coiled like a lasso. Sharp chitinous pieces are contained within the blind terminal cavity of this thread. Projecting outside the cell are one or more sensitive hairs, the cnidocils, or triggers. When some creature comes in contact with them, the thread-cell contracts, squeezing the turgid fluid, which shoots out the coiled thread, turning it inside out with considerable force, so that the sharp chitinous pieces come together to form a barbed point. This penetrates the intruder, injecting at the same time a paralyzing poison. The thread-cells, or, as they are also called, lasso-cells, are very minute, but multitudes of them are shot out to take effect at the same time. The prey is therefore killed or stupefied and is drawn by the tentacles into the mouth so that the creature is soon engulfed within the cavity of the hydroid and digested.

Fundamentally the hydroid structure forms the basis of the evolution of the higher phyla. In fact, all higher animals culminating in man go through what essentially may be termed a "hydroid stage" in their development. That is, from a single-celled egg, they pass through cell-divisions which are more or less comparable with those of the hydroid; namely, a *morula* or "mulberry stage"; a *blastula* or single-layered "hollow-ball stage," and a *gastrula* or double-layered "hydroid stage." Likewise, in all higher animal forms, from the outer protective and

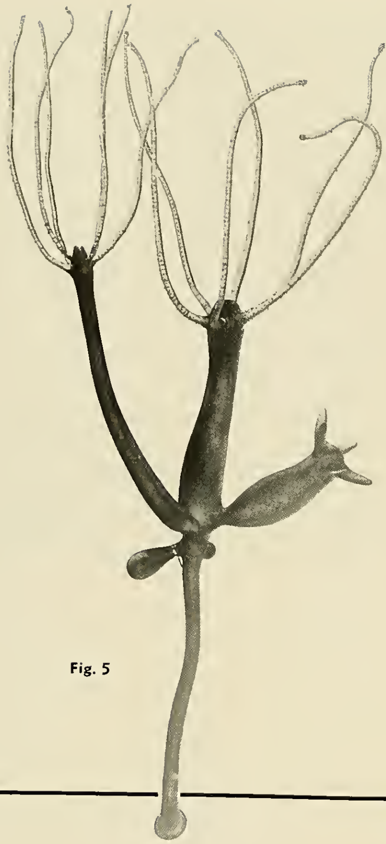


Fig. 5

sensitive layer of cells of this latter stage (the ectoderm) are derived the skin and all protective structures, as well as the brain and various complications of the nervous system. From the inner layer, or endoderm, are derived the digestive system and all contributing glands; and also, through the intermedium of cells or out-buddings of tissues from this inner layer, are formed the body-cavity linings, blood-vessels, connective tissues, inner skeletal structures, reproductive organs and certain parts of the excretory systems of higher animals. So, back in the early history of the earth, the lowly hydroid polyp and its relatives, laid the foundation of higher animal evolution. Fortunately, members of the group have been preserved to us relatively unchanged, as well as groups representing various stages in realizing the possibilities of the hydroids' pioneer work, and these have formed the great animal phyla now existing on the earth.

The hydroids, and their relatives, the jelly-fishes, sea-anemones, corals, gorgonians, sea-pens and the like are comprised within the phylum Coelentera, which includes the animals in which the entire interior of the body acts as a digestive cavity. The Hydromedusae comprise that part of the phylum which centers around the hydroids and many of the jelly-fishes as well as those marvelous floating colonial creatures, the Portuguese Man-of-War, Porpita, Velella, and their relatives. As these form a remarkable series of unusual structures and adaptations, it is planned in this article to describe some of the outstanding species and their habits.

The simplest member of the hydroid group is the fresh-water hydra *(e.g., Hydra fusca),* illustrated in

(Above) *The Fresh Water Hydra is one of the simplest of all the many-celled animals. The inch-long body is a double-layered tube. A terminal mouth is surrounded by stinging tentacles which slay small aquatic creatures to be digested within the tube. The young are budded off and separate from the parent to lead an independent life.* (Model in Darwin Hall)

(Right) *Glass model of a typical marine hydroid medusa* (Syndictyon angulatum) *related to those in Figure 3. Note the transparent umbrella, within which hangs the tubular stomach with terminal mouth. Each of the four tentacles has an eye-spot at its base.*

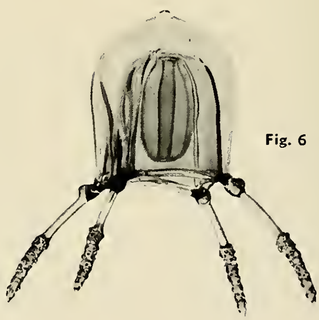


Fig. 6

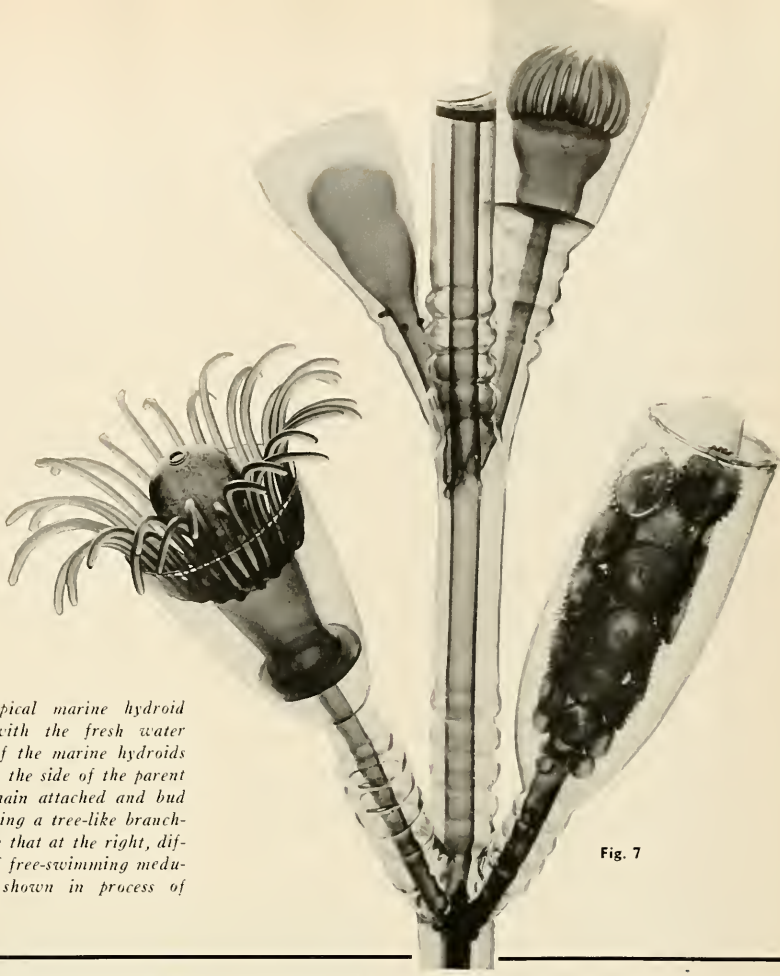


Figure 7. *Model of a typical marine hydroid* (Obelia) *for comparison with the fresh water Hydra* (Figure 5). *Many of the marine hydroids bud off new individuals from the side of the parent but, unlike* Hydra, *they remain attached and bud off others in turn, thus forming a tree-like branching colony. Certain buds, like that at the right, differ from the rest, and bud off free-swimming medusae, several of which are shown in process of development*

Fig. 7

Figure 5. This little creature, an inch or less in length, lives in fresh-water ponds, and is often found in balanced aquaria. It is a simple hollow tube, brown in color, which stands on a disk-like base and stretches out its tiny thread-like cylinder of a body into the water. The terminal mouth is at the summit of a cone-shaped projection, the hypostome, and is surrounded by a circlet of six or seven long, filamentary tentacles plentifully armed with sting-cells.

It captures fish fry, worms, and small crustacea for food, moving about from place to place, either slowly creeping upon its disk-like attachment or, more rapidly, by a series of "hand-springs." That is, it bends its body over in a loop, takes hold of the bottom with its tentacles, and deliberately stands on its head to turn a somersault. Then the process is repeated.

It reproduces by budding a young hydra from its side, which remains attached for a time and then separates to lead an independent existence. It also reproduces sexually, developing sperms between the two cell-layers in the forward part of the body, while ovaries are formed in the lower part, the eggs being fertilized *in situ* in the same or in different individuals. An egg with a sticky envelope is laid, from which a young hydra is directly hatched. No medusa or jelly-fish stage is produced.

Our marine hydroids of the dead scallop shell *(Zanclea gemmosa)* attain the next stage in advancement. The hydroid polyps are budded off from a horizontal branching stem, or hydrorhiza, which weaves its way around and among the moss-animal shells. They do not separate from this stem, thus forming a connected colony, which continually spreads by budding off new individuals asexually. As already described, these polyps, in turn, bud off free-swimming medusae, as the hydroid jelly-fish stage is called. They are like transparent umbrellas *(see Figures 3 and 6)*, with a little horizontal shelf or velum surrounding the bell-opening, while the mouth is at the end of the hollow tubular stomach (manubrium) hanging down like a clapper inside the bell.

There are four canals radiating from the stomach in the substance of the bell to connect with a marginal canal around the rim. The young medusa has two tentacles armed with sting-cells, while there are usually four in the adult. In the latter stage, the walls of the manubrium are swollen by the developing gonads or sex-cells. The fertilized eggs give rise to free-swimming larvae, which settle down on the bottom and grow to form new hydroid colonies.

This method of reproduction is known as alternation of generations, and often occurs in this phylum (e.g., *Obelia, Figure 7*). Thus, a hydroid grows from the larva and buds off other individuals asexually, which remain connected with it. This asexual hydroid generation gives rise by budding to a free-swimming medusa generation which, in turn, produces free-swimming larvae by sexual fertilization. These larvae give rise to a new asexual hydroid generation, thus completing the cycle.

In *Zanclea* the hydroids in the community are all of the same kind. However, if, when collecting in shallow water, one watches the smaller hermit crabs, *Eupagurus longicarpus*, the shells of certain individuals will be seen to have reddish velvety covering *(see Figure 8)*. If such a crab is placed, shell and all, under the dissecting microscope in a dish of sea-water, this will blossom forth into a remarkable colony of hydroid individuals, represented in Figure 9. This species *(Hydractinia echinata)* penetrates the shell-substance to form a network of tubes connecting the members of the colony with each other. The community includes three different kinds of polyp, each specialized for a definite function. The first are the feeding-polyps, with club-shaped bodies and terminal mouths surrounded by a single ring of tentacles. These capture the prey, swallow it, and proceed to digest it for the benefit of the entire community, passing it along through the system of underground tubes.

This is just as well, for the other two kinds of polyps possess no mouths or tentacles and are, therefore, dependent on the feeding polyps. The second series is specialized as reproductive polyps, bearing around their bodies grape-like clusters of medusa-buds. These never develop into free-swimming medusae like those of *Zanclea*, but remain attached, in partially developed condition. Ova and sperm are produced, however, and the former are fertilized *in situ*, giving rise to larvae from which new polyps are directly developed.

The third kind of polyp is the fighting or defensive polyp. It occurs abundantly along the edge of the snail-shell and around the margins of the colony. The individuals are long and slender. Their summits are equipped with spherical batteries of powerful sting-cells. These three kinds of polyps act together for the common good and also form a

Figure 8. *Two specimens of hermit crab* (Eupagurus longicarpus) *with a smaller individual "stealing a ride," photographed from life. Note the velvety surface on the shells of the larger crabs caused by colonies of the marine hydroid,* Hydractinia echinata, *which completely cover it. This hydroid colony comprises hundreds of individuals connected by a network of tubules penetrating the substance of the shell. Figure 9 shows a portion of this colony greatly magnified*

Fig. 8

partnership of mutual benefit with the hermit crab which wears them on its shell. The crab transports them from place to place, thus bringing them to new feeding grounds, where they profit by the minute creatures swimming in the water. The crab also tears to pieces larger prey, the fragments of which float up to form part of the food of the hydractinian colony. On the other hand, the fighting polyps not only act as defenders for their own community but also for the crab itself, because they aid in slaying the creatures on which it feeds.

Thus, two principles are introduced into the hydroid world. The first of these, polymorphism, involves the production within the same colony of different types of individuals specialized for different purposes but working for the common good of the colony on a coöperative basis. This is so successful among the lower organisms that we shall find in the floating colonies of the siphonophores it has been elaborated to a remarkable degree. If mankind were as successful in his coöperative schemes, we should have no difficulty in establishing an ideal Utopian form of government. Perhaps the lowly forms of life are more perfectly constituted for altruism.

The other principle referred to is that of copartnership with other unrelated species as, for example, the *Hydractinia* and hermit crab from such diverse groups as the Coelentera and Crustacea respectively. This phenomenon is usually referred to as commensalism, when the partnership involves sharing the same food.

Fig. 10

Figure 10. *A solitary marine hydroid* (Tubularia harrimani). *It does not bud to form colonies. Instead medusa-buds are produced which remain attached in bunches. They give rise sexually to fertilized eggs from which hatch free-swimming larvae to develop into new hydroids* (From Glass Model)

Figure 9. *Model showing section of hermit-crab shell* (see Figure 8) *greatly enlarged to show the specialized individuals making up the colony of* Hydractinia *growing on the shell. Three varieties of hydroid polyp are shown—feeding polyps, fighting polyps, and reproductive polyps. (See text for details)*

Fig. 9

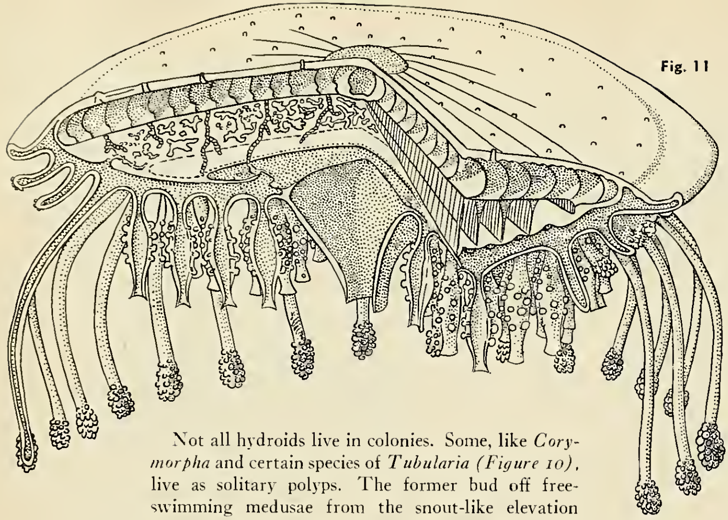


Fig. 11

Figure 11. *Diagram showing structure of the siphonophore,* Porpita (modified from Delage and Herouard). *This is a floating colony kept at the sea-surface by the complicated air-chambers of the central parent individual, the large mouth and stomach of which may be seen hanging down in the center. This is surrounded by several circlets of tube-shaped feeding individuals having mouths. Around the border of the colony are circlets of mouthless fighting polyps armed with sting-cells. The air-chambers are filled with a gas secreted by the parent polyp*

Not all hydroids live in colonies. Some, like *Corymorpha* and certain species of *Tubularia (Figure 10)*, live as solitary polyps. The former bud off free-swimming medusae from the snout-like elevation (manubrium) which terminates in the mouth. The latter produce medusa buds which never reach the stage of complete medusae and always remain attached. The *Corymorpha* medusae have beautifully delicate little umbrellas with a single tentacle attached. They give rise to sex-cells after becoming free-swimming. On the other hand, the *Tubularia* produce their sex-cells early and, as they are never free-swimming, they might almost be interpreted as sex-organs of the hydroid. It is thought by some that this is an initial evolutionary step toward the sex-organs of higher animals.

In other cases, like *Sarsia*, the medusa seems to acquire an unusual degree of importance, for after being detached from the hydroid instead of immediately producing eggs to be fertilized so as to develop a sexually formed larva, which in turn will become transformed into a hydroid, it starts budding off new medusae directly from its long pendent manubrium and these become free-swimming. So that a free-swimming medusa buds off free-swimming medusae directly. The latter, however, produce larvae sexually, and these become hydroids.

In some cases after such medusa buds reach a certain stage, they start to degenerate, losing their medusa-like organs, and finally become sporosacs, i.e., merely pear-shaped sacs from which ova and sperm are formed directly, the ultimate result paralleling the formation of similar gonads in hydroids. These are both instances in which the evenly developed alternation of generations becomes over-balanced in favor of either the hydroid or medusa generation, the alternating generation apparently becoming obliterated.

In some forms, as opposed to the condition in which the medusoid generation always remains attached to the hydroid, and is borne by it, there are certain species *(Phialidium)* in which the hydroid grows directly from the under side of the medusa-umbrella but always remains attached to it, being carried around by it from place to place. From this

Figure 12. *Model showing a colony of* Porpita *as it appears in life, slightly tilted to display the under surface. The colony is supported by a blue disk-shaped float about the size of a quarter, with the structure shown in Figure 11. The circlets of fighting polyps radiating from the margin have knob-like batteries of sting-cells at their extremities. Within may be seen the series of feeding polyps*

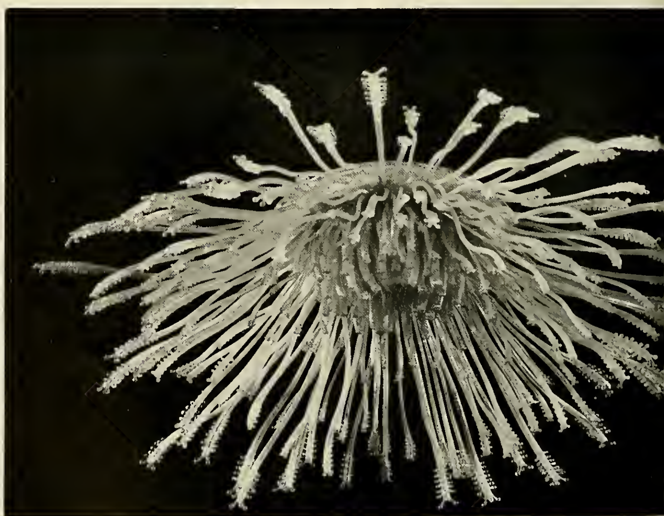


Fig. 12

passenger-hydroid, in turn, new medusae like its parent are budded asexually. So there are all possible stages grading from true alternation of generations in either direction, emphasizing the hydroid at the expense of the medusa, or the medusa at the expense of the hydroid.

On the medusoid side the ultimate result is found in the sub-family Trachylinae, consisting of beautiful medusae which have no hydroid stage whatsoever, giving rise to eggs which hatch out medusae like themselves without any intervening stage, with the result that alternation of generations is completely obliterated.

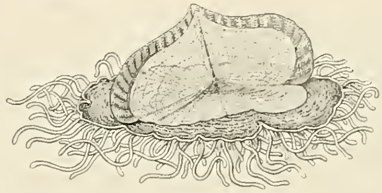
Perhaps the most remarkable specializations occur in that wonderful group of the Hydrozoa known as the Siphonophora. These are oceanic species that form floating and swimming colonies of many types of individuals specialized for diverse functions which operate for the common good. This reminds us of the feeding, fighting and reproductive individuals of the *Hydractinia* on the shell of the hermit crab, but in that case the members of the colony are anchored in the shell. The siphonophores, on the other hand, are floating colonies in which the members bud from an original floating mother-polyp that starts the colony. The best known of these floating cities are the Portuguese Man-of-War *(Physalia pelagica)* and its relatives *Velella* and *Porpita.*

Hundreds of other species belong to the group, comprising many diverse forms, involving so great a variety of complicated arrangements that it would be highly confusing to describe many of them, so our attention will be limited to a few of the most typical.

Imagine one of our medusae, as it swims about, acquiring a greatly expanded umbrella disk stiffened with concentric rows of air-chambers to aid in keeping it afloat, instead of depending on swimming by means of alternating pulsations of the disk. Suppose that circlets of polyps bud from the under side of the disk and hang down in ordered ranks arranged concentrically around the mouth and manubrium of the parent. This is the condition in the free-swimming hydroid colony known as *Porpita,* shown in Figures 11 and 12.

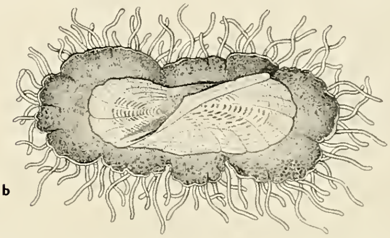
The multitudinous polyps hanging beneath it have assumed various differences in form and function. As shown in Figure 11 some look typically polyplike, having tubular or rather vase-shaped bodies with circular terminal mouths, surrounding the larger central mouth of the medusa. Around the base of each polyp are medusa buds in various stages of maturity. These are, therefore, the feeding and reproductive individuals of the colony. Surrounding them, and extending far beyond the edges of the disk, are ranks and ranks of long, slender club-

Fig. 13



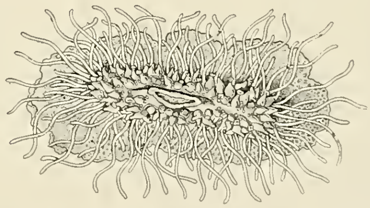
a

(Above) *Colony of* Velella *which resembles a small rectangular raft four or five inches in length. A peculiar sail-like structure is situated diagonally across the upper surface.* (These figures redrawn from Haeckel)



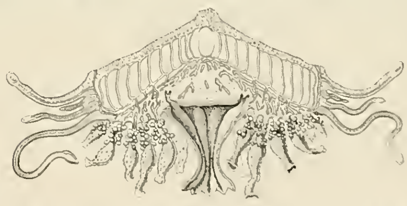
b

Upper surface of a colony showing the sail fore-shortened. The inner lighter portion is equipped with concentric air chambers. Fighting polyps project from underneath its border.



c

Under surface of the same colony showing the outer series of fighting polyps and the inner set of flask-shaped feeding polyps about the central slit-like mouth.



d

Vertical transverse section through the forward part of the float of Velella *showing the concentric air-chambers. Below are the various types of individuals described in the text. Reproductive gonads are visible around the bases of the feeding polyps* shaped polyps, with no mouths, but fringed with tassel-like batteries of sting-cells. These are the fighting polyps, having for their sole duty the capture and slaying of prey to be turned over to the feeding polyps. It is obvious that the fighting polyps, having no mouths, must depend on their neighbors for food, which is passed to them predigested through the internal connections with the main colony. While the feeding-reproductive polyps also have sting-cells, they are not developed to the degree seen in the fighting polyps. The living *Porpita* floats and swims in great schools in the warm waters of the Gulf Stream. Each colony is a little blue disk about the size of a quarter. They are quite abundant in the open sea off the southern New England coast during the summer, especially after a southeast gale brings in spurs of the Gulf Stream.

Closely related to them is another colonial siphonophore, *Velella,* which resembles a small rectangular raft about four or five inches in length *(Figure 13).* Like *Porpita,* the raft is kept afloat by a series of concentric air-chambers, of which the inner part of the raft is constructed, while an upright crest or keel is set diagonally along the upper side of the float and apparently acts as a sail. From underneath the raft an assemblage of polyps similar to those of *Porpita* extend down into the water, including a central feeding mouth and manubrium, while around it are arranged multitudinous pendent feeding and reproductive polyps. As in *Porpita* a fringe of fighting polyps stretches out into the sea on all sides.

The most remarkable of all this strange group of siphonophores is the Portuguese Man-of-War *(Physalia pelagica),* illustrated in Figure 14. A fleet of graceful iridescent bubbles gay with intense scarlet, green and violet dances on the summer sea. But streaming far down below the surface long tentacles of blue, bordered with bead-like batteries of the most powerful sting-cells known to exist among sea-creatures, trail along like death-dealing dredges,

Fig. 14

Figure 14. *The Portuguese Man-of-War* (Physalia pelagica) *is the largest and most spectacular of the Siphonophores.*

A certain species of fish (Nomeus gronovii) *swims, immune, among its powerful stinging tentacles. (Life size glass model in American Museum)*

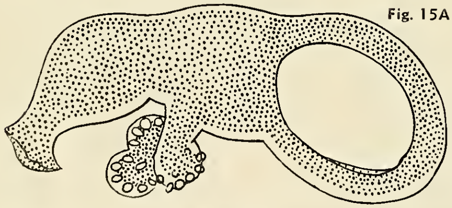


Fig. 15A

Figure 15A. *A newly hatched* Physalia *showing original polyp with open mouth and rear part of body secreting a bubble of gas. A single tentacle projects from below*

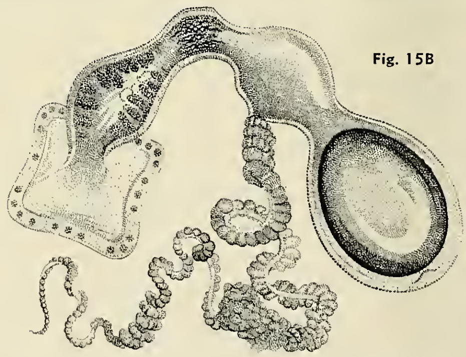


Fig. 15B

Figure 15B. *A later stage with expanded mouth, and longer and more fully developed stinging tentacle. The digestive cells show through the transparent walls of the tubular stomach* slaying fish and all other organisms that come in contact with them. The prey adheres to the strands of this net and is drawn up by their shortening threads until it comes in contact with the hundreds of hungry mouths stretched out by the azure polyps hanging from the common float. Green finger-like polyps of great sensitivity feel over the prey and soon its juices are absorbed by the feeding polyps.

Hanging among the other individuals composing the myriad clusters of this floating colony are finely branched bunches of reproductive individuals like little pompons, salmon-pink or white in color. These are developing medusae of two sorts, male and female. The female medusae reach maturity with perfectly formed umbrellas and become detached to swim away to produce their ova. The male medusae at the base of the cluster remain attached and do not develop the umbrella structure.

It is hard to realize that these floating colonies are not single animals, so beautifully are the different sorts of polyps composing them coördinated in their functions and activities. They are, nevertheless, colonies or cities of individual polyps each of which has come into existence as a bud from a single original polyp which hatched from the egg to start the colony. In the case of the Portuguese Man-of-War, the original polyp is the float. In its earliest stages this was a typical hydroid with open mouth and tube-like body which was able to float at the sea-surface by secreting an internal gas, lighter than water, at the extremity of its sac-like body *(Figures 15a, b)*. Shortly thereafter, the parent polyp began to bud off additional polyps with feeding mouths along one side of its external surface *(Figure 15c)*. These remained attached, thus forming a colony. The parent's body then became greatly inflated with gas, thus acting as a float to support the growing community, while the functions of feeding and digesting were delegated to the rapidly multiplying young polyps *(Figure 15d)*.

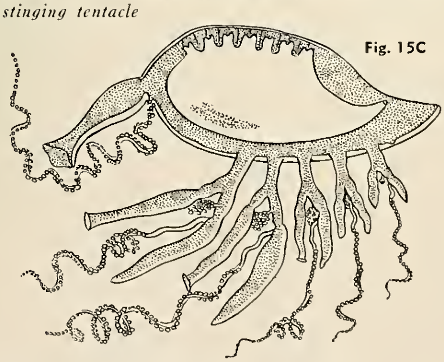
The secretion of the gas increased as the colony grew larger, so that the supporting power of the float kept pace with the demands made upon it. With each feeding-polyp a fighting or stinging individual budded forth. Some of these remained short, while others, with their powerful bead-like batteries of sting-cells forming a close-set border along their entire margin, elongated to extend for down into the depths of the sea, alternately stretching out to their full length and contracting in tightening coils to bring the captured prey close up within reach of the now multitudinous greedy mouths *(See Figure 14)*. By the time the sensitive palpons or feeling polyps and the clusters of reproductive gonads had matured, the Portuguese Man-of-War colony had greatly increased in size and weight, but was always adequately supported by the enlarged float.

This latter is a remarkable structure of great beauty. It is essentially a large thin-walled sac, eight to ten inches in length in adult specimens. In some individuals, its thin, translucent walls are brilliantly colored, with rich crimson and intense violet hues blending into each other imperceptibly. Others grade from red to bright green. It is boat-shaped, with pointed prow and stern, and somewhat resembling a medieval caravel, while its thin walls are equipped with flat, transparent muscle bands the contractions of which continually cause it to change its shape.

A chambered crest adorns its summit and the protean changes of its outline enable it to trim sail and head into the wind.

Small fishes are stung to death and captured by its tentacles, with the exception of one species, seen in Figure 14, the Portuguese Man-of-War Fish *(Nomeus gronovii)*, which is apparently immune; for it swims freely among the deadly appendages without injury. This seems to be a commensal association of benefit to both organisms, for it is said that the fish acts as a lure, attracting other species

Figure 15C (Below) *As the colony grows, new polyps bud forth in clusters, each of which includes a feeding polyp, a feeling polyp, a reproductive polyp and a long fighting polyp or stinging tentacle*



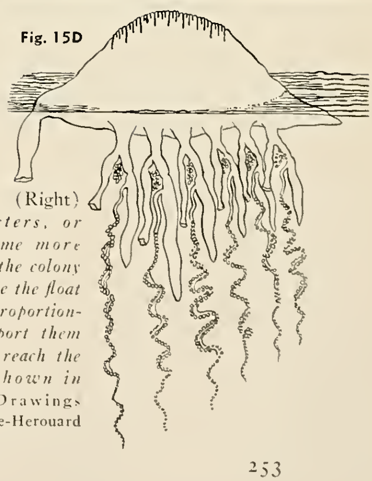


Figure 15D (Right) *These clusters, or corms, become more numerous as the colony matures, while the float increases proportionately to support them Finally they reach the condition shown in Figure 14* (Drawings after Delage-Herouard and Haeckel) to their doom, while in turn it is sheltered from its enemies and perhaps shares the results of the capture.

In siphonophores like *Circalia stephanoma (Figure 16)* the float is reduced to a terminal bulb which barely keeps the colony at the surface of the ocean. This species, however, is equipped with an additional series of polyps, the swimming bells, which are umbrella-like structures surrounding the float in a circle. By their rhythmic contractions they assist in keeping the community at the surface and propel it through the water. A circle of feeling polyps projects just below the swimming-bells, overhanging clusters of male and female reproductive individuals. A single large feeding polyp hangs downward from the center, and interspersed among the other structures are numerous small stinging tentacles. The most important aggressive organ is a huge, branched, stinging tentacle that extends far downward from one side of the colony to trail its deadly nettle-cells far below. Other forms related to this, such as *Nectalia loligo (Figure 17)*, have a double vertical series of swimming-bells below the diminutive float, while a set of protective "bracts" or covers hangs down to protect the underlying organs.

Still other species, among the endless varieties of forms composing this protean group, are without floats and depend entirely on swimming-bells to keep their colonies near the surface. In some cases a single swimming individual is sufficient for this purpose (Monophyidae), as shown in Figures 19a and b, while others have two bells, one below the other (Diphyidae), Figures 19c and 20. These colonies trail the other component members behind them in successive clusters attached to a long filament like a tail.

Each cluster (cormidium) is composed of a protective bract enfolding the base of a small group of individuals, including a feeding polyp, a feeling polyp, reproductive gonads, and a long branched stinging tentacle. Some of these are developed to an enormous extent, forming complicated colonies of great delicacy and beauty.

In this remarkable group of the hydroids, based upon the plan of a simple tubular polyp, Nature has evolved an infinite variety of species of all gradations of complexity, and in the process has solved certain basic principles, such as colony formation, alternation of generations, division of labor among specialized individuals, and the coöperation of different species for mutual advantage. These achievements attained in this lowly group have made possible the development of important features of structure and function in the evolution of the higher groups in the animal kingdom.

Fig. 16

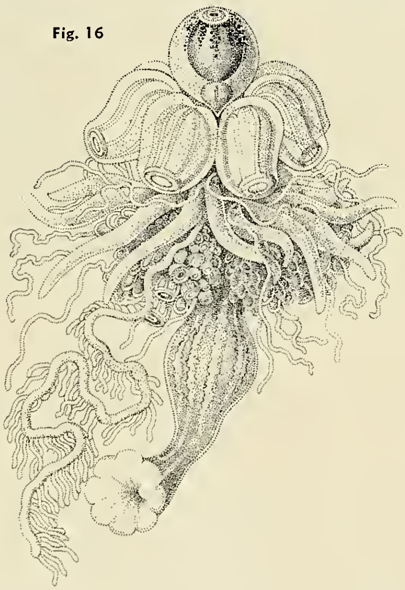


Fig. 17

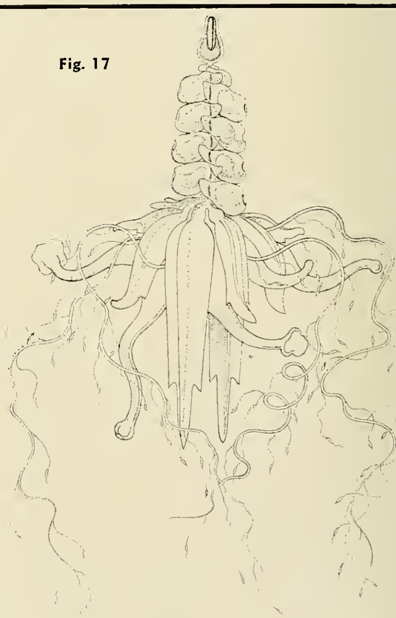


Figure 16. *In* Circalia stephanoma *the float is much reduced, but the colony swims by means of contractile "swimming bells"* (Redrawn from Haeckel)

Figure 17. Nectalia loligo *shows the float further reduced, while the swimming bells are more developed* (Redrawn from Haeckel)

Figure 18. Athoria larvalis, *with diminutive float, has bracts terminating in swimming bells to support its colony clustered around the single large feeding polyp* (Redrawn from Haeckel)

Figure 19. *In* Sphaeronectes (*a*) *and* Ersaea (*b*) *the float has disappeared. They swim by means of a single powerful contractile bell.* Diphyes (*c*) *has two such bells* (Redrawn from Mayer)

Figure 20. Diphyopsis *with two bells trails a magnificent series of corms each bearing a set of specialized individuals* (Redrawn from Haeckel)

Fig. 18

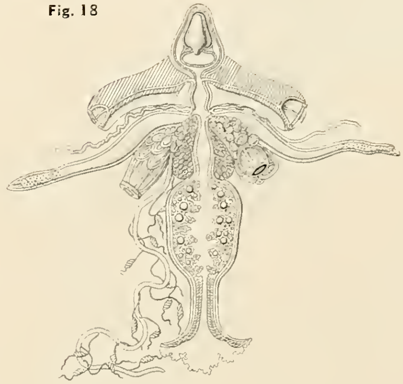
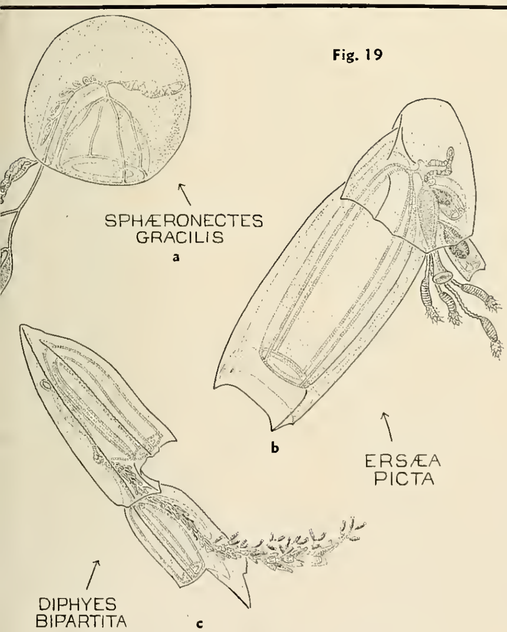


Fig. 20

DIPHYOPSIS
CAMPANULIFERA

Fig. 19



★ The Kingdom of Rei Bouba

BLACK

Deep in Africa's Cameroons a photographic expedition stares open-mouthed at a Bantu Monarch's retainers sporting chain mail, possibly a heritage of Crusaders that filtered 4000 miles southward during seven centuries

THE sun was setting, a red ball in the dust-ladened air. It was the middle of the dry season and the harmattan—the prevailing wind from the north—held, suspended in the hot air, countless millions of tons of powderlike sand, blown from the Great Sahara, a thousand miles to the north.

In disgust, after a day of unremitting attempts to get our safari across, we had made camp on the banks of a wide, sluggish stream.

For months we had pushed our slow way, ever southward, from the raw October gales of the Mediterranean at Algiers, our starting point, over the interminable, blistering, rolling sand dunes of the Great Western Erg; through the Hoggar Mountains of the mid-Sahara; wallowing through the swamps of Northern Nigeria, formed by the annual overflow of the bleak Lake Tchad; and, finally passed over the mountain barrier into the highlands of the North Cameroons.

In all the 4000 miles our cars and trucks had never faltered—though many were the days when twenty miles was the best our eleven native servants and ourselves could push and haul our motorized caravan over deep sand that, like a giant brake, retarded our progress; or through greasy black mud in which our wheels spun helplessly.

Here, however, we were faced with an even worse problem. Since early morning we had wracked our brains for a means of getting the heavy trucks over a river that was too deep to ford and yet not deep enough to float the impromptu raft made of native dug-out canoes if laden with the weight of a car.

On our way southward to the sea we had to cross the domains of the mighty Lamido Bouba Djamaha—king of Rei Bouba. For three days the drums in the last village had carried the message of our impending arrival to this absolute ruler of a nation of some 50,000 blacks. They had not failed to emphasize that we not only came in peace, but also that our presents were many and magnificent. After a delay that befitted his rank, the distant staccato rumble, relayed over 150 miles of park-like country brought the news that we would be welcome in his capital city.

This river, an unnamed tributary of the mighty Benué that joins the Niger in its march to the sea, formed the western frontier of Rei Bouba; while a wholly imaginary and unsurveyed line separated this African kingdom from French Equatorial Africa to the east. There was nothing for it. A bridge would have to be built.

A runner was sent back to the village; the drums again spoke through the night air; and as the morning mists rolled from the muddy river, 200 unclad, filed-toothed savages congregated in front of our main tent, drawn by the message that salt could be had for a day's labor.

Armed with our axes and their own primitive tools, several hundred trees six to eight inches in diameter were felled and cleared of branches. These were cut into six-foot lengths and driven into the soft ooze of the river's bottom. By early afternoon we had a bristling path of piles stretching from bank to bank. On this were laid first the heavier branches and finally vast quantities of thorn bush.

The light safari car was driven gingerly across. All went well. Then the trucks were off-loaded, and lurched drunkenly over the soggy matting of interlaced foliage. Finally the contents of the trucks

*Determined to make a photographic record in sound and color of Africa's least camera-hunted people, Lawrence and Margaret Thaw safaried 11,300 miles via auto trucks and light car through arid sands, treacherous swamps and lush jungle in a jagged diagonal from Algiers to Nairobi. In six months of adventurous travel, they succeeded in recording the weird cadence of savage voices and the primitive pantomime of many rituals, but they never beheld anything more amazing than the Black Knights of Rei Bouba. For all their adventures in lands rarely visited by westerners other than professional ethnologists and explorers, the Thaws are a fairly representative New York couple. This is the third extensive African expedition that Mr. and Mrs. Thaw have made together.

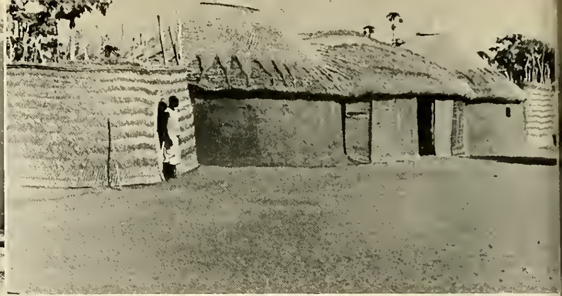
KNIGHTS

By LAWRENCE COPLEY THAW
and
MARGARET STOUT THAW*

Courtesy Metropolitan Museum of Art

(Above) A CAVALRYMAN *of Rei Bouba wearing the chain mail which makes these tribesmen in equatorial Africa one of the most fantastic military anachronisms to be seen anywhere in the world.*

(Left) *Selected because of its similarity to the chain mail worn by these Black Knights, this shirt is of 16th Century Turkish origin*



(Above left) Palace gate of an African monarch whose horsemen wear chain mail and other trappings, reminiscent of the days of the crusades. Admission to the presence of the Lamido of Rei Bouba, a rare experience for native and white man alike, was one of the most thrilling moments in Lawrence and Margaret Thaw's 11,300 mile safari

(Above) Guest quarters of the Thaws in this strange kingdom in the Cameroons, eight degrees from the equator

(Left) Half-naked palace slaves bearing the expedition's gifts to His Majesty. A grovelling posture and a wailing, terror-stricken voice are required of the Lamido's subjects in his presence

Antiquated quilted armor and peaked metal helmets recalling to mind the soldiers of Saladin make these black knights of Rei Bouba appear to have stepped out of a bygone age

(Right) Long bows reminding one of those that twanged in Robin Hood's Sherwood Forest were another military anachronism that strained the Thaw's credulity in this equatorial African monarchy. A quiver for arrows is carried on the back, but the traditional woodland green of the archer's costume gives way to a leopard skin cape and barbaric colors

Only once or twice a year does the monarch Bouba Djamaha *(below)* appear in public; but he consented to hold a gala regimental review in honor of his guests. Swathed from head to foot in spotless white, his 300 pounds were heaved aloft in a huge sedan chair and toted about by 20 sweating subjects amidst a sea of spears.

That the Thaw party boasted a harem of only one (Mrs. Thaw), puzzled the Lamido. How did the expedition ever get its heavy work done, he wondered

On location for the Thaw's camera battery were foot soldiers, cavalrymen, spear throwers and archers, marching by in serried ranks as varied in trappings as the tradition-steeped regiments of a middle European principality. Particularly the chain armor worn by many of these black knights *(see title-page photograph)* makes them appear thoroughly out of date and out of place in equatorial Africa. Although the primitive African can smelt iron he is ignorant of steel-making and certainly far short of the skill required to make shirts of closely woven mail. How these relics could have filtered down to a Bantu tribe of black men over a long period is an unanswered riddle. In far-off China and Japan, chain mail of oriental design and manufacture was used for ceremonial purposes up to the 19th century. In certain Arab communities its use has been reported even more recently, as well as in the region of the Caucasus Mountains north of Persia. But the kingdom of Rei Bouba in equatorial Africa is perhaps the only location where this curious military anachronism is in evidence today

More in character were the huge rhinoceros skin shields *(below)* borne by the Lamido's trusty spear throwers; yet these were decorated curiously with pendants of iron, and the weapons, including many swords, differed from those found among neighboring tribes.

(Above) Rei Bouba on parade. The king of kings for thousands of blacks contemplates their display of might in the form of proudly brandished obsolete armor and weapons. Most astonishing to him was the "hardwater that burned the hand" which the Thaws produced from their portable refrigerator

As if further to scramble fashions and traditions already confusing enough to send anthropologists dithering back to the coast, the Thaws included French curassiers' uniforms in their gifts to the Lamido. His Majesty's horsemen promptly clapped this latest adornment on their wooly heads and perched themselves in blissful anachronism on steeds accustomed to quilted armor. Several thousand of the Lamido's troops, resplendent in regalia both ancient and barbaric, marched in the grand parade in honor of the visitors

BLACK KNIGHTS

THE POPULACE went wild at the festivities for which the Lamido declared a holiday. Medieval pageantry blended dissonantly with primitive jubilation, as tomtoms and weird trumpets made the huge square resound with a hideous din. The young man blowing a horn *(in the foreground)* set the pace for the occasion by sending out his soul in a supine solo

STRING, BRASS, AND PERCUSSION instruments in full play at Rei Bouba look better than they sound, according to the Thaws. Mass hysteria destroyed all attempt at harmony in the nerve-shattering ovation for the Lamido's first public appearance in many a moon. Our own method, a confetti snowfall along Fifth Avenue, may be harder on the clean-up corps but it is easier on the spectators

(Left) A SAVAGE DANCE perpetrated by the archers provided the finale to the afternoon and in some measure to the Thaw's visit. Music by Bouba's court troubadors was recorded and to their delight played back at them from the records. The expedition could scarcely move with the gifts that the hospitable Lamido presented to the Thaws, and they left convinced that in all Africa they could behold nothing more amazing than the Black Knights of Rei Bouba

were carried over on the heads of our indefatigable crew. Tents were pitched, fires built, our cannibalistic helpers given their salt, and with a sigh of relief we settled ourselves for a well-earned meal and rest.

Early the next morning, we continued our way, following a faint track that led ever onward through a rolling country of scrub trees and thorn bush. We had traveled about a hundred miles when we ran across a small herd of kob. We needed meat, so Mrs. Thaw shot one, directly in front of the car; and the echoes of the shot had no sooner died away than, riding up the faint trail, directly in the line of fire, came four horsemen.

"Medieval" escorts

We rubbed our eyes! It was as though we had been transported back to the Middle Ages; for, galloping toward us were four medieval knights in chain mail, each armed with an enormous spear. By means of signs they conveyed to us that they were to be our escort; and, forming themselves about the safari car, led us over the brow of a small hill.

At its crest we could see, less than a mile away, a large town, surrounded by a mud wall in which were strategically located a dozen or more thatched-roof gates. Toward the nearest of these our anachronistic guides escorted us. We entered, and our convoy was immediately swallowed in a vertical maze of twisting narrow streets, lined on either side with huts and compounds made of remarkably woven grass. After a seemingly interminable period of twisting and turning, during which our bulging trucks experienced grave difficulty in negotiating some of the sharper turns and threatened the flimsy structures with destruction, we debouched into a huge square.

One entire side of this open space was formed by a 20-foot wall, in the center of which was an elaborate gate of grass matting of obviously superior workmanship. At this gate, guarded by more medieval knights, we stopped. Our interpreter, whom we had picked up a week before and who spoke what he fondly believed was French, informed us that we were at the entrance to the Palace of that puissant Prince, the Lamido. All that was lacking was a moat, drawbridge and portcullis.

Mr. Thaw ordered our boys to unload the gifts which we had brought the Lamido and to follow us in with them, but was immediately restrained from this course by exclamations of horror from the interpreter and the threatening gestures of the palace guards. It was quickly explained to us that none of our boys would be allowed in the Presence. They seemed not at all averse to passing their burdens over to the Lamido's palace slaves; in fact, having been imported by us from the East Coast at the start of our trip, and being three thousand miles from their own country and language, they had evinced not a few signs of uneasiness since we had entered this strange land of sword and armor.

Preceded by the interpreter, who first divested himself of all his clothing except a loin cloth, and followed by a dozen of the already nearly naked palace slaves, we passed through the gate and entered a large compound, at the further end of which stood a large grass hut.

As we approached the hut, the interpreter and all the blacks bent themselves double; and, as we reached the door, the interpreter prostrated himself on hard-packed earth before the gloomy interior. In a voice that literally wailed with fear (we later learned that this terror-stricken tone was "de rigeur" when addressing His Majesty), he gabbled unintelligibly for several seconds. There was an answering boom from within the hut; and our interpreter, without raising his head from the earth, motioned us to enter.

A 300-pound potentate

With a tingle along our spines we did so; and, as our eyes became accustomed to the twilight of the interior, we found ourselves in the presence of a perfectly enormous black. At least we assumed he was black, for all we could see were his piercing eyes. He was completely swathed, from head to foot, in voluminous white robes. On his head was a white turban, while his face, evidently aping the Touaregs a thousand miles to the north, was covered with a white cloth. As we entered he rose. He must have been a good seven feet tall and weighed easily three hundred pounds!

His introductory speech was long and boomed from his mighty chest like the sound of one of the great war drums. The interpreter was so stricken with fear as to be utterly useless. We replied in English and French (it might as well have been Chinese for all he understood) and we could see his keen eyes darting covetously out through the doorway to where his slaves waited with our presents. We gathered from his tone that we were welcome in his domains and we tried to impress on him, in return, our pleasure at being there.

At a gesture the slaves advanced, cringing, and laid our gifts at his feet. We gave him four French firemen's helmets; four old French curassier's helmets and breastplates; several swords; cheap jewelry for his many wives; flashlights; and last, but by no

Continued on page 309

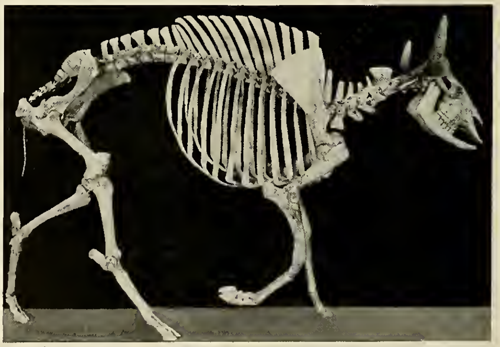
Drawing by John C. Germann

Mount by Charles Lang

TOWERING 6 feet 6 inches at the shoulder, this relative of our cattle is larger than any other member of its family. The modern gaur lives in dense country in southeastern Asia, is rarely seen except by those who hunt it

(Left and below) THE BONES that would have been eaten if Doctor Granger had not rescued them from the Chinese drug merchants. Innumerable priceless skeletons have been ground up in drug shops during the centuries these merchants have been exploring for "dragon bones." But to them science owes its knowledge of the fossil mammals of China, for many specimens might not otherwise have been found

AMNH Photos



MEDICINE BONES

The story of a prehistoric animal which the American Museum rescued from the drug shops of China, where every pharmacist is a fossil hunter and every fossil a dragon

(Left) The million-year-old gaur, largest known bovid, pictured in its early Pleistocene setting. *(Below)* The same region today, showing the temple or ancestral hall where the author lived while excavating "dragon bone" ridge *(in background)*

Photo by Walter Granger

By Walter Granger
Curator of Fossil Mammals, American Museum of Natural History

There has recently been mounted in the laboratory of the Department of Palaeontology a specimen of more than ordinary interest. This is a skeleton of the great gaur from early Pleistocene deposits of Western China. The gaurs still survive in Southeastern Asia and are the largest members of the family Bovidae, which includes, besides the cattle, all of the even-toed hoofed animals—the antelope, deer, sheep, goats, camels and others. Since this fossil gaur is considerably larger than the living species it becomes the last word in bovids, standing six feet six inches high at the shoulder.

Today these great animals are found living in Southern India, where they are erroneously called "bison," and in Burma, Siam, Malay Penninsula and Indo China where they are known as seladang. They are mostly creatures of the dense forest and not frequently seen except by those who hunt them. The gaur group in the Vernay-Faunthorpe Hall represents a scene in South-Central India where the animals occasionally come out into the open in passing from one wooded area to another.

In addition to being the largest known member of its family this fossil skeleton has another distinction—that of having been rescued from the medicine shops of China. To the Chinese the bones and teeth of fossil animals are known as dragon bones and dragon teeth, "lung ku" and "lung ya," and have been articles of the Chinese pharmacopœia for hundreds of years. A treatise on medicines written during the reign of the Emperor Ch'ien Lung describes the different kinds of dragon bones and gives a long list of human ailments for which the bones, teeth or horns are considered a specific. Also the different ways of taking this medicine are given. The bones may be soaked in hot or cold rice wine and the wine drunk off, or they may be powdered and taken dry or fried in fat. Teeth are considered more effective than the bones. Concerning the origin of the dragon bones, this author states that "they constitute the remains of those dragons which, lacking rain and clouds, were not able to fly up to Heaven." Another legend which I have heard from the modern "lung ku" diggers is that these are not the bones of dragons which actually lived at one time but that they are formed after the likeness of dragons in the earth where they are found. This belief in the efficacy of dragon bones as medicine is deep-seated with the Chinese. The introduction of modern medicine into China has not yet obliterated this superstition. The digging of dragon bones still goes on, and the native pharmacies throughout China still sell them. They can even be purchased in the drug stores of New York's Chinatown.

To many of us this use of fossil bones as medicine, like that of the velvet antlers of the Sambur deer, the scales of the pangolin, the horns of the rhinoceros and the dung of bats, seems ridiculous. Yet if we look at it in the proper perspective we may reasonably assume that they are no less effective, although perhaps less palatable, than some of the patent medicines which have made millionaires of their proprietors here in our own country.

At any rate the palaeontologist is grateful for this dragon bone superstition, because it has been the means of leading him to the localities in China where fossils occur. Some of these localities would eventually have been discovered in the process of scientific search, but others would probably never have been found. Of course, the gratitude of the palaeontologist is tempered somewhat by the abhorrent thought of all the priceless skulls and skeletons which have been ground up in the drug shops. Still, what has been eaten has been eaten and after all, nature, with her erosion of fossiliferous strata, has ground up more specimens than even the most populous race of humans could possibly have done.

It is interesting to note that our first considerable knowledge of the fossil mammals of China was based on a large collection of teeth and jaw fragments obtained from apothecary shops throughout China. These were collected in about 1900 by a German scientist, Doctor Harberer, and reported on by Doctor Schlosser of Munich. The great disadvantage in this entirely novel method of fossil collecting was that the collector could not get satisfactory information as to where the fossils had been found and so was forced to guess at the geologic age and the faunal groupings of the species represented. It was not until nearly 20 years later, when geologists and palaeontologists began to locate the actual deposits, that our knowledge of Chinese fossil faunas was put on a firm basis.

The location of one such deposit fell to my lot and this became my first Chinese venture after arriving in Peking in 1921 as a member of the Central Asiatic Expedition. Information had reached us through a British Consul on the Upper Yangtze River that quantities of fossil bones were being brought down by wholesale drug merchants to the river at Wanhsien in Eastern Szechwan Province, well above the Yangtze Gorges. The Consul had even obtained the name of the little village, Yenchingkou, near which the dragon bones were being excavated. Getting precise information about anything in China is difficult, but this seemed authentic and so, with an interpreter and a few Peking servants and assistants, I set out for Yenchingkou, which was found to be located 20 miles from the city of Wanhsien. It could be reached by journeying ten miles up the Yangtze and then ten miles inland on the south bank. The little hamlet lay at the base of a massive limestone ridge rising 1700 feet above and extending to the westward for nearly 50 miles, running parallel with the river. The dragon bones, I was told upon arrival in the village, came from the top of this ridge.

I had seen some of the bones in the shop of a wholesale dealer in Wanhsien and had already determined the fauna as being Pliocence or early Pleistocene. To an experienced fossil collector the occurrence of fossils of this age on top of a Palaeozoic limestone ridge seemed fantastic and yet, as I found the next day after my arrival, that was exactly where they were.

We established headquarters in Yenchingkou or "Salt Well Valley," and moved into the only suitable place, the village temple or ancestral hall. This became our home for the ensuing five months and also for the winter season on two subsequent visits. The traveler in the interior of China, if he has his own menage with him, finds the numerous temples much better stopping places than the dirty, noisy, vermin-infested inns. The people of the village were always glad to have us occupy this temple because our presence gave a degree of immunity against occasional seizure by the soldiers. Also, I paid a dollar and a half a month rent for the place! I suspect, too, that we afforded a good deal of entertainment for the villagers since, previous to my arrival, only two or three foreigners had ever passed through the place and none had stopped long enough to be looked over satisfactorily.

The conditions which we found on top of the dragon bone ridge were most unusual. It seems that in early Pleistocene times numerous shafts or pits had been sunk into the rock by the dissolving action of surface waters on the softer spots in the limestone. Vertical caves they might properly be called. These shafts had no great diameter but some had been dissolved out to a depth of 50 feet or more and during this time they had acted as traps for the animals living along the ridge. Many animals undoubtedly fell into the pits and were killed. Others died on the surface and their bones gravitated into the pits. Eventually this process of pit forming seems to have ceased or at least slowed down and the pits began to fill up with the soil and débris from the top. Today they are found filled to the

(*Right, background*) "DRAGON BONE" RIDGE. Remotely situated above the Gorges of the Yangtze where no white man had previously passed the winter, this section had long been the stamping ground of Chinese pharmaceutical fossil hunters. The fossils come from the top of the limestone ridge, 1700 feet above the valley

All photographs by Walter Granger

(*Left*) THE TOP OF "DRAGON BONE" RIDGE is pock-marked with shallow sink-holes, into which surface water drains. What little arable land there is between the bare limestone is highly cultivated

(*Left*) A MODERN PIT, or sink-hole, 40 or 50 feet deep, similar to the one into which our fossil gaur fell, possibly as much as a million years ago. The brink is masked by vegetation, making it still effective as a trap for unwary animals.

The pits from which the fossil bones are excavated were formed apparently early in Pleistocene times by the action of surface water on the softer spots in the limestone. Into these shafts the prehistoric animals fell and were covered by débris

SEVERAL PITS which have been worked out and abandoned may be seen in the photograph at left. A large one over 100 feet deep which had produced many tons of "dragon bones" is visible at right center

(Above) IN SUCH MUD-WALLED, grass-thatched farm houses as this the "dragon bones" are stored after excavation and laid out to dry. Later a cleaning bee is held at which all hands gather and scrape bones

(Left) SEVERAL THOUSAND POUNDS of fossil bones from the pits accumulated by a wholesale drug merchant and awaiting distribution. Elephant tusks and rhinoceros and gaur bones can be made out in the pile

(Left, below) THE PATH up the steep slope of "dragon bone" ridge. *(Below)* Women and children exercising their privilege of working over the dump and keeping such small skulls or bits as are discarded or overlooked by the workers

(Above) A PIT IN FULL WORKING ORDER, showing the scoop-shaped baskets which bring up the mud and bones. This pit yielded many bones of the small proboscidean, *Stegodon.*

This strange fossil-collecting industry is carried on by the farmers in the fall of the year after their crops are harvested. In competition with the drug merchants who travel up and down the ridge several times each winter, Doctor Granger was able to buy the specimens at about nine cents a pound

(Below) AN EXPEDITION PARTY returning to Yenchingkou from a several days' trip along the top of "dragon bone" ridge. The three forward coolies are loaded with camp equipment; the other three are carrying baskets filled with choice fossils picked up at the various pits encountered along the way

(Below) THE WINTER'S COLLECTION of fossils, stored in the hold of this junk, is on its way down through the Yangtze Gorges to Ichang. The huge fossil gaur and his companions of Pleistocene times are on their way to the museum exhibition case—instead of down the throats of ailing Chinese

surface, with the bones of this early Pleistocene fauna buried at varying depths, usually more than 20 feet. A few open pits may be observed along the ridge today which are in the process of deepening and are undoubtedly acting as traps for unwary animals, so it is not difficult to visualize conditions existing in earlier times.

Into such a pit our gaur fell several hundred thousand years ago. He fell at least 30 feet and his bones were finally buried to that depth by the gradually accumulating surface drift.

As associates of the gaur in this region there was an interesting variety of animals. The largest of these was the proboscidean *Stegodon*. Then there was a large rhinoceros, a giant tapir, deer of several species, hyenas, a tiger, a giant panda and numerous smaller forms of carnivores, monkeys and rodents. Some of these animals have close relatives living along the ridge today, others such as the rhinoceros, the hyena, and the gaur, have relatives living today but in remote regions; while two, the *Stegodon* and a clawed ungulate or chalicothere, seem to have been the very last representatives of their respective families.

It would be interesting to know just how the Chinese discovered that there were fossil bones deep down in these pits. Possibly it was in an attempt to dig a well. Somehow or other, however, they did find them and having once encountered them and observing that they were different from modern bone and especially noting that they adhered to the tongue, which is the test for genuine dragon bones, they realized that they had something of commercial value. For at least 50 years now the digging has been going on continuously.

The excavation is done entirely by farmers who live along the top of the ridge and eke out a precarious existence in summer by tilling the soil between the exposed rocks. In the fall of the year, after their crops are harvested, several farmers will group together into a little company and set out in search of a pit. Having located a pit by studying the surface carefully, the excavation work begins. There is no way of telling from the surface how deep the pit is and frequently the diggers draw a blank—a shallow pit with no bones. But sooner or later they will locate a deep one, and after digging down too far to throw the mud up by hand they will rig up a crude pulley over the pit and by means of a bamboo rope and bamboo baskets will continue the excavation. When the bones are finally encountered they are hacked out of the mud with a short handled native adze, and hauled to the surface. At the end of the day the accumulated bones are taken to a nearby farmhouse and spread out to dry. Later on a cleaning bee will be held and all hands will gather at the farm and spend the day scraping the bones clean of the adhering earth. After this the bones are thrown into a pile in a corner, ready for the wholesale merchants who travel up and down the ridge several times each winter.

Here again was a novel kind of collecting quite unlike anything I had experienced before. My task was to keep track, so far as possible, of all pits along the ridge that were being worked and yielding fossils. This necessitated my climbing to the top of the ridge nearly every day or sending one or two of my boys up, so that we might be at the mouth of the pit as the bones were brought up and pick out the choice specimens before any further damage was done to them. Frequently though, a pit at some distance would be worked out and the bones dried or even cleaned before I would learn of it. There was nothing to do then but to go to the farmhouse and there, with the aid of a flashlight perhaps, root about in the attic or under the family bed or wherever the bones were stored, and rake out the precious skulls and jaws.

Since I was rather choosey in picking out the specimens, and being a foreigner besides, I naturally had to pay more for my specimens than the wholesale drug merchant would pay. My average price was about nine cents a pound, to which I would add a bonus if the workmen would excavate the skulls with special care and not attempt to clean them. I found toward the end of the first season that I was not at all popular with the Wanhsien drug merchants.

The pit which yielded the gaur skeleton had been entirely excavated before I reached Yenchingkou the second season. I was shown the abandoned pit and then taken to the nearby farm land where the bones had been laid out to dry. I recognized at once that here was an almost complete skeleton in fine preservation and not too badly broken up in the excavation. We gathered it all up, had it weighed and paid for it. Then I informed the owners that two of the long foot bones were missing, also one upper leg bone and one half of the lower jaw. They assured us that there was nothing more, but the next day all but one of these bones appeared, brought in from neighboring farmhouses. Also there was a basketful of broken bits brought in by children. These were worth only a small sum per catty* to them, but to me they were extremely valuable because they helped to complete the broken ribs and vertebrae. In the laboratory last winter we spent many days fitting this basketful of fragments back

*A weight of the East Indies, China, etc., commonly equal to about (in China by treaty, exactly) 1⅓ lbs.

where they belonged, and in the end only a handful was left that could not be placed.

Of all the hundreds of specimens obtained during the three seasons spent here, this was the only one complete enough to mount as a skeleton. Undoubtedly many complete skeletons were excavated during our time there, but this was the only instance where we could isolate the bones as belonging to one individual. When I suggested that I or one of my boys should go down into the pits to assist in the excavation work, it always met with stern disapproval. It was just one of the things that wasn't done and so we early abandoned this idea.

With the arrival of warm weather in early March, the thoughts of the dragon bone diggers gradually drifted away from the pits and back to the land, because the Chinese are, above everything else, farmers, and the raising of food is their most important task. At about the same time our own thoughts began to drift back to our headquarters compound in Peking and to the summer's work in Mongolia. And so after a round of feasting among our well-to-do farmer friends, our temple court would one morning be found swarming with carrying coolies sorting out our camp equipment and specimens, and adjusting their loads. Then to the accompaniment of firecrackers carried on a long pole by a villager, our column would pass through the little hamlet and down the ten-mile trail to the river. From here a ten-mile drift down the river in a sampan brought us to Wanhsien, where our equipment and accumulated winter's collection would be loaded aboard a chartered junk and we would begin the long, exciting and perilous journey down through the Yangtze Gorges to Ichang. From Ichang a river steamer to Hankow and a rail journey to Peking brought our winter's work to a close.

Undoubtedly each winter since our last visit to Yenchingkou there have been tons of choice fossils excavated from the pits there, and in the absence of a scientific collector on the spot they have all gone the usual way. Our three seasons did give us an insight into this interesting fauna, and our great collection of Asiatic fossils was much enriched; but here as elsewhere in China it will not be until science replaces superstition that fossils will cease to be merely "dragon bones" and become museum specimens that help to tell the story of the history of life on the earth.

(Above) THE MODERN GAUR, as seen in the American Museum's Vernay-Faunthorp Hall, representing a scene in South Central India. The animal is also found in Burma, Siam, the Malay Peninsula and Indo China, where it is known as the seladang. Though the living gaur is the tallest and perhaps the heaviest of all living bovids, his fossil ancestor was considerably larger

FRESHMAN YEAR IN AFRICA—*With Harry Snyder, already well known to* NATURAL HISTORY *readers, a seasoned comrade of the North American game fields tells his first story of wildest Africa*

By GEORGE G. GOODWIN
Assistant Curator, Mammalogy
American Museum

SO MUCH has been done to discredit the terrors and wonders that once were ascribed to Africa that I, for one, really expected to find it quite an ordinary sort of place. I knew that the thrilling adventures so vividly told give an altogether wrong impression and are to be discounted at least fifty per cent. The vast jungles shrouded with interlocking vines, with beasts of prey lurking to spring from every dark corner, the deadly snakes and poisonous vines lining the forest trails, and the black natives dancing with painted bodies around their fires—all these I knew was mere childhood fancy. I expected a reasonable amount of game in a land perfectly safe though probably infested with insect pests. No one ever made a greater error.

Where fancy becomes fact

In this great continent with its endless miles of uninhabited country one finds deep tropical jungles, rain forests with hanging vines and lichens, myriads of singing beetles, croaking frogs; sandy deserts, dust plains, beautiful lakes, rugged mountain peaks and ridges; native people living in primitive conditions, their faces not only painted but often deeply scarred, and game in the tens of thousands; rhinoceros charging without the least provocation, elephants that can crush out the life of man instantly, deadly snakes, red and green cobra that lift their weird heads and sway to and fro giving warning to approach no nearer, great fat puffy adders six or seven feet long, with bodies as thick as a man's arm and capable of inflicting almost instantaneous death. This is the Africa that can be found if one wants to look for it. The beaten path, on the other hand, can be as safe as the American Middle West.

I left New York on the *Queen Mary* for England. Our tents, specially built for the trip, were 9 x 12, with a floor and netted front, back, sides, zipper-fastened down the front. This insured us against stray snakes, and we were perfectly free from all flies and insect pests. A 25-horsepower outboard motor, films, cameras, guns, ammunition, and a collecting outfit were all we took from New York. The safari outfit was procured in Nairobi.

Transferring the baggage to the *Llangibby Castle* at Southampton, I joined the boat at Marseilles on March 24. Stopping at Genoa, I sailed down the Italian coast, and saw Strombali erupting during the dark hours of the night.

A day in Egypt

At Port Said I learned that I could motor to Cairo and join the boat again at Suez. This seemed a good opportunity to try out my motion picture camera in the bright African sun. The purser said I would have no difficulty in getting pictures of the Pyramids. When I left the boat about 7 p. m. the customs officer took one look at the camera, immediately called up headquarters, and very reproachfully informed me that I ought to know better than to try and smuggle a 35 mm. camera into Egypt. Did I think they were so stupid that it could possibly get through without being seen. When I replied that such was not my intention, he inferred that I was slightly crazy, and politely but firmly insisted that I return to the boat. After a little talk, however, he got the chief inspector and after considerable argument and a solemn oath that I would take no "bad" pictures, I loaded my camera onto a car and started for Cairo. Every ten miles or so the car was held up and searched by soldiers. My camera I passed as a suitcase. Evidently there is one thing that is definitely prohibited in Egypt—a standard motion picture camera. I arrived in Cairo at 2 a. m. and at Shepherds Hotel had a few hours sleep which was troubled by ghastly dreams of Arabs pursuing me with knives.

The next morning the taxi driver refused to transport me to the Pyramids when he saw my camera, but a persistent dragoman eventually found one who would obey orders and ask no questions. At the Pyramids I had to leave the car and mount a camel and got well by the guards before they saw my camera. I was promptly ejected from the grounds. Arguments and persuasion were of no avail. Returning to Cairo, I saw various officials but could make no headway. At noon I made a second attempt to enter the Pyramid grounds, and the chief officer at the guard-gate, realizing that I was not going to be easily put off, eventually permitted me to pass but refused to assume any responsibility. After a half hour in the torrid heat I got a fair general picture of the Sphinx and Pyramids, when the guards, in white, flowing robes, realized what I was doing and demanded to see my permit. Having about all the pictures I wanted and as things seemed to be getting rather hot, I started to make my exit but was stopped at the entrance by inspectors who wanted the exposed film. My chauffeur stepped on the gas but apparently being a little nervous he gave it too much and the car stalled, but we were well away before they could catch up with us. The chauffeur drove all the way across the desert from Cairo at a speed little under 70 miles an hour. There was no sense of security until the film was safely deposited on the boat at Suez.

At Mombasa Mr. J. A. Hunter met me at the boat. Our baggage was rushed through the customs and put on the train that evening for Nairobi, where we arrived the following day. Safariland Ltd. had our outfit well under way, and four or five days later we were out in the field.

Off for elephants

Our first camp was pitched on a flat at Masanga across the river from Voi. The Voi River is a small muddy stream that overflows its banks during the rainy season; but fortunately the rains had failed here and it was relatively dry, with few mosquitoes. Fever is usually prevalent here during the rainy season and most of the white population seemed to have it frequently. We had heard that there were some big tuskers in this vicinity which eventually proved to be moderate sized animals, with 60- or 75-pound tusks. Along the Voi River we saw many brilliantly colored birds, various species of snakes, mostly poisonous, and big iguana. On one large red ant-hill I saw a big python which slid down a hole when I approached, and I could hear its long body coiling back and forth in the maze of holes in the ant-hill.

We spent two days here getting information on elephant. We hired an additional 30 colored boys to cut trails, and elephant scouts were sent about 70 miles to the southeast into forested country where few, if any, white men had been before. Our plan was to make camp at Pika-Pika, a group of small rocky hills surrounded by flat thorn country, but our scouts apparently had not found any elephant here and we moved farther on into the jungle. Soon we began to see game. The first animal I saw was a lesser kudu that struck across our trail like a flash. Later we saw congonie, oryx, impalla, zebra, wart-hog, dik-dik, and giraffe.

Before leaving the States I was questioned as to the gait of the giraffe, and so I observed this especially. Having watched several hundred of them in motion, I can now say definitely that the giraffe paces. Once in a while it seems to break into a trot, but not for long.

Toward evening we arrived ahead of the outfit at Kilabasi, a rocky mountain ridge covered with loose rock and dense tropical foliage. We pitched camp in the foothills about a mile from a native village, and here we awaited reports from the scouts, who were apparently somewhere in the vast jungle that spread out on all sides. Round potholes eroded in the rocks from one to ten feet in diameter were full of fresh rain water. In some, beautiful blue water lilies and other tropical aquatic plants were growing; and brilliantly colored snakes were common.

A native village

The next day I followed the trail from the water-holes to the native village. There were about 30 persons in all, living in relatively primitive conditions in five thatched huts. Both men and women were perfect examples of physical development. The men usually wore some kind of cloth sheet around their shoulders, the women a kilt made of cloth cut into ribbons. They were somewhat timid but friendly, and when they found that we meant no harm, they regularly visited camp. The rather charming and aristocratic-looking chief went so far as to offer us a sheep from his small herd of animals and seemed a little hurt because I would not deprive him of his small wealth. These natives hunt quite a bit with poison arrows. This practice, of course, is now forbidden by law, and they were somewhat sceptical at first about letting me see their bows and arrows, but when they knew that I would not report their activities they even shot some arrows for me. They are not wanton killers, but being natives and the original owners probably feel that they are entitled to the few animals they can get for a living.

The elephant scouts returned and reported tracks of a big bull about six miles from camp. John Hunter and I went to investigate and saw the spoor of what to my mind was an enormous bull. The trail was not more than a day old and apparently going directly from camp. We followed it for several miles in the moist, sweltering heat, and the scouts advanced, while the natives cut a trail ahead for us. For three days we kept this up; then the scouts returned in great haste and reported a big bull with tusks that would tip the scales at 130 pounds. They were eager to get this animal, but inasmuch as Harry Snyder would not arrive for a few days we returned to camp. Instead, the scouts having reported that there were some sable antelope about 30 miles to the south of camp, a gang was put to work cutting a lorry route in this direction.

Meeting an enormous tusker

Hunter returned to Nairobi to meet Harry Snyder, and I was left in camp with about 60 colored boys to continue the road cutting and keep track of the elephant. Three days later I received word by radio to meet Harry, Sandy Macnab, and the white hunters at Mackinnon Road Siding about 60 miles away at 5 a. m. We all arrived back at camp later that day, and the next morning the guides we had sent out the night before returned stating that there were two elephants instead of one. They had left two scouts in the bush as markers. Following their trail for about ten miles we came to the first scout, and some five miles away found the second. Apparently something had gone wrong. The elephants had got their wind and had gone at a gallop. We tracked them for a long distance, and they seemed to separate frequently and come together again. After a while they slowed down, and one lagged behind; and we unknowingly passed within 20 feet of the beast secreted in a patch of thick thorn bushes. Apparently he had suspected something was following and had circled around to see. Shortly after this we saw through the thorn-trees what looked at first like a small, red hill, and it was some time before I could realize that anything so enormous could really be alive. The elephant was standing with his tail toward us. As we approached and got within 50 yards he whirled around and spread his enormous ears to catch any sound. The movement was so fast, yet done with such perfect ease, that not a stick cracked or a branch of vegetation moved. I blinked my eyes to make sure he had really moved at all. Facing us with his trunk raised in the air, its tip gently swaying to and fro feeling for our scent, this spectacle of my first elephant at such close range will remain in my memory. True, on one side of me some fifteen feet away there were two white hunters probably capable of bringing down the beast should he charge, but I held only a movie camera in my hand and to all intents felt quite alone. That elephant, I believed, was making up his mind whether or not to charge. His tusks were long and stained with red clay and no doubt weighed considerably over 100 pounds. This whole episode was over in a few seconds. The elephant, in spite of his enormous bulk, faded away like a shadow. He did not seem to turn around but backed away and without a sound disappeared in the bush, leaving no trace except deep impressions of his ponderous feet. This elephant, in my opinion, was by far the biggest tusker we saw on the entire trip and I, for one, am glad that the white hunters miscalculated its size and did not give the word to shoot. Long may he enjoy the lonely forest of the African veldt!

The trail cutting was pushed on, and our next objective was a small mountain near the Tanganyika border. We spent several days along the trail that had already been cut to the sable country, through very rough country and marsh land, where our car frequently stuck. Game was not uncommon here, though extremely shy, as it usually is in enclosed country. Warthogs frequently scurried away, backing into their dens as they do instead of going head first. We found the tracks of sable antelope but were unable to come up to them. On the way we passed several waterholes where elephant had been drinking and found great holes in the ground where they had dug out the roots of the trees. Pushing on, we came in sight of Mount Karanza, and the following day, taking a light outfit, we camped on top.

Stalking

From here we had a wonderful view of the country and could see the plains in Tanganyika. Scanning the forests until dark we saw only a few giraffe, eeland, and some antelope, but early the next morning we could see a small herd of elephants about six miles away, moving through the thorn-trees and dusting themselves with red earth. At first we did not see anything very large, but by nine o'clock we picked out an old bull away to one side of the herd, which appeared to be an exceptionally big animal. As the wind was right we started our stalk. Down in the thick thorn-trees the country-side all looked the same, but the scouts were well trained, and they led us unerringly to where we had first seen the bull. By this time, however, the animal was foraging in more or less of a circular route, and we had to be careful as the wind seemed to be changing. Time was one of the chief considerations, as the beast was moving toward the mountain and would soon strike our trail, when he would stampede and it would be useless to follow him. Making a semi-circle of about a mile, we heard the branches of trees being broken and as we drew closer we could hear the rumbling in the elephant's stomach. It was interesting to me to find that we could hear this rumbling at a distance of several hundred yards. Proceeding cautiously we came upon the great beast breaking trees off six inches in diameter with relative ease and munching the green shoots at the top. He moved with a slow deliberation seeming to know exactly how much energy to put into each action. He was chewing on a branch an inch and a half thick, the end of which was hanging out of his mouth. In their hurry to get closer to the elephant, the scouts failed to note what was immediately under foot. They stepped over a clump of weeds, Harry followed, then Sandy, and finally their two gun bearers, and when I came up I saw that this little clump of weeds contained an enormous puff adder. Its thick body was loosely curled on the grass and its brilliant eyes stared intently on all that were passing. Should one of them have stumbled, the story of this elephant hunt might have had a different ending.

Hard to kill

We were able to approach within 30 yards before he suspected our presence, giving us a good opportunity to note his actions and estimate the weight of his tusks. Apparently Harry and the white hunter who were about 30 feet to my left had decided that this was an exceptionally large animal, with tusks well over 100 pounds. As the beast turned I kept my camera focused on him and he took one step in our direction, then stopped with his ears spread, gently swaying back and forth, intent upon retreating at the faintest sound. Harry moved to get a shot from the side, and I saved a few feet of film for a possible charge, which apparently was cut short by an almost perfect shot from Harry's rifle. The animal dropped in his tracks. Six or seven other shots were put into what we considered vital spots to make sure the animal was dead. Hunter said this was necessary, as one time he shot a bull elephant, went over to the animal, sat on its head and had his picture taken, cut off the end of its tail, and then went off after another bull. When he came back the elephant had gone! Satisfied that our animal was dead we called our boys and sat down to have a drink in the shade of a large tree. In a few minutes, however, one of the natives ran up and said that we had better go and kill the elephant or he would be gone. Sure enough, despite the heavy ammunition the beast was attempting to get up and would, I believe, have gone away.

Returning to camp, tired out from the long tramp in the torrid heat of the jungle, we sat down for a sundowner. All the colored boys in camp, dressed with tropical flowers in their hair and branches of trees stuck in their clothing, started to dance and chant toward the camp and eventually picked up Harry on their shoulders and marched him around, chanting and singing. Everybody was having a good time. It was fortunate that it was not quite dark and I had an opportunity to get some motion pictures of this unusual scene. Sandy thought he was getting this in color, but later found that for some reason his camera was not loaded.

Charged by a rhino

The shots at the elephant had apparently driven all other game out of the district; and we learned from the natives that there was a large swamp between Karanza and Kinshara, visible in the distance, through which it would be practically impossible to cut a trail. The only way to reach the Kinshara country seemed to be to return to Voi and go in from the other side. Starting out one morning from a camp about 50 miles south of Moctow, we rounded a bend after crossing a small plain, and were attacked from behind by two rhinoceros, charging our hunting lorry from not more than 30 feet. They were within 20 feet when Sandy raised his gun and hit the horn of one, turning the animal across the front of the car and pushing the other one off. So we got through without a serious accident. These animals seem to be the kind that knock you down first and ask questions after. Personally, I now have a great respect for rhinoceros. They charged almost every time I met them at close range.

We sank almost to our knees in soft, wet mud searching for elephant in this region, but apparently there were no very large ones and we contented ourselves with the photographic opportunities.

But when Sandy and I, with one white hunter, reached the foothills of Kinshara the scouts came to report tracks of a large herd of elephants close by and advised us to go no farther with the outfit. Just as the boys were unloading the trucks and preparing to put up the tents we heard the screams of elephants over a little ridge less than half a mile away. All action was then stopped and everybody was told to keep quiet. We started over the ridge and had not gone more than half the distance when we met the elephants more or less coming toward us. There were bulls, cows, and calves, and for a while elephants were stretched out in a long line before us. Cow elephants with their calves are always dangerous and normally are left strictly alone by white hunters. One big cow suspected our presence,

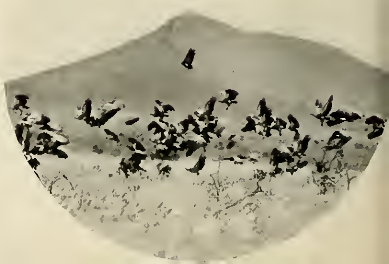
One of the chief objectives of the Snyder East African Expedition was to explore some of the vast regions in British East Africa untouched by white man, where game abounds in tens of thousands and the natives live happily under primitive conditions. Accompanying Mr. Harry Snyder, internationally known sportsman and patron of the American Museum, were his associate Colonel A. J. Macnab and Mr. George G. Goodwin, Assistant Curator of Mammals in the American Museum of Natural History, both of whom have participated in previous work with Mr. Snyder in the Canadian Northwest

(Left) A symbol of unspoiled Africa: a magnificent, black-maned lion in the famous Serengeti Plains in Tanganyika. Being old and irritable, he was given a wide berth by the expedition

Twenty or more lions were seen in one group by the expedition on several occasions, and photographic studies were made at extremely close range, as testified by the picture at left showing five male lions feeding. Large manes are less common among African lions than is generally supposed

(Lower left) A regal lioness photographed at about ten feet. The abundance and fearlessness of these animals was demonstrated when one of them approached the open door of Mr. Goodwin's tent at midnight to investigate and was frightened away only by the beam of his flashlight

Vultures, whose presence is a signal that lions are probably feeding on a kill in the vicinity

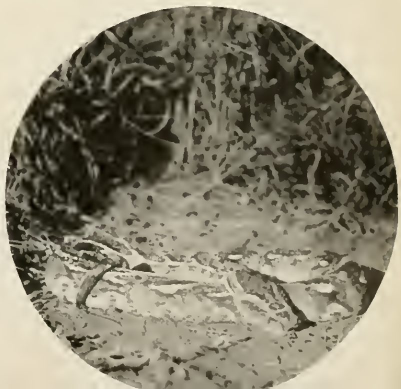


THE FORMIDABLE FIGHTING TEETH of the wild lion are rarely shown more impressively than in the photograph above. The deadly tearing and shearing force of the two long canines and six chisel-sharp incisors between is sometimes underestimated even by those who know the animal well. This powerful killing mechanism, which recognizes no superior on the plains of East Africa is, of course, supplemented by a set of claws adapted to tearing open the viscera of the victim in swift strokes, and even though a man thus injured does not die of internal injuries, he is very apt to succumb to infection carried on these carrion-stained claws. The hungry lion and the mother with cubs are the most dangerous

THOMSON'S GAZELLE, a graceful little creature of Masailand, only about 26 inches tall at the shoulder

THE TOPI, a relative of the hartebeest. Its troops of light fawn-colored calves chase each other fleetly among the herd

A PUFF ADDER, thick as a man's wrist and five feet long, killed by Goodwin



Perhaps the largest elephant ever recorded: a prize specimen shot by Mr. Snyder. The height of the elephant as measured by Mr. Goodwin from the base of the front foot to the top of the shoulder in a straight line, was 12 feet 4 inches. History spoke unexpectedly when dissection revealed a wrought iron bullet in the skull of this patriarch among pachyderms. This type of projectile has not been used in this region since the Swahili hunters and slaves raided the country 70 years ago

(Left) Scanning the country for elephant at Pika-Pika, a group of rocky hills in flat thorn country visited early in the expedition

(Left) Majestic mount kilimanjaro, the highest peak in Africa, showed its snow-capped head through the clouds only 200 miles south of the equator at one of the expedition's most beautiful camp sites

(Above) Harry Snyder scans the horizon for game from the top of the hunting car. On one occasion the lorry was unexpectedly charged by two rhinoceros at 30 feet. On another, one of the cars was attacked by a wounded hyena, probably the only incident of its kind recorded. The hyena left its teeth-marks in the front fender, and had it chosen to enter the car might easily have crushed an arm or a leg to a pulp

(Upper right) Mrs. Harry Snyder, wife of the expedition leader, and Mrs. Richard Cooper, Jr., beside a rhinoceros killed by Harry Snyder

(Center right) Camp atop a 1500-foot peak, Mount Karanza, a vantage point successfully used as a lookout for game

(Below) Harry Snyder with a large pair of elephant tusks weighing 105 and 108 pounds respectively

(Above) Colonel A. J. Macnab, Harry Snyder, and J. A. Hunter, the white hunter in charge of the native outfit, photographed near Nairobi

(*Below, left*) Native women, somewhat bashful before their first camera

(*Center, below*) A primitive gristmill for corn

(*Right, below*) Winnowing the chaff out of the ground corn by pouring it from a basket in the breeze

(*Right*) Decorative scarring of the skin, a fashion which finds expression among many tribes in central Africa, is seen here in an abdominal oval design

(*Below*) A natural pond-garden typical of the wild Kilabasi region, where numerous potholes, one to ten feet in diameter, have been eroded in the bare rock

(*Above*) A beautiful blue water lily of a type plentiful in these reed-grown pools turned in our direction, and diligently watched our approach. The white hunter suggested that we remain ready for a hasty retreat, should the animals come closer. The danger apparently lay in the fact that the elephants were moving directly toward the trail that the scouts had crossed shortly before; should they come up to it and get their scent, our position would be very precarious, for they must stampede straight in our direction. There were at least 43 animals in the herd. The bulls as they passed were relatively small, with the exception of one big fellow with only one tusk. Undeterred, I moved ahead and got a close-up picture of a cow that was standing under a thorn-tree apparently disinterested in what was going on. I did not chance to get more than 40 feet or so when one of the scouts, tossed a stone which hit me in the back and frantically motioned to get to a safe position. The scouts themselves were disappointed. They had found us a herd of over 40 elephants and there was not a single animal that we considered suitable for a trophy. They suddenly remembered, however, the tracks of these elephants had shown that there was an old bull following about a mile from the herd. Approaching old age he had apparently been driven out of the herd by a younger and stronger bull. We backtracked the elephants for about two miles, then suddenly heard a considerable crashing of trees and branches. Sure enough there ahead was the old bull.

A stampede through camp

His ivory was white and he seemed to be a reasonably large animal. There is no doubt that he was extremely annoyed about something. The scouts did not like his actions and would not advance to very close range. In fact, they stood in front of me and made it quite clear that they were not going to let me get close enough to take pictures. Sandy, however, proceeded a little closer with his white hunter and gun bearer. While we stood there, the elephant deliberately broke off a good-sized tree and tossed it over his shoulder, apparently to rub his sides on. He was picking and lashing around in all directions. I believe that if he had suspected our presence he would have charged. Sandy brought him down with one shot. Breaking his rifle, the gun bearer slipped in another shell, and Sandy moved on to give the animal one more shot. The gun he was using was a single trigger 465, and from some mechanical defect both barrels went off together. The "kick" was so unexpected that Sandy landed in a thorn-bush, and it took two gun bearers and a white hunter some time to extract him. We returned to camp and were greatly amused that the whole herd of elephants had charged right through when the shots were fired. All the boys had taken refuge in the nearby trees, with the exception of one who could not make it. He jumped into one of the trucks and glued his hand to the horn. A few minutes later it was difficult to convince him that the danger was past, and he had to be dragged out of the seat.

Reconnoitering west of Moctow, Harry and I saw some vultures on top of a tree which probably indicated a lion kill. To get over there we had to make considerable detour to cross a deep donga and when we approached within a couple of hundred yards, sure enough a lioness stood up in the long grass, close to the antelope on which she was feeding. Presently we saw that there was also another lioness. Having no white hunter to advise us on how close we could approach, we made two or three circles of about 100 yards and took some pictures, though it unfortunately rained heavily during the whole episode. Sandy, who is an experienced driver over rough country, safely maneuvered the car back on the trail.

Lions

The site on which we camped that night was one of the most attractive of the whole trip. Our tents were under some big, spreading thorn-trees, more or less surrounded by extensive, rolling plains covered with large herds of zebra, oryx, and various kinds of antelope; and in the distance we could see majestic Mount Kilimanjaro. Harry and I set out over the open plains to get pictures and if possible to collect large-maned lion. The second day out we came across a lioness with cubs near a kill. Hunter carefully maneuvered the car around the animals to within what seemed to us very dangerously close quarters. A giraffe nearby kept his eyes on the lions but seemed little afraid of them and passed at close range. After that we saw lions and more lions. One group included sixteen animals, females and nearly grown cubs, and one of them passed within a few feet of the car. Sandy shot a big-maned lion in very good condition, and the same day got a cheetah. The next day we suggested that he bring his luck with us, as we expected to find the sixteen lions we had seen the previous day and get some more pictures. To our great satisfaction, at the same spot we found a big-maned lion and a lioness. Taking the car fairly close, Harry and I got out and made a stalk. At 30 yards I managed to get some good pictures with the three-inch lens, and just as the lion started to advance in our direction, Harry, with one well-placed shot, brought the animal down.

We now had two lions from this district and as time was rapidly flying I took part of the outfit 40 miles ahead to Lake Jipe to find a suitable place to camp accessible to the lake. The lake itself was somewhat disappointing. It was large enough—20 miles long and probably several miles wide—but the lower half of the lake was full of weeds and the shores all around for 150 yards were overgrown with tall reeds fifteen feet or more high without a break except for little narrow trails made by hippopotamus and used by the natives in their dugouts. This made it practically impossible to launch our big steel boat. I tried to make our boys cut a road through the reeds for the boat, but no argument could persuade them to go into that crocodile-infested water. I was able, however, to hire about 30 local fishermen, who, stripping and seizing their pangas, thoroughly enjoyed the job. Singing and laughing, they vigorously attacked the reeds, diving under the water and cutting them off at the roots. But as is usual, they lost heart as the novelty wore off and before the job was half finished wanted to quit. Leeches covered their bodies under water but were no real discomfort as I learned when I joined the fray. Leading them they started to sing and we got a canal cut through before dark.

We pushed the boat into the lake, which was as still as a mill-pond, and found that the motor was strong enough to cut right through the weeds. Many kinds of waders, ducks, and other races of aquatic birds could be seen on the floating islands; and crocodiles were swimming about. Just before dusk hippopotamus started to come out for their evening swim. My attention was first attracted to them by a snort and splash near the bushes, as one of the huge creatures dived and emerged to look around. Only his nose, eyes, and ears could be seen. Just before going under again, however, he rose and showed part of his shoulders. During the day they rarely came out of their seclusion in the tall reeds. Four o'clock in the evening appeared to be about the time when one could look for them, and from this time on they were active until seven or eight the next morning. Occasionally they wandered out on the banks of the lake.

"Calling all hippo hunters . . ."

We were just planning how to get good pictures of hippopotamus when a native runner came up stating that in a lagoon at the lower end of the lake there was a very large hippopotamus that made a practice of raiding their small patch of corn. Would we shoot the animal and rid them of this marauder?

Harry Snyder and I started with the understanding that the distance was short but it turned out to be about ten miles before we had to leave the car. Quite a few natives were waiting for us and they said we could get to the side of the lagoon without more than wetting the soles of our shoes. Two guides and two gun bearers accompanied Harry and me down a narrow trail that became more obscure as we advanced into a swamp. Mosquitoes, apparently affected with malaria, swarmed around us, and deadly tsetse flies carrying sleeping sickness buzzed about our heads. Overhanging palm trees shut out the light of the sun and the odor from stagnant water under foot filled the air. Perspiration dripped off us as we pushed through this humid jungle. Every few yards we sank deeper and deeper into the mud and slime until we were up to our waists, but the natives urged us on saying that it was only a little farther. As we advanced I found that we were actually walking on submerged palm leaves that had fallen from the trees and were floating in a tangled mass of weeds. Once I slipped through and went fairly up to my neck, and Harry, who was carrying his gun, had difficulty keeping footing.

Hippopotamus at ten feet

Eventually we came to within 20 yards of the edge of the lagoon, with very tall weeds obstructing our view. We could hear the hippopotamus and occasionally got a slight glimpse of him through a break in the reeds. Between us and the lake there was a deep hole that seemed almost insurpassable. One of the guides tried it but being a small man he nearly went under. Harry and I helped each other advance step by step. When we were not more than five feet from the reeds and just up to our arm-pits in water, the great hippopotamus rose out of the water about ten feet away, opened his enormous mouth, let out a grunt, and stared at us. Moving a step forward I put my camera into action, but because of the close range of the animal and having no experience as to what might happen, Harry decided to shoot rather than take any chances. Firing a 465 Holland-Holland on firm ground requires a certain amount of resistance from the hunter, but shooting it when up to your arm-pits in water and standing on floating reeds is a different matter. With the roar of the gun Harry went under, his feet entangled in the floating palm leaves, but he managed to struggle free and pull himself up on my shoulder. The gun bearer fortunately got the rifle as Harry went over. With the general commotion I lost my footing but managed to keep the camera dry. I got 100 feet of pictures of this thrilling episode and even though the light was poor expect good results.

The hippopotamus was killed but sank, and we went back the next morning to get him out of the lake. This proved to be no easy task. We had all the natives from the neighborhood down to tell us how to go about it, but nobody would go into the water, which was now full of crocodiles already enjoying the hippopotamus meat. All the pulling in the world would not move the animal onto the beach. The natives advised that somebody get on the lake side of the hippopotamus and take a rope and roll him over, but they were afraid of the crocodiles. Then someone devised the plan of seizing one of the boys and throwing him in. The splash frightened the crocodiles for the time being, and before long 20 or 30 natives were over on the lake side of the hippopotamus, singing and laughing, the whole village dragging the beast out to the shore.

Leaving Lake Jipe we pushed on over the border toward the Serengeti, where we had prospect of getting good lion pictures. To go there, however, we had to cross over the Ngoro Ngoro Crater. On the Kenya side we encountered difficulty in transportation, as the trucks frequently sank to the axles in the soft, black loam. On this side of the Crater the trees were shrouded with lichens and clinging vines, and the trail followed along a precipice that dropped to 1000 feet or more. It took us a day of hard work to get to the top, over 9000 feet in elevation. Continuing the next day down the other side we were surprised at the decided change in climate. The country became dry and parched, and we made the descent in a short time. By noon we met our first lion in this district. He was a big, yellow-maned creature, sitting away out in the open plains, and apparently well fed and in good condition. Antelope were plentiful here and although they kept at a safe distance they paid little attention to the lion. We were able to approach within 30 feet of the animal and got some good still and motion pictures.

Toward evening we came to some big rocks out on the plains, more or less overgrown with brush. Drawing closer we noticed a lioness sitting on the top, which disappeared in the bushes. As there was water nearby we made camp here. About midnight I was awakened by a scratching on the rocks which were about ten feet back of my open tent. With my flashlight I saw a lioness coming down, apparently to investigate but being disturbed by my light she disappeared into the bushes. The next morning we saw 24 lions. At a distance of 25 feet we got some excellent pictures. To crown the day, on our way back to camp we saw a magnificent black-maned lion sitting under a tree. He seemed irritable and very old, and as we did not want to have to shoot him we approached carefully and got our pictures.

Near the Kenya border we were amazed at the vast herds of zebra. One herd alone that passed in front of the car must have totaled 1000 animals or more. We camped near the Sand River on the Masailand, where the wild life of the plains was almost unbelievable. Frequently toward evening we estimated that in one area there were at least 10,000 head of game at one time. A few lions seemed to be following the herds. Harry Snyder got a nice, big-maned lion, and later Sandy got one.

I was not satisfied with the number of elephant pictures we had taken and made a special effort to find the herds whose depredations we had recently seen. Scanning the forests from a high point with a 42-power telescope, I was delighted to see these elephants coming down a steep slope toward the Sand River, apparently to drink. Snatching up our cameras we pushed over to meet them. The distance, however, was considerable, and by the time we got to the river the elephants had apparently changed their minds. We made a big detour, but as often is the case, we came upon them sooner than we expected, and we saw elephants coming from all directions. We counted 103 of them around us, and the situation became rather tense. From where I stood I got pictures of a big bull pushing down tree after tree and feeding on the succulent tips. Elephants are dainty eaters in spite of their enormous bulk. One big cow seemed to be suspicious, and our white hunter decided that this was the time to move. We retreated a couple of hundred yards. The elephants still coming toward us. Again and again the white hunter made us move back, and as much as I disliked to stop taking pictures of these magnificent creatures I had to. When the first elephant reached our trail he stopped for a second, then backed up about ten feet. The elephants behind him, not knowing what it was all about, immediately attempted to prod him forward with their tusks, but nothing would budge him and he turned, squealing. By this time the rest of the animals had come up and they all turned and stampeded right over the spot where we had been standing a short time before.

There was one place we had to see on the northern frontier, and here the most interesting animal was probably the rhinoceros. We saw more of them here in one day than on the rest of the entire trip, and compared with those we saw near the coast, these animals were not so prone to charge unless suddenly stalled at close quarters.

Returning to Nairobi we saw the magnificent sight of Mount Kenya with its snow-capped peaks partly shrouded in clouds. Our trip into Africa ended here. This was our first trip to the co-called Dark Continent. We had seen and learned much about these magnificent beasts of the wilds—had practically lived with them. We may return to Africa, but this first impression will always remain.

FERNS, THE ADAPTABLE

By MARGARET MCKENNY

Lordly rulers of the plant world in the days before the dinosaurs, they have learned to clothe our forest floors in modest beauty, and, lastly, to lend cheerful indoor greenery to our winter homes

(Right) The rare Hart's-tongue Fern

Drawing by Edith F. Johnston

As autumn's last flare of defiance to winter fades on the hillsides we turn from the outdoor garden to that of the living-room or sun-porch. And, impatient with the seeming lack of life without, we long to throw a strand of vital, pulsating green to bridge the snowy gap between fall and spring. The most delightful plants with which to do this are the ferns. For ferns, though seemingly so frail, through generations of suiting themselves to the earth's climatic changes, have proved their remarkable adaptability, and beautiful examples will thrive indoors or out, if given ordinary intelligent care.

Thouands of years ago stately fern-like trees towered over much of the earth's surface. At that time great stretches of our continent were covered with shallow brackish seas, and on their shores, rivaling in height and girth the giant club mosses and scouring rushes, these plants unfurled their royal pennons in the warm, moist air. Overhead spread abundant clouds during the Carboniferous Period, protecting the delicate texture of their foliage from the sun's rays and encouraging their growth by heavy rainfall. Almost identical with the frail fronds of our own ferns of today were those rippling blades of translucent green. But as the geological ages rolled on hard times fell upon this plant world, and those fern-like growths which had attained great size and had developed seeds instead of spores, fell to extinction. Sinking below the black ooze they became part of the coal measures which now release in our furnaces the tropic heat of that period. Hidden deep in the coal's inky folds their imprints have come down to us, and paleo-botanists have classified many hundreds of these prehistoric forms.

But the true ferns that were associated with the seed-bearing fern-like trees lived on. The climate grew colder and the landscape changed, but for over 200 million years their banners have waved. Now only in the tropics do we find ferns as trees, but their kind, instead of being swept out of existence as were so many animals, bowed to the inevitable. Now where their ancient relatives once towered in majesty, in dwarf stature they clothe meekly a cooler, sterner earth. A new forest growth has sprung up above their bowed heads and they hug closely the soil, seeking protection from the lords that have succeeded them.

As ground-covers of the temperate regions of our country, ferns now cover vast areas. Their huge trunks have shrunk to root-stocks and their fragile, feathery fronds rarely exceed a man's height. A few are evergreen, but almost all of them yield docilely to the sovereignty of the first touch of frost and, sheltered beneath the forest humus, await the warmth of spring and summer, only faintly reminiscent of the steaming tropical heat of their past.

Where ferns have taken refuge, both in the evergreen forests and in those composed of deciduous trees, they are of great beauty and of great use. Their intricately patterned fronds, many of them as frail as finely woven lace, unfold in loveliness unequalled by any other plant; and friendly to man, their matted roots hold the soil securely when rivers flood the forest floor. Sometimes, as in the northern New England states, whole hillsides are clothed in their green drapery, and in the cool shady ravines the rocky edges of every stream and pool are veiled with their filmy fronds.

For many years we have grown the ferns of the tropics in our greenhouses, where the warm moist air duplicates the conditions of their natural habitat; or have watched their brave struggle to live in the hot, dry atmosphere of our living-rooms; but only lately has it been realized how readily many of our native ferns respond to cultivation.

One of the fascinating aspects of the cultivation of ferns is growing them from spores. The fruiting fronds should be gathered in the summer and autumn and folded up carefully in very smooth or waxed paper and then kept in a cool, dry place.

The ideal time to start the spore-growing experiment is the fall. By spring your little plants will have grown large enough to be set in the open, to start their career as rugged individualists. Very little equipment is necessary. Take ordinary clay pots and sterilize them by boiling them for a few minutes. Then pack them full of sphagnum moss and invert them in saucers of water. Place over each pot a wide-mouthed glass jar. This will prevent evaporation of moisture, and soon the pot will become damp with the water which has soaked up from the saucer. As soon as the pot is moist, the glass should be removed and the spores sifted gently on the sides and tops of the inverted pot, the glass replaced and the whole kept in the light but out of the direct rays of the sun in a temperature of about 65 degrees.

Within two or three weeks thin prothallia will coat the pot with a green film. On these small, heart-shaped prothallia the male and female spores are formed, and from their union grows the new fern plant. First a single frond appears, and within

THREE STAGES IN THE CINNAMON FERN

L. W. Brownell Photos

The "Fairy Ring" at left is formed of typical young "fiddle-head" fronds growing from a fairly mature root system. The tangled, wiry mass of roots may have developed from a single spore, which necessarily passed through the prothallium stage, not shown here. Below, at left, is shown a later stage, nearing maturity; and at right a single fully developed fern.

The plant will produce fronds year after year from the same root system. The circular shape of the "fairy ring", of which these are unusually beautiful examples, results under natural conditions from the fern's tendency to extend its immediate domain, and can be likened to the "fairy rings" of mushrooms

Margaret McKenny Photo

Devereux Butcher Photos

(Above) UNCOILING "FIDDLE-HEADS" *of the Christmas fern.* (Above, right) *A later stage of the same species, showing the unusual feathery shape of the pinnae or leaflets. This evergreen fern shows its deep, glossy green above the melting snows and sends up a silvery new growth in April*

Drawing by Edith F. Johnston

six weeks the fernlets are ready to be transplanted. Do not try to "prick out," as the florist says, each individual plant. Take a clump and set it gently in a pot containing a well-sifted mixture of soil consisting of one part leafmold, one part loam and one part sand. Later, when established on their own roots, these plants can be separated, each one going in its own pot. As these plants are still in the incubator stage, again place a glass over each pot in order to simulate the steaming dampness of the tropics or of those far-off ancient times. At this period of growth, protection is needed; for this is the time when millions of young ferns in their natural habitat die because of the capriciousness of Nature's watering system.

At the last International Flower Show, a remarkable exhibition of 60 species of our native ferns came to the crowding spectators as a revelation of beauty and grace. This exhibition showed how easily ferns will respond in growth to man-made conditions. The plants were dug in the fall, and in order to give them a rest period, were subjected to an artificial

beauty. Its evergreen fronds, a deep glossy green, cheerful all winter when disclosed by melting snow, are succeeded by the silvery new growth in April. In the far West, its close relative, the sword fern, *P. munitum,* often stands shoulder high, and in that mild climate the truly evergreen fronds last through a number of years, the clumps often showing 200 or more fronds from one root.

One of the most adaptable ferns of the East, is the interrupted fern, *Osmunda claytoniana.* It should

glaciation or freezing in the open until January first. Then, they were gently forced into growth until the middle of March, in a cool shaded greenhouse. By that time they were as advanced as they would have been in the woods by late midsummer, their foliage mature and their fruiting fronds perfected.

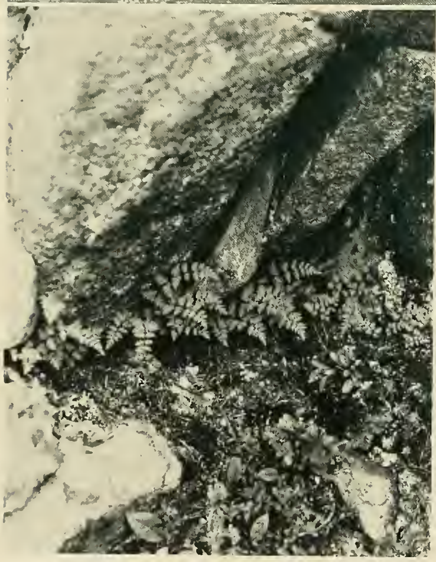
This exhibition attracted thousands, proving that the beauty near to us, often in our own woods and fields, is too frequently overlooked in our desire for novelty.

We may not all wish to force ferns, but to know a few of those most easily grown under garden conditions is exceedingly desirable. It is true that ferns have preferences as to soil and situations, but the majority of them if given shade, moisture and a plentiful supply of leafmold will thrive joyously under cultivation, not grudgingly eking out an existence as do so many of our native plants which demand a definite woodland environment or an alpine atmosphere.

In the wild garden, the Christmas fern, *Polystichum acrostichoides,* increases yearly in size and

The Climbing or Hartford Fern

(Drawing by Edith F. Johnston)



(Above) GIGANTIC RELATIVES OF OUR POTTED FERNS. *Some of the largest tree ferns of Australia and New Zealand reach a height of 80 feet, of which sizable examples are shown above at Whangaroa Harbor, New Zealand. (Courtesy Horticultural Society of New York)*

(Left) OUR ROCKY MOUNTAIN WOODSIA, *a humbler beauty*

form the framework of every collection of ferns and will thrive in dry rocky situations where few other plants will exist. Its cool green is delightful at the north of buildings or along shaded driveways, where more fragile ferns would perish.

For the margins of streams or rivers in partial shade, or even in the open, as well as by pools or at the north of the house, the stately ostrich fern, *Pteretis struthiopteris*, gives height and dignity to a planting of shrubs or lower-growing ferns.

The cinnamon fern, *Osmunda cinnamomea*, its tight-rolled crosiers wrapped in silvery wool, comes early in spring. Though it is found in swampy, open woods or in the marsh, so adaptable is it that it will grow amazingly well in any partially shaded situation, even unfolding its patterned greenery against walls of brick and stone in the city garden.

Almost as easily grown is the marginal shield fern, *Dryopteris marginalis*, which loves to root between two boulders dislodged from the rocky wall above. Its blue-green fronds are almost evergreen, persisting in their handsome verdancy until the new growth unfurls its chaffy coils.

Delicate in texture as appears the royal fern, *Osmunda regalis*, with its finely cut fronds sweeping down to the waters of a secluded lake or stream, it too will thrive by a man-made pool and even in the garden where the soil is quite dry. However, shade and moisture are its delight and produce in it its truly regal beauty.

The maidenhair, *Adiantum pedatum*, both in the East and West, is a lover of cool shaded glens, and though it looks loveliest spreading its fronds toward the margin of water, it will complacently multiply in the shaded rock garden and within a few years will veil a moist bank under the shade of overhanging trees.

Quite as adaptable as the maidenhair, the bladder-fern, *Cystopteris bulbifera*, stretches its slender pennons at the base of limestone boulders or weaves a green, lacy pattern on a north-facing bank, above a stream. In spite of its secluded habits of growth it responds quickly and luxuriantly when grown in a shaded border, its lime-loving proclivities making it take readily to the neutral soil of the flower bed.

Carpeting the rocks with its evergreen, leathery fronds, the common polypody, *Polypodium virginianum*, with its tenacious tangle of rootstocks, adds beauty to the rugged side of many a boulder or the scarred face of a cliff. Its prototype in the far West, the licorice-root fern, *Polypodium glycorrhiza*, though occasionally found on rocky banks, prefers to grow on the boughs of mossy trees or on fallen trunks. In the western woods, the fronds shrivel in the summer, coming out in plumy beauty under the first fall rains, but under cultivation, with plenty of artificial moisture supplied, it is as evergreen as its eastern cousin.

Among other easily grown species the hay-scented fern, *Dennstaedtia punctilobula*, although almost weedy in growth, is exceedingly valuable for wide sweeps of lively green in the open woods or on the hillside. It increases so rapidly that its greedy roots often crowd out more delicate ferns in a collection, but where a quick effect is needed it is of great worth.

(Below) The Common Polypody *carpets the rocks with evergreen, leathery fronds*

(Below) The Sword Fern *often grows shoulder high and produces 200 or more fronds from one root*

Margaret McKenny Photos

Near old stone walls we find a fern similar in appearance to the hay-scented, the New York fern, *Dryopteris noveboracensis.* Its frail fronds, tapering toward both ends, make a lovely background for delicate blooms in the wild garden. Against the shaded side of a boulder, the wood fern, *Dryopteris intermedia,* spreads its intricately cut green lace, a striking contrast to the stern gray granite. It requires shade, plenty of leafmold and a cool runway for its roots in quite acid soil.

In a number of our states limestone boulders and outcrops are prevalent. Too often their beauty of form is hidden by woodbine or by poison-ivy, while their crevices should be storehouses for some of our choicest ferns. In these favored sections, in sheltered ravines, grows the walking fern, *Camptosorus rhizophyllus,* that odd example of a fern's adaptation to adversity. Not trusting to reproduction from its rain of spores on the sides of the inhospitable rocks, it turns the tips of its slender fronds downward to the soil in the rock cracks, a soil built up by the disintegration caused by lichens, and the decay of mosses and its own substance. The hairlike tips root, the next generation spreading out from the parent plant, walking year by year on green-shod feet in an intricate pattern over the boulder's scarred surface.

Another exceedingly rare fern, the hart's tongue, *Phyllitis scolopendrium,* is found only in a very few sections of our country, usually in lime talus at the base of a cliff. Strange as it may seem it responds gratefully and energetically to cultivation if given a limey soil. It has a long straplike leaf, entirely unlike the usual cut frond which we associate with ferns.

One of the daintiest of ferns is the maidenhair spleenwort, *Asplenium trichomanes.* Often growing in association with the walking fern, it sprays its delicate tendril-like fronds down the north face of many a limestone boulder. Seemingly so frail and shy, if given the proper conditions it will increase amazingly.

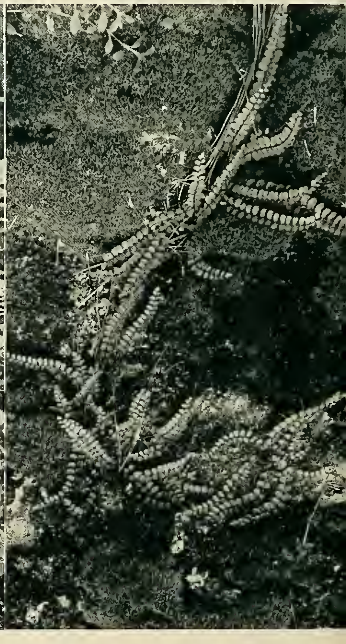
So, if you would witness the full wonders of fern growth, gather the spores from the native plants in the fall. Watch them develop through the prothallium stage, and observe the daily uncoiling of the characteristic fronds, whose delicate beauty has been the ferns' inheritance through the ages. You will be spectator to a miracle which took place constantly in that dreamlike forest of prehistoric times where, as Donald Culross Peattie says, "the golden spores were piled like snowdrifts in the peat," and where shade, moisture and warmth combined to foster a luxuriant growth. You can feel, too, that you have robbed no shady glen or country lane, but have added to the country's store of native plants, as a true Conservationist.

(Below) THE WALKING FERN: *an odd example of adaptation to adversity. It turns the tips of its slender fronds downward into the soil and "walks" on green-shod feet*

(Below) *The Northern Wood Fern,* Dryopteris spinulosa, *whose delicate green lace adds beauty to the foothills of Mt. Rainier, Washington, where this photograph was taken*

(Below) THE EBONY SPLEENWORT (Asplenium platyneuron), *well known among the 20 or more American species of this very large genus of polypodiaceous ferns*

Photos by Margaret McKenny



FLAGPOLE SITTERS—*Tropical plants, scorning the jungle's murky floor, make ladders of forest limbs, perching ever nearer a tree-top paradise of life-giving sunlight and torrential rain*

By HENRICKS HODGE

HUMAN flagpole sitting, like so many so-called original ideas, is a direct but useless copy of Nature. Years before man trod this globe of ours, there existed flagpole sitters, green plants living upon the tops of the original flagpoles, tropical forest giants. These progenitors of "human flies" have their modern forest descendants which differ from their human mimics in a number of outstanding points, one of which is numbers. For every pole-sitting mortal, nature can produce a million pole-sitting plants, the million and one (plants and man) sharing but one common thing, the desire to be "in the limelight."

For a place in the sun

What a driving force is light! A window plant makes obeisance to it in one-sided growth; in a forest, trees silently fight with one another to become members of the upper foliage canopy; from beneath a carelessly placed board, our light-starved lawn grass, "jaundice-ridden," feebly bends up for light balm; near the equator jungle plants become competitive acrobats in their zeal to lay themselves upon the altar of the sun.

It is the very same light "drive" which forces certain favored plant species to leave the darkness of a shady forest floor and to become a part of the "gallery" of the flagpole sitters, for the tree-top rows of branched seats are continually flooded with life-giving solar rays. Such plants which merely rest upon other plants, are known as epiphytes. To see them best in all their glory and luxuriance, one must visit the tropics. Here they reach such tremendous numbers that the uninitiated might consider them parasitic on their hosts, whereas in reality they are only looking to the latter for mechanical support, taking no more nourishment from their tree-top branch than does the human from his flagpole perch.

Unlike the latter, the epiphyte must pay for its tree-top seat—indirectly, through the loss of root connection with the moisture and mineral-laden soil. To most plants such a loss is a serious handicap, one which to a newly uprooted terrestrial plant usually results, as any would-be gardener well knows, in death through wilting (water loss). Herein lies the reason for there being few non-tropical epiphytes. Desiccation, or water loss, is a danger which epiphytes, like their terrestrial cousins, must fear and combat, and they can only win the battle when the elements are favoring them. This situation is most characteristic in rainy, tropical regions. Epiphytes say, "If our roots cannot reach the moisture held in the soil, bring the moisture to our roots!" and this demand is fulfilled in the wetness, dankness and humidity of most tropic climates. The next time you curse the wetness of your vacationland's climate, think of it in terms of an epiphyte paradise!

Little wonder, then, that our temperate forests show scarcely a single higher plant that can be called epiphytic, for the atmosphere which bathes these regions is too dry. Such forests, to flagpole sitters, are deserts where death alone stalks. True it is that an afternoon's walk will show a few lichens or mosses clinging tenaciously to some tree's bark, but compared with the tropics, this is as nothing.

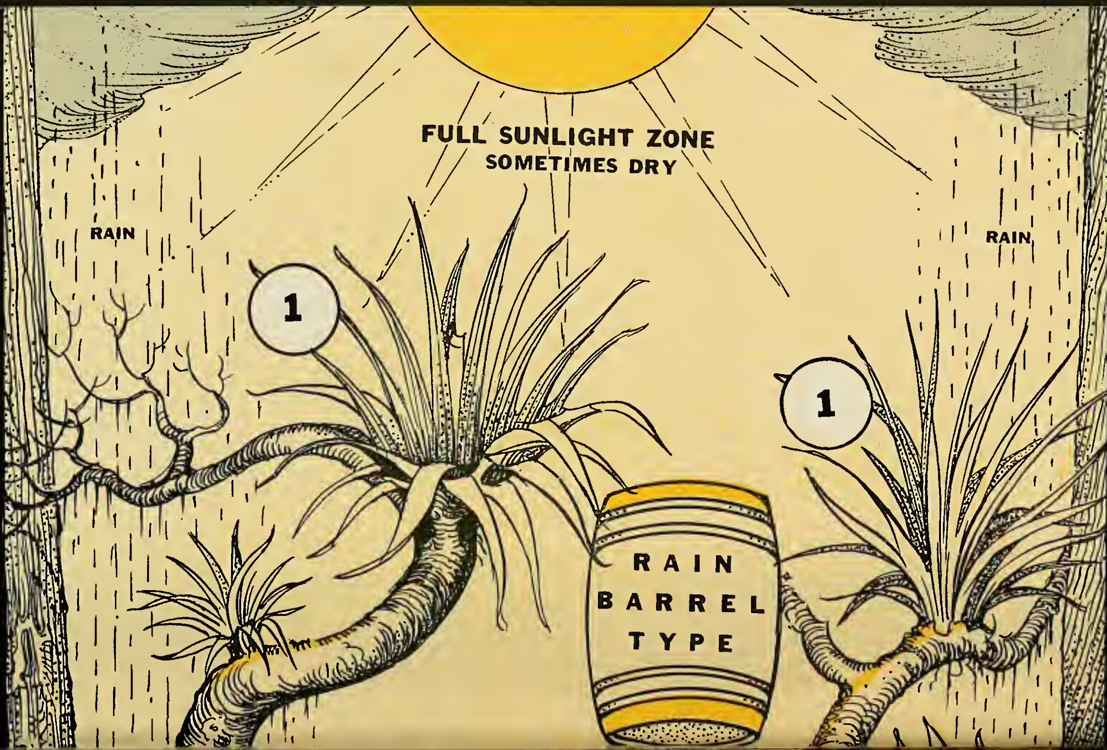
In rain-soaked regions

What a change an equator can make, particularly if the region abounds in rainfall! In such places, so striking to the casual visitor, are found those evergreen tropical forests whose floors are steeped in continual twilight, where the absence of strong sunlight permits the rain of one day to splatter into the droplets of the preceding day's deluge. Only in such incessant raininess can the inhibition born of desiccation be eliminated. No longer do plants have to waste away their lives in insufficient light—in spindly growth on the forest floor, as is so often the case in most temperate forests. A super-saturated atmosphere replaces the wetness of the cool earth's depths, and with roots again able to dangle and bathe in the necessary ever-present moisture, the

THE FIGHT FOR SUNLIGHT

Showing the strange plants that have forsaken the earth in their struggle to rise from the dank basement of the tropical forest toward its sunflooded roof

Sunlight is the indispensable element for all verdure. In the dense growth of the tropics, plants become veritable acrobats in their struggle to lay themselves upon the altar of the sun. In this struggle, a strange congregation of plants have been developed, which require no connection with the earth and take their nourishment out of the atmosphere. These so-called epiphytic plants depend upon trees and other plants for mechanical support but not for nourishment as do parasites. This chart illustrates the distribution and characteristic features of several important types, without attempting to show their relative size.

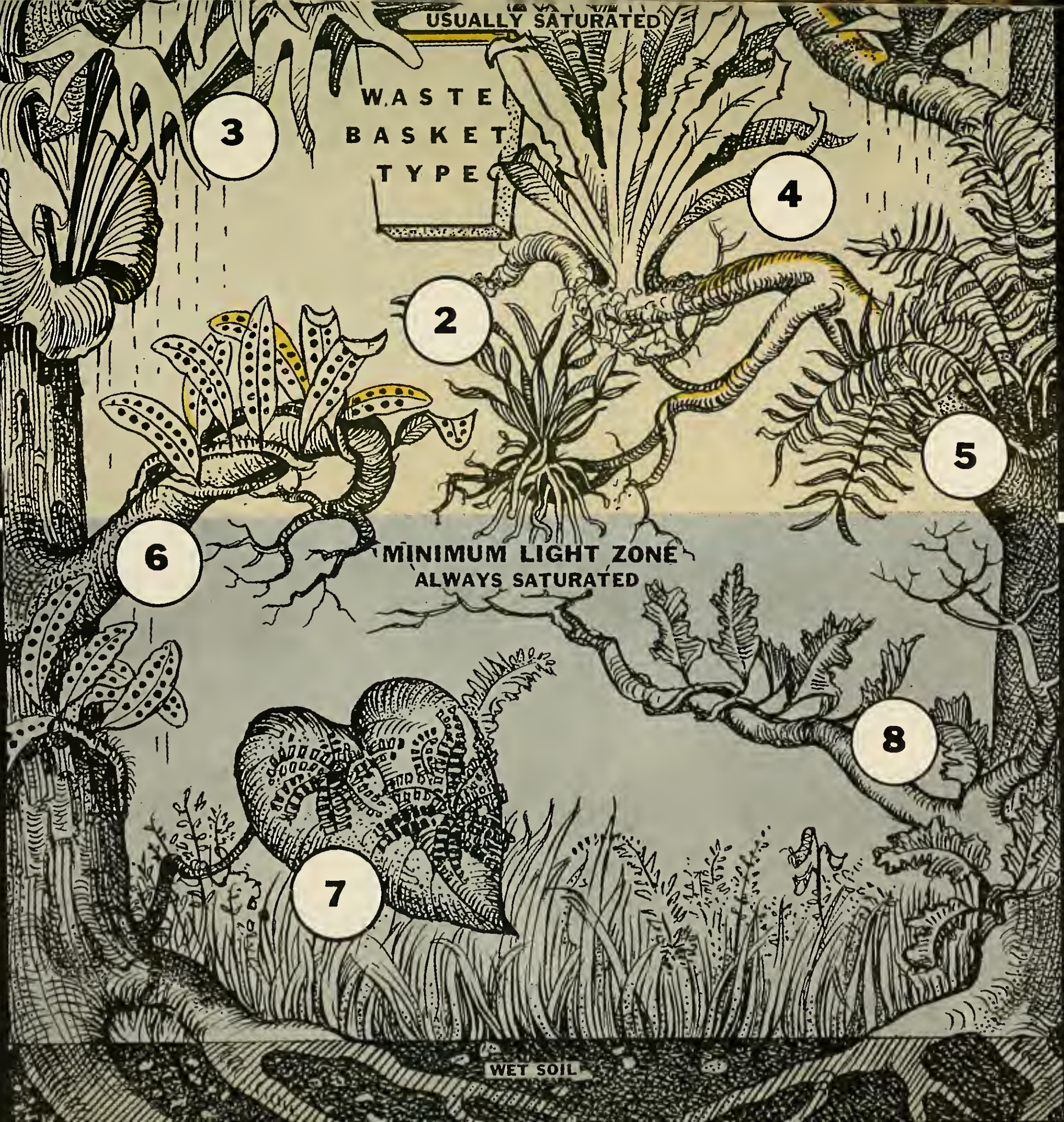


On the roof of the jungle the soilless plants, in their greed for sunlight, face the most severe conditions, for these tip-top seats are "scorchers." In them their exposed roots face the equivalent of desert conditions when between rain storms the sun is able quickly and frequently to dry things out. True flagpole sitters of the plant world are, therefore, few in number and hardy.

Just as moisture is necessary to plants whose roots are buried, so is moisture necessary to plants with aerial roots. So it is in the humid tropics that most of the plants whose roots dangle in the air are found. Similarly it is here that the struggle for sunlight is most dramatically demonstrated, for beneath the thick tangle of tropical forest, these aerial gymnasts of the plant world have to climb 150 feet or more to reach the topmost gallery in the sun.

Loss of root connection with the soil in any case means that water must be carefully conserved, because there is no longer a stable supply. Various interesting methods have been developed by the soilless plants to fortify themselves against unfavorable changes in the water content of the air, such as water storage basins, spongelike roots, and "shellacking" of the leaves to lessen evaporation. Among the leaves most heavily "shellacked" to retard the escape of moisture are those of the Bromeliads. An example of this group is Tillandsia (1), whose converging leaf formation conceals at the base a "rain barrel" for storage of water during dry periods in the sun-bathed summits of the forest. *(See also photo 1, over.)* These "hanging aquaria" are sometimes peopled with tree frogs and snails, and serve as breeding tanks for assorted aquatic in-half-way rungs of the jungle ladder enjoy moderately abundant sunshine without suffering so severely from water shortage for their exposed roots. Nevertheless this zone is sometimes almost as dry as the highest, and various methods of protection against drying are seen, such as thick, succulent leaves, rain-barrel catch basins, and the sponge-like covering (velamen) of the orchids' roots (2), which soaks up available water like blotting paper and is the indispensable nourishment-getter of all our "corsage" orchids.

A natural waste basket of moisture-holding humus is



tycerium), (3), where old leaves and other vegetation accumulate *(See photo 4)*. Another "waste basket" epiphyte is the Bird's-nest fern *(Asplenium nidus)*, (4), which stores water in the humus it collects in its funnel-shaped formation of fronds. *(See also photo 5.)* Gallery seats for certain ferns (5) are also provided well up on the trunks of palms where old leaf stalks leave pockets for humus in which the roots can find footing. *(See photo 6.)* In this zone we also find the tropical Polypodium ferns (6), whose tiny leaves are many cells thick and protected by a waxy surface. *(See photo 7.)*

Nearest to the saturated ground and in a zone perpetually shaded live the plants which are least able to rise above the requirements of moisture in their quest for sunlight. The lives of these epiphytes depend on the perpetual drip from above; and their tissues are so thin, indeed, that direct sunlight would dry them up.

In this dim light, tiny hepatics (liverworts), (7), rob the leaves of some of their food manufacturing surface. *(See photo 8.)* At the base of the jungle ladder, where moisture is greatest but sunlight weakest, grow the so-called filmy ferns *(Trichomanes)* (8)—perhaps the weakest contestants in the fight for sunlight but plants successfully adapted to their damp, shady habitat. The leaves of these elfin delicacies of the fern world are only one cell thick and hence highly perishable. *(See photo 9.)*

From these "thin-skinned" ferns of the jungle basement to the "thick-skinned" Bromeliads of the roof, plants exhibit a wide range of inventions to make life possible under varying conditions of sunlight and moisture. Both of these elements are indispensable, and the fight for sunlight in the jungle is never won without superior equipment for gathering and storing moisture.

HENRICKS HOGE
Botanist
LAURENCE BLAIR
Artist

HANGING GARDENS *of the* JUNGLE

Supplementing chart on preceding page

1. In the forest roof, where sunlight is strongest, only the hardy bromeliad types can persist without root connection with the soil. (A species of Tillandsia)

2. The familiar Spanish moss is neither a moss nor a parasite but a relative of the pineapple which uses trees and even telephone wires merely for support

3. A typical catch basin for water storage high in the forest is seen in the whorl-like arrangement of leaves in this Bromeliad, also related to the pineapple

4. The appropriately named Stag Horn fern is a tropical example of a plant "waste basket" adapted to the accumulation of moisture-holding humus

5. Lacking connection with the earth, the Bird's-nest fern likewise stores moisture in its funnel-shaped "basket" of fronds, here viewed from above

6. As this fern demonstrates, palms offer good gallery seats to plants which have forsaken the earth, particularly in the stumps of their old leaf stalks

7. This close relative of our common Polypody fern rises above the bottom rungs of the forest ladder with leaves that are protected by a waxy surface

8. In the dimly illuminated "basement" of the forest even the light-absorbing surface of the leaves is robbed by the tiny liverworts. (About twice actual size)

9. Characteristic of the dampest, deepest recesses of the jungle are the filmy ferns, whose fragile leaves are only one cell thick. *(Trichomanes Draytonianum,* Hawaii)

1

2

Photo below by Ewing Galloway. All other photographs by Henricks Hodge

3


INCHES
1

species of the forest floor have, with one accord, evolved into a group of "flagpole sitters."

Visitors to the heaviest rain forests often notice an utter absence of bright colors, a green lushness being the only and predominant color born of the perpetual gloom and mist. Epiphytes are on all sides. A ladder of foliage continuous and dripping rises to the tree tops—a ladder whose every rung is laden with epiphyte pilgrims seeking the great god Light. On the various ladder levels can be noted definite types of plants. Thus on the tree trunks nearest to the débris of the jungle floor can be found only those timid ones which hardly dare to leave, despite the moisture-laden air, the earthy source of their water supply. The so-called filmy ferns, tiny elfin delicacies of the great fern world, confine their thin, membranous, easily dried-out tissues (one cell layer in thickness) to the deepest gloom surrounding the base of their jungle ladder.

On the half-way rungs, the epiphytic flora changes, for a higher elevation means less humidity, insufficient for the demands of the filmy-ferns. The latter have given over their places to plant types which are partly drought resistant, such as their distant cousins, the Polypodium ferns, and orchids and Peperomias. Everywhere the tree trunks are covered with plants bearing thickened succulent leaves indicative of the moisture-storing devices such an aerial habitat has demanded. These forms give way to plants clinging to the highest rungs of the ladder—plant types which a botanist would call xerophilous (desert-loving)—and these forms, far from the bathing influence of a water solution, must truly be able to withstand extreme desiccation. Little wonder, then, that some epiphytes resemble, in the thickness of their stems and leaves, desert plants, for the cause of such thickened storage modifications is the same drying influence, in the former case present in soil, in the latter, in air. If a day should pass without rain (not impossible), the burning tropical sun would soon make shriveling skeletons of such hardy pilgrims-to-its-altars had they not some type of protective water-retaining device.

Moisture-storing devices

The bromeliads (a group almost entirely epiphytic), small orchids, and other species which throng such hanging gardens, are not without protection. Many of them encase their moisture-laden tissues in a waxy cellophane-like wrapper, which, like its industrial analogue, effectively retains all essential liquids; others, the orchids in particular, thicken up various parts of their stems the better to hold maximum amounts of water; still others build themselves leaves of blotter or sponge-like consistency, the better to "lap up" any available moisture from the air to be stored in readiness, not for the proverbial "rainy day," but rather for the dry day. Some, like many of the bromeliads, construct catch basins by arranging their leaves in whorls so that the rain, descending, is guided as in eaves-troughs to the central rain barrel storehouse. In such hanging aquaria enough water accumulates to support a varied and interesting tree-top life including tree frogs and snails and serving as a breeding tank for an assortment of aquatic invertebrates. Indeed, many an aerial-minded collector has found himself unexpectedly but refreshingly drenched by accidentally seizing such a "tank epiphyte."

Aerial roots

Amongst the aerial orchids a peculiar kind of air root is seen. No longer capable of absorbing from the soil raw materials to aid in food manufacturing, these progressive organs become encased in a blotter-like layer, called velamen, which is as friendly to water as is a sponge, soaking it up on the slightest presence. Aerialists all are our much cultivated "corsage" orchids, for their ancestors were all plucked from some tree-top seat. Take a look at a growing Cattleya plant when next you visit the flower show and note the spongy whiteness of the root surface. Underneath the velamen, through which light easily passes, lies a green bark whose color proves it to be a food-manufacturing tissue, not normal in underground roots, but here, in sunlight, a highly efficient addition to the food factory of the leaves. Such aerial specializations reach their climax in such orchids as Taeniophyllum, whose plant body is nothing more than a mass of green scrambling roots. Since stems and leaves are totally lacking, all food manufacture must be undertaken by these roots.

All these varied water-storing modifications make this topmost gallery almost immune from the danger of drying, provided, of course, that regular rains continue. Certain of these tank forms (Caraguata and Stelis) in Jamaica have been shown capable of withstanding six to seven weeks without replenishment of water. Quite a difference when compared with certain of the inhabitants of the lowermost epiphytic levels, for instance, the filmy ferns, *Trichomanes capillaceum* and *T. rigidum,* which dry up after the fatal limit of seventy-two hours without water. Little wonder, then, that these latter seldom migrate far from the protection given by shade and the humid atmosphere near moist soil débris.

As one would expect, where rainfall is light epiphyte numbers diminish and their height from the ground is usually lessened. In such situations where conditions are almost approaching those of most temperate forests, the hardy bromeliad types alone can still exist in the air. Their ruggedness in withstanding water lack is best exhibited by their close relative, our own native *Tillandsia usneoides*, or Spanish Moss (not a moss at all but a member of the pineapple family!), which sometimes drapes its slender, rootless body over such dry, unlovely substrates as telephone wires. Indeed, so specialized have certain members of this genus become that, even when collected and placed in contact with heat in a botanist's press, they have been known to continue their flowering even to the stage of setting seed, as though they were still up in the heights on a jungle ladder in the burning heat of a tropical sun.

On every limb

Where rainfall is heavy, on high tropical mountain slopes, the epiphyte numbers increase tremendously, and here, if rain is well-nigh continuous so as to bathe the air in reeking wetness, the members of the more delicate creeping clan can even migrate to the upper level of the forest. In such regions of constant atmospheric saturation, every available tree-top seat is taken. Mosses and liverworts cling to the branches and in so doing, cushion them with deep, moisture-retaining sponge pillows which offer excellent foundations for the clinging roots of even woody epiphytic shrubs or small trees. The smaller branches are colonized by the familiar orchids, bromeliads and ferns, and in some cases, the smaller forms—filmy ferns, Selaginellas, mosses, and various blue-green algae—are even driven out upon the leaves of the host, there to become known as epiphyllous (literally "on the leaf") plants. Here every available space is taken and the sun's energy is being used to its maximum manufacturing capacity.

Any forest tree may play the part of flagpole, some species surpassing others in this capacity. The various palms, with their old leaf stalks as prime spots in which humus can gather, offer the best seats. Because of this, jungle palms, and even those planted out in the open, resemble living ferneries. Orchid enthusiasts, when planting their pets in matted fern fibers, are unwittingly reproducing in their greenhouse pots a wee bit of just this type of epiphytic habitat. The accumulation of pockets of humus high up from the ground promotes the storage of moisture, and certain epiphytes even build up such an original natural cache by adding any of their old basal leaves which happen to fall into this much-matted natural waste basket. The familiar staghorn fern, with its creeping, moisture-retaining fronds, is a tropical example of this epiphytic type. Tree ferns themselves gather beneath their gorgeous fronds hosts of smaller relatives, nursing them into health and sunlight just as an old hen broods her chicks. Seeds of epiphytes, dropping by gravity, blown by wind, or carried by animal, are practically assured of germination when such excellent seats can be had just for the taking.

A rough tree trunk is, however, no prerequisite for attachment. Xerophilous bromeliads think nothing of picking out the smoothest of Royal Palm trunks on which to perch, and a steel flagpole would offer a better attachment surface than polished bamboo stalks or glossy tree leaves, both of which are often sat upon by this aerial pageantry. In such sites, the epiphyte legions make use of every little foothold, of every known type of root attachment, in order to hang on. The leaf-scarred trunk of a cocoanut palm is a little better haven, with light guaranteed from all sides during the day. Many are the plant flagpole enthusiasts who avail themselves of this opportunity and, when in place, make the "hostess" look as though she were garbed in lush green pantaloons.

Broken trees

In but one way can epiphytes injure the plants whose body they look to for support. A visitor to a rain forest is hardly able to distinguish the skeleton framework supporting this fantastic world. The weight of such a luxuriant fairyland always produces stresses and strains which the strongest forest giant was never meant to endure. The result, then, is inevitable: broken limbs, broken trees, wind-falls. But even in death, the old corpse is utilized to the last, and is only replaced when some young sprout —a forest lord-to-be—capitalizes on the opening made available, and in tropical exuberance lifts another armful of epiphytes to share the sunlight in the upper reaches of a jungle fashioned for flagpole sitting.

FUNGI—WONDER PLANTS—*Known chiefly as a literary backdrop for scenes of eerie horror, molds and their relatives reveal extraordinary beauty under the microscope and exhibit such amazing activities as "lasso-throwing" and "bullet-shooting"*

By HAROLD J. BRODIE
Department of Botany, University of Manitoba

THERE is a popular belief that those bizarre members of the plant kingdom called fungi (pronounced funj-eye) arise from decaying things and are venomous. As a result of this belief, the average person is prejudiced against appreciation of the beauty and fascinating habits of the fungi, regarding them as loathsome excrescence to be shunned and remaining unaware of some of the most amazing of Nature's works.

The expression of this idea finds its way into our prose and poetry: whenever particularly eerie events are described, we are almost certain to detect "an odor of mold and decay," or to come upon something "covered with noisome growths." Merely because the mushrooms and their allies are commonly encountered in cool damp places and often prefer the dark, we persist in preserving toward them an attitude which is curiously medieval.

Admittedly there is a sound basis for such disfavor, an economic one. We read about the loss amounting to millions of dollars every year caused by the red rust fungus which attacks wheat and, to come nearer to home, what housewife has not seen oranges become covered with blue or green mold, or bread suddenly bring forth an unwelcome growth of black?

A new world of beauty

Despite the fact that fungi are intimate associates of man in every phase of his life, popular acquaintance with them seldom extends beyond our having heard of wheat-rust, kitchen molds and the common mushroom. Yet rich is his reward who troubles to look more closely. Under his magnifying glass or microscope will be revealed a world of exquisite color and form. Whoever searches may easily find little plants with curious bulbs like blown glass, a fungus which is able to shoot its spores or "seeds" toward the light with astonishing accuracy by means of an ingenious mechanism, and he may be even more amazed by a fungus which forms loops or lassos in which eel-worms are caught to serve as food for this wild-west member of the microscope world. These and a thousand other marvels may be discovered by anyone who has a well developed bump of curiosity—and a little patience.

Not all interesting fungi are microscopic. In the late autumn, when the cool woods are moist and there is a delightful smell of decaying leaves, fungi appear in great numbers. There are large fleshy ones shaped like the common edible mushroom, some pale and others with livid caps warning of dire consequences if they are eaten by the unwary. Some are like tiny clubs all brown and yellow, others snow white and shaped like the corals of the sea. Many books have been written to record their wonders and many lives spent in solving the why and wherefore of their habits.

Attractive as are the larger forms, let us consider some of the less conspicuous kinds, fungi which are present wherever there is organic material for them to grow upon, such as decaying fruit, vegetables, meats, moist paper, straw and manure.

You breathe them

"Where do they come from?" you inquire. The air we breathe contains myriads of fungus spores so minute and light that they are kept constantly floating about, settling only when they reach a place where the air is very still. There are also bacteria in the air and this is the reason why the surgeon must be absolutely certain that his operating room has been scrupulously cleansed before an operation. These spores are able to withstand long drying and low temperature and are thus capable of remaining in a living condition for many months—often for years. Recently biologists have discovered that fungus spores withstand the low temperature and rarefied atmosphere of the stratosphere, miles above the earth. By producing millions of minute, resistant spores, fungi have provided themselves with an excellent means of getting into every nook and corner where there might possibly be something suitable for them to grow upon.

Usually spores are round, but some are of odd shape and are as beautiful and unusual as the plants to which they give rise. Each spore contains a substance called *protoplasm,* a jelly-like material present in all living things. As long as the spore remains dry, and perhaps cold, it is dormant; but let it alight upon cook's preserves which have been set aside to cool, and what happens? Moisture penetrates into the inside of the spore and the protoplasm begins to swell and grow. In a few hours, the wall of the spore bursts and a clear filament emerges and elongates rapidly, branching and developing into what is called *mycelium.* Mycelium is just the biological term for a network of microscopic threads which are usually colorless, shiny and filled with protoplasm. Very small amounts of this living cobweb are practically invisible to the unaided eye, but when large masses of it have accumulated, it presents the appearance of absorbent cotton. Under the microscope, the fungus cotton is seen to be composed of delicate branching fronds.

One of the most surprising things about mycelium is that we can take a wisp on a needle and, by transferring it to a fresh lot of food material, obtain an abundance of new mycelium just like the old. One cannot chop a sunflower into fragments and obtain new sunflowers by placing the fragments in the earth. Yet this would be analogous to what can be done with mycelium. Those who grow mushrooms commercially obtain them by sowing "spawn" in beds of earth and manure, and spawn is nothing more than dried mycelium obtained from an older culture of mushrooms.

How to collect fungi

Some of my readers may possibly wish to collect and study microscopic fungi themselves. First, then, where to look. The answer is "anywhere"—on moist materials such as rotting fruits and vegetables, on old logs and rotting leaves in the forest, and a thousand other places. The fungi may be examined directly with the aid of a small hand-lens which magnifies about ten times. With this simple instrument, the wonders of much of the fungus world may be seen. For the more minute forms, however, a microscope is required. It need not be an expensive one. An ordinary students' microscope which gives a magnification of from 100 to 500 diameters will be quite adequate.

Suppose we have found a mold on an orange and wish to see its beauty revealed under our microscope. Taking a needle, we remove a bit of the fungus and place it in a drop of water on a small glass slide—merely a bit of glass one inch by three inches. Over the fungus in the drop of water we next place a very thin glass disc called a cover-slip. The fungus so mounted is ready for examination and many breathless moments may be had exploring the wonders to be found in a bit of common mold.

Fungi may be readily grown in the laboratory for scientific purposes. A "culture" is started from spores or mycelium of only one kind of fungus, and, during its lifetime, this culture is guarded against the entrance of other organisms. This is the practice of *pure culture.* The foods upon which fungi are usually grown are a sugar of some sort, such as malt sugar, and a protein material such as peptone. For the sake of convenience in handling, these substances are added to a kind of jelly called agar, obtained from seaweed. The nutrient jelly can be melted, poured into various kinds of containers and allowed to harden, giving a solid medium suitable for growing and studying fungi. It is allowed to harden in glass tubes or in shallow flat dishes with covers, and the dishes must be kept covered and the tubes plugged with absorbent cotton in order that the cultures may remain uncontaminated. If they were not so protected, bacteria and other organisms would lose no time in making use of the ready-prepared stock of food. Because special materials and some means of sterilizing the glass apparatus are required, the amateur would probably not be able to grow the fungi he found, but it is really not at all a difficult process if one has the proper equipment.

For a while after the mycelium has been placed in a tube on nutrient jelly, it grows rapidly, soon filling the available space with a white, cottony growth. Frequently the mycelium is brilliantly colored and sometimes it produces a pigment which dissolves in the jelly, coloring the latter bright red, yellow or orange. Some of the commonest molds, when grown in tubes in this way, exhibit intense colors.

Rapid growth

Whether the fungus finds a suitable home in cook's preserves or in our laboratory culture tube, it grows apace. The rapidity with which a large amount of mycelium may appear is little short of miraculous. The fine filaments stretch out in every direction, and in a few days may cover a great deal of material. This is an obvious advantage to the fungus, for it can thus spread rapidly through a manure heap, a patch of forest soil, or the entire lot of cook's preserves. Food in solution goes into the mycelium, undergoes chemical changes of a very

FUNGUS SECRETS

The Wonders of a Tiny Plant World Revealed by the Microscope

Close relatives of the common mushroom, the microscopic fungi on these pages are shown in all their rare beauty. Their moat-like spores, teeming unseen in the air we breathe, need only settle on a favorable medium to blossom into delicate wonderlands

Photographs by Harold J. Brodie

(Below) A decayed turnip leaf supports the dainty fungus *Botryosporium sp.* To the naked eye merely an annoying fleck of mold, it is magically endowed by the microscope's lens with the frosty charm of a snow-covered shrub seen at night

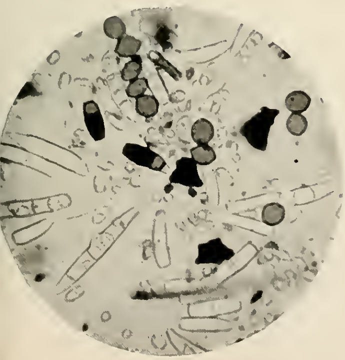
(Above) Lilliputian guns: showing the remarkable mechanism by which *Pilobolus* (manure fungus) distributes its spores. The clear, glass-like bulbs explode under sunlight, shooting to the winds the buttons of concentrated spores at their tips

(Left) Common mold, the housewife's bane, becomes in the photomicrograph a fascinating miniature forest. The dark clusters are spores. More primitive than seed-producing plants, spore producers have existed from earliest times

(Below) SPRINGING FULL-BLOWN from the breathing pore of an onion leaf, this tree of the fungus world *(Peronospora Schleideni)* bears spores on the ends of its branches. Fungi are remarkably adaptive; another species *(Harposporium Anguillulae)* grows in loops which act as lassos, trapping microscopic worms for food

(Below) REWARD to the serious student of the fungi is this microscopic view of *Circinella umbellata.* Despite the delicacy of fungus tissues, traces of their hyphae (or branches) are left in rocks of the Devonian age (300 to 350 million years ago)

(Below) SPORES: the "seeds" of fungi. Although the longest shown is only 1/1000th of an inch, they are remarkably hardy, some surviving dryness for years. Recent investigations proved spores capable of withstanding the conditions in the rarified atmosphere of the stratosphere, miles above the earth. Center picture shows the effect of indirect lighting on the cobweb-like threads of a fungus. *(At right)* Fungus candlestick—the spore-bearing stalk of *Mortierella.* The spore contains protoplasm which remains dormant until favorable medium for growth is present. Then moisture swells the protoplasm, the spore elongates and develops into mycelium

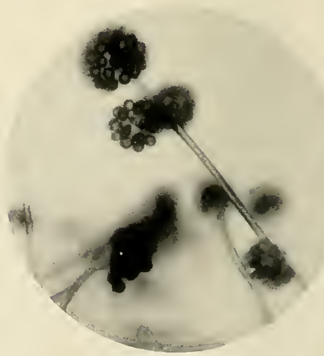


(*Below*) FUNGUS JEWELRY revealed in microscopic view of common black mold (*Mucor sp.*). Delicate fungus threads like these, together with bacteria, are the great agents of decay in Nature. There are helpful types, however, like the orchid root fungus which aids the germination of the seeds

(*Below*) CHRYSANTHEMUM GARDEN? A growth of green mold (*Aspergillus sp.*) such as might be found on a musty orange. Admiration of the beauty in color and form of *Aspergillus* is tempered by the knowledge that it does great damage to almost all kinds of organic material

(*Below*) PIN-HEADS of common bread mold (*Rhizopus nigricans*), which penalizes many summer week-enders. Moisture and warmth will produce this black growth in such quantity as to cover the loaf completely in a day or so. The long upright stalks bear spores ready to spread the fungus through all sorts of food. (*Center*) With light from directly below, the microscope turns the threads of this fungus into snowy twigs

(*Right*) Grape-like spore clusters of *Cunninghamella*. Unlike their more complex relatives the flowering plants, fungi can live in darkness, nourished by the material prepared by other organisms



complex nature and, by means of the substance called protoplasm which is constantly streaming inside the mycelium, is moved rapidly from place to place. As a result of the streaming of the protoplasm, food stuffs in solution can be moved from an older part of the mycelium to a younger part where they will be more needed.

To what end this activity? Like all other living organisms, fungi reproduce. This they do by means of the tiny bodies called spores, which we may liken to the seeds of flowering plants. Millions of spores may be produced by one fungus and, although the chances of their reaching a suitable environment are slight, because of their numbers there is every probability that the fungus will be propagated.

Among larger fungi, spores are produced by the fleshy fruiting structure generally known as a mushroom or toadstool. Remember that the mushroom is but a part of the entire fungus—it is simply the fruiting body, analogous to an apple on a tree. For one mushroom on the lawn there may be several square yards of mycelium below the grass, and this mycelium corresponds to the apple tree, being the vegetative part of the fungus plant. When the mycelium has accumulated a certain amount of food material through growth processes, it prepares for spore production. A small knot of mycelium is formed and this becomes transformed into a mushroom almost overnight. Development is rapid because of the large amount of food which has been stored and upon which the growing mushroom is able to draw.

Efficient mechanical principles

It is obviously advantageous that the fruiting body, whether like a mushroom or of some other form, be formed so as to serve best the purpose for which it has been brought into existence, namely, the production of innumerable spores and the efficient liberation and dispersal of them. Sound mechanical principles and laws of physics have been employed by the fungi to this end. Mushrooms are so organized that the maximum number of spores are produced with a minimum of material, and the mechanisms for insuring spore dispersal are superlatively ingenious.

As with the larger fungi, so among the microscopic forms such as the molds, the same principles apply except that the mycelium does not build large fruiting bodies. It does, however, produce its spores on specialized upright parts which show great diversity of form: some are like miniature trees or shrubs, some have long straight stalks, and others are gracefully curved and coiled (*see accompanying photographs*). If we could suddenly grow small like Alice and wander among the fungi growing on a moldy fruit, we should find a Wonderland as astonishing as that which confronted the immortal heroine. You may remember that Alice was able to accomplish this remarkable feat by eating a bit of one side of a mushroom, upon the recommendation of the Caterpillar!

Who would have imagined that such an interesting fungus as *Pilobolus* could be found on the manure heap? This little plant, which is one of the first fungi to appear on fresh manure, consists of a swollen basal part or holdfast, a short stalk about half an inch in length and, at the top, something resembling a bulb of glass. In fact, the whole fungus has a glassy appearance and usually a yellowish tinge. On top of the bulb is a black object consisting of a mass of spores. The interest in this fungus is that it is really a Lilliputian gun. The bulb at the top explodes and shoots the black spore mass to the remarkable distance of eight feet. Inside the bulb there is a spot of protoplasm sensitive to light. The clear bulb acts as a lens, focusing the light on the sensitive protoplasm which causes the fungus gun to aim directly at the light and to shoot its spore projectile with great accuracy in the direction from which the light is coming. In nature, fungus guns which happen to be partly covered by straw, by shooting toward the light, shoot for open space and thus disperse their spores as widely as possible. The spore mass is provided with a drop of mucilage to enable it to adhere readily to any blade of grass which it may chance to strike. The grass is then eaten by a horse, and so the Pilobolus spores reach the manure heap, there to begin again the interesting life cycle.

Lassoers

The same manure heap holds other microscopic marvels. There we find the fungus, already mentioned, which captures eel-worms by ensnaring them in loops. Eel-worms (more properly *nematodes*) are present in the alimentary tracts of horses and are therefore to be found in tremendous numbers in horse manure. Nematodes or round-worms are colorless, mostly microscopic in size, have slender tapering bodies and move by writhing incessantly. A dozen or more fungi are known which are adapted to an interesting relationship with these worms. The fungi produce rings or loops acting as nematode traps. The wiggling worm finds itself caught in a fungus lasso and begins to lash about furiously. The more the hapless creature wiggles, the farther the fungus ring is pushed over the tapering body. In some of these fungi the loop actually constricts, making escape impossible; in others, the worm appears to

Continued on page 309

THE INDOOR EXPLORER

Of Masks and Man

INHERENTLY a season of far-reaching transformation, autumn is a time when we very often do not even recognize our own children for the cogent reason that they disguise themselves with that peculiarly sleazy form of the mask known as a false face. The first outbreak of this wholesale juvenile masking comes, of course, shortly before and during Halloween. Follows a brief lag and then a fresh burst of enthusiasm at Thanksgiving time. Although an inquiry into the origins of Halloween* sheds some light on the custom of masking at that time, it is difficult to reconcile the mask with America's native feast day of Thanksgiving. At first glance, we are likely to lay the blame on the proximity of the two celebrations. The false faces our children bought at Halloween have not yet lost their charm by the last Thursday in November, and so, though it seems only last night we were handing out cookies to a gang of masked doorbell-ringers, we are again roused from our easy chairs to repeat the boon at Thanksgiving. This may be the explanation and then again it may not, but the practice of masked begging from door to door is not a new one. In fact, lo, it is a heritage from the poor Indian. False faces, in the sense of masks representing a more or less human face, were among the most important paraphernalia of the Iroquois Indians. Not every Iroquois could own one, however; they were the badge of the famous Iroquois false-face society, a group of braves who performed certain rituals with their faces hidden behind large weirdly carved wooden masks.† These masks were not alike, but rather divided into separate categories of which the most notable, for our present purposes, was the beggar's mask. The men who owned these masks were privileged to wear them on a round of begging from wigwam to wigwam on specified feast days. At each stopping place they were presented with a ceremonial alms which amounted to nothing more than a hand-out. To refuse them was considered tempting Providence. It was bad luck also for the Zuni Indians of the Southwest to refuse the masked beggar fraternity which they harbored within their precincts and who like the beggar-maskers of the Iroquois were

accorded the customary right to solicit from their neighbors on appointed days. These were the clownish Mudheads, whose ridiculous name covers one phase of a quite serious tribal phenomenon widely distributed throughout the world. The reference is to the prevalence of secret masking societies among the young males of many primitive people. In these societies, the mask was indispensable.

Indeed, the psychological impact which the mask seems to have in all its forms on masker and audience alike, supplied the life blood of these societies. Many authorities regard as undeniable that the simple process of donning a mask changes the entire being of its wearer. The initial change is physical. The structure of the mask may be such as to dwarf the actual stature of the person, but far more often it is used to inflate him, to make him awesome, unfamiliar, mysterious and, in a very literal sense, supernatural. That is the psychological effect. The mask is the device of witch-doctors and of primitive men of power. You yourself with all your rational outlook may experience anything from a slightly uncomfortable nervous twinge to a pronounced galvanic shock when faced unexpectedly and in poor light by even the blotched cardboard affair your son has picked up at the local notions counter. What then must far more suggestible people have felt when confronted by the inspired handicraft of their greatest artists. They believed that what they saw was not of this earth. They did not think it *represented* the supernatural—to them it *was* the supernatural. That is one reason why religious agnostics are few and far between in primitive tribes—especially where secret societies can be counted on to make the spirit world exceedingly real three or four times a year.

The male secret societies masked themselves as the spirits of their ancestors wherever these were worshipped by the tribe, but don't think for a moment that they cynically exploited a simplicity of mind they did not share. It seems fairly certain that the mask affects both wearer and observer. Although the wearer of the mask may be supernatural only to the man who sees him, that belief reflected in the face of the observer seems to communicate itself to the wearer in such a way that by autosuggestion he becomes temporarily convinced that his supernaturalism is real. All this goes a long way toward explaining the auto-suggestion, the curious self-intoxication, of the witch-doctor. It also leads us to guess that it was partly the tremendous stimulation of watching the faces of the women and children of the tribe through the eye-holes of these masks that induced the men periodically to play at being visitors from the spirit world.

In many cases it was only when the young lad was at last initiated into the secret society that he discovered—and it must have been momentarily

*A modest investigation of Halloween around the world was conducted in this department last month.

†Readers desiring a more detailed account of this phase of aboriginal culture are referred to *The Lore of the Demon Mask* by Dr. Clark Wissler in the July-August, 1928 issue of NATURAL HISTORY.

the very essence of disillusion—that all the spirits who had so deliciously horrified him all his life were only his father and uncles and brothers. It would seem that this sharp disillusionment must still be echoed in our own culture. The profound primitive secrecy with which these holy things are guarded prevents us from fully discovering how young men do feel once they have been formally initiated into such contemporary secret clubs as, say, the Senior Societies at Yale. But we cannot help suspect the lad's vinegary aftertaste when he settles down to a life of miserable secrecy with a "brother" who, maskless and banal, sits next to him in French class all year. Perhaps the delight of sensing the semi-devout curiosity of less favored students is adequate compensation, just as the feeling of becoming supernatural at appointed times of the year may compensate his savage counter part. But somehow, in each case, once the secret veil is rent the illusory grail would seem to contain but small beer compared to the heady wine of agreeable mystification.

Relatively few of us, for better or worse, ever find our way into masked societies. For the most part our associations with masks are connected with the stage. Every schoolboy learns about the Greek theatre where the tragic actors not only wore thick-soled shoes bearing a startling resemblance to our a sequence of guises sufficient to trace the career of a single character from childhood to senility. Texture and coloring were also varied so as to signify particular states of health and emotion.

To put on a mask in ancient Greece was to act, and the rites in honor of Dionysus, for all practical purposes, were the springboard of the intensely vital Greek drama. Before this god of vegetation took his place in the Greek hierarchy, there was only masked ceremony; after him there was drama.

If we are to seek the origin of the mask in general we must also discover the first theatre, for the two, inextricably bound up with religion though they are, seem to be very nearly synchronous.

The written play is a product of rather advanced civilization. It had no place in the savage's scheme of things. His theatre which was and is the outward, tangible, form of his religion was expressed in that ancient and honorable art—pantomime—of which the mask and the dance are inseparable accompaniments.

When the American of today takes brief summer leave of pavements and subway trains to return to the open country, he cannot fail to see and hear the things which so profoundly influenced the savage. The billowing movement of wind through the tall that could be as fast as his own excited pulsebeat, or as slow as the passage of planets in their orbits. There is a simple savage credo in Gershwin's "I got rhythm, who could ask for anything more" which has quite as deep a meaning as Browne's loftier "music of the spheres."

And out of this profound feeling for rhythm came the primitive's dance and his pantomime and the masked rites that probably arose in connection with his totems.*

Who was the first actor? In all probability the hunter. After the tribe had eaten the kill and tossed the bones to the dogs, he would rise to regale them with the story of the chase. Doesn't it seem logical that he would imitate first himself creeping up on the unsuspecting animal and then, seizing the hide and severed head of his erstwhile quarry *(to put on a mask is to act)* prance about in the firelight mimicing its startled snort and futile efforts to escape? There in the circle of bare earth around the campfire the first play was acted and the hunter gave an inspired performance, as the flickering flames cast strange shadows and lent a wierd, subtle grace to his movements; for the campfire was an important property. It was the first stage lighting.

How long ago this play took place we can only guess. But carvings on the walls of Stone Age caves picture

modern beach clogs, but further enlarged their presence by masks fitted with mouthpieces which, like the bell of a trumpet, served to carry the lines of Aeschylus to an open-air stadium full of spectators. These masks were made in such variety that they could supply individual actors with yellow grass of the fields and the majestic bending of trees in its path. The lapping of the waters of rivers and lakes and the heavy pound of ocean waves; the slow rising of the moon and the setting of the sun; all this, like the fleeting gait of his game animals in the bush, reflected a rhythm the ritual of the re-enacted hunt and show that animal masks were even then well known.

Whenever it took place, the play, if

Totem Poles, Totemism Today and Tammany's Tiger which appeared in this department last February, 1938, contains a discussion of the difference between totems and animal worship.

not tragedy according to our definition of the word, was certainly no laughing matter. It was at the very least heroic drama. Many centuries rolled by before the mask of the clown bowed its jocular way into the world. Only when man had learned to separate his pantomime from its deadly serious religious context could comedy emerge; and, except for Aristophanes, comedy rarely reached its highest level until Molière graced the age of Louis Quatorze. In the interim, however, and possibly from shortly after the time of the first play, masks made their independent appearance on every continent of the earth. From the beautiful turquoise creations of the highly civilized Aztecs, which gave rise to the picture language of that people, up through the wood-carving cultures of the Pacific Coast Indians to the Eskimos of the North, masks had early become a favored medium of artistic expression. The materials were determined by the particular locality, but whether it was worn by a Vancouver Islander like the one on the cover of this issue of NATURAL HISTORY, or by a Congo tribesman, the mask cast its mysterious spell.

Out of the primitive notion of scaring demons from the temples, developed the Japanese nō drama, one of the most polished though highly stylized dramatic forms in the world. In Tibet, masks were donned by lama priests in a dramatic ceremony symbolizing the seven incarnations of Buddha. While in China, the masked play also took a religious form with stylized stock characters.

Although Buddhism seems to have tolerated and even encouraged the mask, Mohammed would have none of it. When his militant teachings swept over Islam, artists were forbidden to make anything in the image of man in vegetable or animal form. This doomed masks and fetishes of all kinds, and acting suffered accordingly. Mohammed has been called the Hitler of the Arabs, and I venture the scholar who essays the task of documenting this resemblance would find it difficult not to comment on the curiously similar effect of both these men upon the art that preceded them.

It may well be that such sweeping repressions as the gutting of a national theatre are generic to every religion that arises under more or less revolutionary circumstances. It is certain at any rate that when Christianity had freed itself of the catacombs and become the vital force in Western civilization, both the mask and the thetre suffered equally from the wrath of a new ascetic philosophy. The early Christians were determined to take measures that could mean nothing short of sudden death for the theatre —lock, stock and barrel, or rather, masks, plays and players. Of course, what the Christians trampled out had been slowly dying for a long time. That they refused baptism to both actors and actresses did not suddenly stultify the profession's social standing at one stunning blow (only recently has it recovered something of

its one-time respectability). The actor's status had been sinking ever since greedy Roman producers formed the picaresque habit of flogging a batch of unwilling Welsh slaves into pulling on thick-soled shoes, masking and learning parts that were cheerfully transcribed from Greek texts without much thought of a credit line. The arrant commercialism of the sprawling Roman empire had slowly undermined the vitality and travestied the content of the Greek heritage. The theatre had lost all touch with its source in serious religion and was already disappearing without benefit of the rising Christian clergy. Although to put on a mask is to act, Roman taste, coarsened into insensitivity by circuses and "Triumphs," could no longer get any thrill out of simple dramatic exposition. Thus the mask rapidly died out. What took its place? The same thing that took the place of orthodox acting in some moving pictures of pre-depression America.

The resemblance of declining Rome to this particular period in American life has by no means been neglected by various commentators. It seems to have been a case of two cultures responding to forces which were markedly similar in many respects. What the theatre men gave the Romans was precisely what Mr. C. B. DeMille gave the Americans—spectacles. But the Romans did Mr. DeMille one better. Instead of blatant posters proclaiming the "super-colossal" qualities of the spectacle, paid claques—almost tantamount to cheering sections —were sprinkled through the amphitheatre. The spectacle itself, lacking the resourceful trickery of the camera, went in for grim reality. In watertight bowls whole fleets of nearly lifesized ships came to grips in naval battles with no holds barred. And at the close of the evening's performance the pool was drained and the corpses of those drowned in the "sham" battle were lugged off to the lion's den.

Small wonder that the early Christians were against the theatre. So harsh were their decrees once they had gained power that all pretensions to a legitimate theatre disappeared and gradually the jongleurs (from which our term "juggler" is derived) took its place. As the term implies these performers, largely made up of minstrels and acrobats, were the forerunners of the wandering vaudeville company. But the theatre proper was never completely crushed. The common people were much too fond of the masked mimes to give them up so easily. And it is not difficult to see why. On the evidence of cave drawings, masked drama in some form had existed in Europe since the Stone Age, and was deeply ingrained in the popular mind. Before the Medieval era had progressed very far, the Church had learned this to its profit. Many forms of art had been proselytized in teaching the rising religion. It is no secret that some of the greatest Italian painters produced their finest work under the aegis of the clergy. Similarly the prevailing love of theatre was utilized in the rapid spread of papal doctrine over all Europe.

Mother Church proceeded to consolidate her position by producing the celebrated Miracle Plays. Thus masks, long the implements of primitive religion, shouldered the task of spreading the Christian gospel. No longer fashioned to represent creatures from the pagan's world of spirits, they helped portray the lives of saints and stories from holy writ. Terrifying devil's masks preached the first "fire and brimstone" sermons, while an English record dated 1504 tells of paying "for a pound of hemp to mend the angels heads" and another of "eight heads of hair for the apostles and ten beards, and a face or visier for the devil."

But the Miracle Plays were sometimes little easier on their actors than the Roman spectacles. A fifteenth century record discloses that the men playing the parts of the crucified Christ and the hanged Judas were taken down just in time to escape death. It seems likely that this earnest "realism" was to be expected of the crude strivings of an art-form emerging in a none too gentle time and place. The passion play of Ober Ammergau, which is the modern version of these Miracle Plays, happily wreaks no such near-disasters among its actors.

The clergy itself had early taken to wearing masks. At the Feast of Fools, a festival of decidedly pagan origin, some of them turned their vestments inside out and conducted such hearty buffooneries within the church itself that Innocent III had finally to ban clerical masking in 1207.

Eventually the Miracle Plays passed out of the church and the more or less independent actor again contrived to show his head. With this secularization came the Morality Plays, a stylized drama changelessly revolving around the concept of Good and Evil engaged in pitched battle over the protagonist's soul.

Meanwhile the jongleurs and minstrels had evolved the Commedia dell' Arte whose intense influence on the development of the modern European theatre via Molière and Shakespeare is axiomatic in any history of the stage. What became of the mask in the hands of these early masters of modern stagecraft? The folk theatre had developed such familiar masked personages as Harlequin, Pantalone, and later, Punch. From the former had come the half-mask of the garden parties in Renaissance Italy and later the masked ball. Then, too, the Feast of Fool's masks seem to have been adapted to such long-lived festivals as Mardi Gras. But, although "Masques and Madrigals," familiar pastimes of noblemen, gave rise to such masked fantasies as *Mid-Summer Night's Dream,* as a device for serious dramatic expression the mask began to dwindle. A wedge had once more been driven between the theatre and religion and this figurative operation seems always to bring on the decadence of the mask.

There are, of course, mechanical reasons for the decay of the mask in modern theatrical production. From Shakespeare's time to our own the emphasis has been on the spoken word, the interplay of dialogue and on realistic action. By its very nature the mask would fit angularly into such a program. It requires slower, more cadenced movement on the part of the actor, obviates delicate nuances of expression and muffles the quick "catch" line. Once lifted out of its proper environment, it becomes too specialized and unwieldy an instrument for any appreciable exploitation in the theatre of the last 300 years. But this does not mean that the mask is doomed. It has enjoyed an astonishing longevity, for instance, in China, where the strictest traditions prescribed the precise type of mask to be used for each of the unabashedly stock characters. It is curious to note that the Chinese theatre is, however, a very moralistic one in which most of the plays consist of interminable sermons, not infrequently conducting the audience through all of the 128 hells in the ten purgatories of Chinese religion. The entire theatrical performance seems indescribably chaotic to western eyes. The audience leaves and returns at will and seems to be constantly in a state of flux. Small groups drink tea, chat and even play games during unimportant parts of the drama. Yet all this is not so far from certain aspects of our own theatre as we might at first imagine. In China the property man is almost always on the stage. But the same was true of last winter's Pulitzer Play. Furthermore, the fact that the breadth of his purgatorial display often obliges the Chinese producer to start in the middle of the afternoon and continue the performance all night harks back to our own theatre of less than a decade ago when the maze of Freudian psychology forced Eugene O'Neill to appropriate almost as much of his audiences' time. Mr. O'Neill, it will be remembered was also stimulated by the Greek drama and was indeed the author of probably the best known modern play in which masks were used throughout.

It may or may not be significant, but the writer cannot bring himself to regard as accidental the fact that our only broadly successful contemporary exponent of the mask should also be something of a preacher. Mr. O'Neill's work can scarcely be classified as religious in the limited sense of the word, but he is a forceful expressionist with some profound theories about human life, which is probably all that can be expected from an individual philosophical proponent in a disunited and polytheistic world.

The mask, however, cannot safely entrust its future to the chance arrival of unusually gifted personalities like Mr. O'Neill. Its most durable function seems to subsist within the limits of serious symbolical art—a form which does not mix well with the so-called realistic theatre. The extent of its dramatic use in the years to come would seem then to be contingent on the future emergence of a widely accepted, deeply moving faith or philosophy which would require a symbolistic teaching. Devotees of the mask who would welcome such a movement should take heart at the sudden vitality recently exhibited in some theatrical quarters, which may indicate that the mechanism for the triumphant return of the mask is already at hand.

INFORMATION TEST

A few informational high spots that may be gleaned from this month's NATURAL HISTORY

Score 10 points for each correct answer. Correct answers on page 318

1. It has been discovered that a tribe in equatorial Africa

....*(a) wears chain mail today,*

....*(b) can read Egyptian heiroglyphics,* or

....*(c) are all color-blind?*

2. When two species of animals live together and share the same food it is known as

....*(a) polymorphism,*

....*(b) commensalism,* or

....*(c) asexual reproduction?*

3. The most powerful batteries of sting cells known to exist among sea-creatures are possessed by

....*(a) the sting ray,*

....*(b) the Portuguese Man-of-War,* or

....*(c) the barracuda?*

4. Plants that abandon all connection with the earth and grow on other plants are called

....*(a) epiphytes,*

....*(b) Mammalia,* or

....*(c) hydroids?*

5. Mushrooms and ringworm disease both belong to the division of plants known as

....*(a) fungi,*

....*(b) mosses,* or

....*(c) epiphytes?*

6. The largest tree ferns living today attain a height of

....*(a) five feet,*

....*(b) twenty feet,* or

....*(c) eighty feet?*

7. The walking fern is so called because

....*(a) its waving fronds resemble a person walking.*

....*(b) its spores can be seen marching in regiments,* or

....*(c) it turns the tips of its fronds downward to root in the soil, generation after generation?*

8. The "hand-spring" is a method of locomotion used by

....*(a) the dik-dik,*

....*(b) the fresh-water hydra,* or

....*(c) a puff adder?*

9. While fossil hunting in inner China, Doctor Granger was in competition with

....*(a) drug merchants,*

....*(b) bandits,* or

....*(c) missionaries?*

10. A gaur is

....*(a) a giant bovid that lived several hundred thousand years ago,*

....*(b) the giraffe's ancestor,* or

....*(c) a rare horse?*

FUNGI—WONDER PLANTS

Continued from page 303

be held partly by an adhesive substance. Finally, when the worm has ceased to struggle, the fungus pierces the body of its victim to utilize the contents as food.

A fungus which makes itself known to every housewife is *Rhizopus,* the common bread-mold. A loaf of stale bread, if kept moist, is almost certain to become covered with the black growth. Like all its fellows, *Rhizopus* grows from spores which are in the air or on some surface with which the bread comes into contact. It grows with amazing speed, in a day or so often covering the entire loaf.

Under the microscope, *Rhizopus* is seen to consist of long upright stalks, several arising from a single point. On the end of each stalk is a black spherical mass of spores much like the black head on an old-fashioned pin, and in each head there are many spores ready to spread the mold through all sorts of food. This organism is one of the very common causes of spoilage of vegetable matter, and it seems to have no special beauty to make amends for its bad habits.

Rainbow tints

The blue and green molds are members of a ubiquitous group causing the decay of fruits and sweet materials such as preserves. *Penicillium* produces spores in chains at the end of a whisk or brush-like structure of sorts, while *Aspergillus* has its spore in chains radiating from a central globular head. These molds produce spores in millions, and a puff of air over a musty orange sends a visible cloud of green into the air. Aside from the tremendous damage to almost all kinds of organic material caused by the green molds, they are interesting because of their diversity of form and, above all, their color. When grown in culture they are rainbow-hued. Frequently bright green spores are produced and the nutrient medium is colored purplish, affording a striking color contrast.

These are but a few of the hundreds of fungi to be found everywhere—

"Earth's crammed with heaven
And every common bush afire with God:
But only he who knows takes off his
shoes. . . ."

When we have become aware of the existence of the fascinating world of the fungi, we are astonished to find them practically everywhere, intimately associated with all living things, including man. "Intimately" is not merely a figure of speech, for in addition to growing upon and often destroying his crops, destroying produce of all sorts including the timbers of his home, fungi attack man himself. They are able to grow on the human skin, and in the ears, and may be a source of great discomfort. Ringworm is a fungus disease, as is also the affliction known as Cuban Itch.

Living things which man must encounter perforce, which he must tolerate in every phase of life or else combat, are surely worthy of a little attention. If he is to prevent the depredations of fungi, he must learn the secrets of their habits. The reason why fungi are such queer fellows as to form and why they are able to thrive where other plants would fail, must be sought in a knowledge of their structure and life processes. The word "plant" in the popular mind refers to a green thing with stem, leaves and roots, such as a garden lily. The same essential features are possessed by a host of organisms ranging from very small weeds to the great trees of the forest. The name "flowering plants" is applied to them for the very good reason that they all produce flowers. Flowers exist for the purpose of producing seeds, bodies capable of giving rise to new individuals, weeds or trees. An important fact which should be borne in mind is that every seed contains a minute embryo plant.

In addition to the great group to which the garden lily belongs, there are countless humbler plants which lack flowers. To this class belong the ferns, mosses, and certain lesser known kinds such as horsetails, club mosses, algae and fungi. In this lower stratum of plant society, reproduction is not by means of seeds, but by spores which are minute bodies, simple in structure and not containing an embryo. In fact a spore usually consists of a single cell. Like seeds, however, spores propagate the plant which produced them. The spore-producers are considered to be more primitive than the seed-producers. Primeval plants were doubtless of this lowly kind, the more highly developed flower and seed-producing types appearing later in the evolution of living things.

Fungi need no light

The fungi differ from their relatives among the spore-producers and also from the flowering plants in one very important respect: they are not generally green. The green leaves and shoots of higher plants owe their color to the presence of a substance called chlorophyll. Utilizing the energy of the sun's rays, chlorophyll is able to convert inorganic chemical substances, obtained by the plant from the soil and from a gas which is present in the air, into the very valuable material starch. Light is absolutely necessary for this, and green plants must have light in order to carry out a process which is the basis of their growth.

Fungi, on the other hand, lack chlorophyll: any green color which they may have is due to the presence of some other substance. Most mycelium is actually colorless. Fungi require organic materials such as sugar and protein for food, materials, that is, which have already been built up from simpler chemicals through the activity of green plants. A lily may grow and thrive in soil from which it derives only simple chemical substances, but it must have light. A fungus lives upon more complex organic materials, but it is able to live in darkness.

To make a final comparison, the lily grows relatively slowly because of its complex structure. The fungus plant body, you will remember, consists of a simple network of threads and it is only when spores are to be produced that more complex organization occurs. Rapidity of growth is correlated in the fungus world with the simple form of the vegetative body.

Let us bear some of these considerations in mind when next we see a mushroom or a growth of mold. Remember that the fungus came from a spore which germinated and grew into a thousand lovely threads. Using as food the organic substances upon which it grew, it caused the decay of those materials. We can no longer hold the view of the ancients that fungi arise spontaneously from decaying things. Curbing our annoyance at the loss of a basket of fruit or a loaf of bread, let us examine the molds with a magnifying glass to see what marvels of color and form will present themselves and let us recognize the fungi as organisms having their own place in the scheme of things.

Many years ago, the master Swedish botanist Carl Linnaeus wrote these lines: "He looks upon a globe varying in a thousand ways, so that new things are always presented for the delight of his curiosity, lest the threadbare common objects make him weary."

As long as we possess a bump of curiosity, we need never grow weary!

BLACK KNIGHTS

Continued from page 263

means least, a small saluting cannon that made a satisfactorily ear-splitting noise. He was impressed; that was obvious.

By this time the interpreter had gotten hold of himself; and, while evidently still in mortal terror, recovered enough of his voice to translate for us the king's booming expressions of thanks.

We carried on a rather three-cornered conversation for a few minutes, as we explained to him how his wives should affix the latest thing in bracelets, necklaces, earrings and Woolworth clips, though the latter were quite a problem, as the ladies were blessed with neither clothing nor hair.

We could see that his Majesty was intensely curious about something, and finally it came out. How was it, he wanted to know through our groveling friend, that a chief of the obvious importance of Mr. Thaw, traveled with only one wife? Surely this was far beneath the dignity of so august a personage! It was carefully explained to him that the reason for this obviously ridiculous state of affairs was the fact that we had traveled for many moons from the lands that lay beyond the Great Sands, and that we perforce had to travel light. Hence the rest of the harem had been left at home under the usual strict guard of fifty armed giants, and only the favorite wife had been chosen to go along. This was pretty thin, and we could see that he only half believed it. How, for example, did all the heavy work of the expedition get done unless an adequate supply of wives were along to do it?

Machine-age magic

We further explained to the Lamido that his fame had penetrated far and wide and that, if he and his people would perform before our magic boxes that recorded their every act and sound, we would disclose great magic to him. He agreed to this and instructed the interpreter to conduct us and our boys to a compound, behind his palace, that had been reserved for us.

The next morning, comfortably ensconced in our compound, presents from our host began to arrive, borne by a small array of palace slaves. Cooked meats; honey; peanuts; rice; potatoes; beautifully woven grass mats; leopard skins; and a bow and quiver of arrows, followed one another until the courtyard was filled and we were wondering how we could ever carry away so much stuff. Outside, a squad of women had been detailed to supply us with water and wood.

Soon the interpreter arrived resplendent in one of our swords and a fireman's brass hat jauntily perched on his woolly head. He informed us that if our magic boxes were ready the Lamido was prepared to honor us with a parade of several thousand of his troops. Tom Hogan, our cameraman, gathered together the three movie cameras and the sound recording apparatus, and we crossed the central square to a place of honor near where the king was to review his army.

The square was lined with black faces and was a sea of spears; for the king only appears in public once or twice each year and when he does, it is a gala event. We did not have long to wait. A rhythmic booming on a dozen great war drums, each borne on the head of one man and beaten by another, signaled the king's approach. Soon the gates were flung open and, borne on the heads of 20 men, appeared Bouba Djamaha, in a huge sedan chair.

The population went wild. Drums and tomtoms beat. Weird trumpets and other musical instruments blared. No attempt whatever was made at harmony—it was just din. The ovation lasted a good ten minutes, and then the parade started.

An amazing procession

It was medieval pageantry. Squadron after squadron of mailed and helmeted cavalry swept by. The horses wore quilted armor of the crusader type while the helmets were reminiscent of those peaked affairs of the soldiers of Saladin. Company after company of infantry tramped past, huge rhinoceros hide shields in one hand and bundles of throwing spears in the other. Even their weapons were different from those found elsewhere in equatorial Africa. Many carried swords, while the archers, resplendent in leopard skin uniforms, bore weapons which reminded one of the English long bow, and a quiver for arrows slung on the back.

How could this armor have reached central equatorial Africa? It seemed genuine and of the period. The mail was of steel; and, while the African can smelt iron from his native ores, he has no knowledge of making steel; nor has he the skill to make closely woven chain shirts. The West Coast of Africa was unknown during the Middle Ages. Could this equipment have filtered down, in some bygone century, over 4000 miles of desert and jungle, from the Arabs to the Touaregs, through the Housas and on to the people of Bantu stock? It seems almost impossible, considering how perishable medieval chain mail is and even allowing for the unusual care that a primitive people might bestow on anything to them so wonderful. Yet here it was, in everyday use.

Chain mail of oriental design and manufacture was worn for ceremonial purposes in China, Japan, and elsewhere

Continued on page 314

Meeting a Cattalo

By Clyde Fisher

THE Cattalo is coming. And I mean literally. For two years he has been on his way toward the rising sun. His home is in the great Northwest (Grand View Ranch, Colville, Washington). Since 1936 he has been lumbering along, at 8 or 10 miles a day, drawing his driver and wife in an old-time covered wagon. When I met him in late April of this year, he was nearing St. Louis, having traveled a little more than halfway across the continent.

Although I had heard of this interesting hybrid—a cross between a domestic cow and a buffalo bull, named by "Buffalo" (Col. C. J.) Jones the "Cattalo"—I had never seen one. In the North Dakota State Museum in Bismarck I remembered seeing the dressed skin of one of the beasts, the thick, woolly hair resembling that of the bison parent more than that of the domestic cow.

When we first spied the covered wagon approaching, I thought it was being drawn by a horse, but as we came near I noted that the animal resembled a buffalo, and then it flashed upon me that it was a *cattalo*. So, we stopped and had a talk with the cowboy driver, an affable fellow, who was pleased to find someone who knew his animal was a cattalo. He told us that "Jumbo" was born in 1929—the father being a buffalo bull and the mother a Holstein-Shorthorn cow. The hybrid offspring, now a magnificent, burly beast, is entirely jet black in color. As an 8-year-old he weighed 2,300 pounds. When the driver learned that I was a museum man, he was sure I would be interested in Jumbo's shoes. So, he whispered into the animal's ear, and Jumbo, showing creditable understanding, immediately lifted a forefoot and turned up one of his divided iron shoes so that I could examine it. Without these metal shoes, similar to those put on the cloven hoofs of oxen, it would have been impossible for him to travel as he has over hundreds of miles of paved highways.

Although he readily complied with this request, he did roll his eyes and wriggle his ears, I thought, a little disgustedly. Evidently he was in the best of health and in perfect condition—a beautiful beast—but I imagined he looked a little homesick for the ranch, or possibly for the Great Plains of his bison ancestors.

In this modern machine age, when some of us drive across the continent and back on a two weeks' vacation, it is good to find a man and wife so unhurried that they are willing to take three or four years to travel from the Pacific Northwest to the Atlantic seaboard. It takes one back to the days of the Oregon Trail. At the speed Jumbo is traveling, he should be in New York City in time for the World's Fair, and if that is not a treat for a cattalo, it will be for those who see this fascinating animal.

YOUR NEW BOOKS

SCIENCE FOR THE CITIZEN • ORIGIN OF LIFE ON EARTH

CANOEING NATURALISTS • ANIMALS' SOCIAL LIFE • OUR FORESTS

ANGLER'S FIELD BOOK • AFRICAN ENCHANTMENT

SCIENCE FOR THE CITIZEN, A Self-Educator based on the Social Background of Scientific Discovery

- - - - - - - By Lancelot Hogben

Alfred A. Knopf, $5.00

THE author of *Mathematics for the Million* has undertaken an even larger field in this new book, which he says "is partly written for the large and growing number of intelligent adults who realize that the *Impact of Science on Society* is now the genuinely constructive social effort. It is also written for the large and growing number of adolescents, who realize that they will be the first victims of the new destructive powers of science misapplied."

The book is divided into five parts; namely, The Conquest of Time Reckoning and Space Measurement, The Conquest of Substitutes, The Conquest of Power, The Conquest of Hunger and Disease, and The Conquest of Behavior. The author evidently believes in the innate curiosity of man and in his practical educability. At the same time he shows that it is social necessity that determines the field to which the scientific investigator directs his search.

To master the first part of the volume will give one a working knowledge of astronomy and physics, with a background of the history and the social necessity that has directed the development of these sciences. Aided by clear, illuminating drawings, the reader understands how Aristarchus measured the relative sizes of the sun and moon, how Eratosthenes measured the size of the earth, exactly how to make and calibrate a sun-dial, how the distance of a star is measured by its annual parallax—to mention only a very few of the steps in the history of astronomy. The basic principles of optics are clearly set forth.

Since Professor Hogben does not hesitate to popularize most abstruse phases of science, one wonders why he does not go beyond Newton's law of gravitation and give us a glimpse of Einstein's theory of relativity.

The second part is a fascinating story of man's conquest of materials, the history of chemical achievement. With no attempt to separate physics and chemistry, and beginning with man's earliest practical efforts to make the most of his environment, the growth is carried, without hesitation, through the marvels of coal-tar products and other organic compounds.

In part three, we have a century of inventions with a consideration of "the superfluity of mere toil"—the invention of the ship, the steam engine, glass and pottery, the magnetic compass, the lightning conductor, the electric battery, etc. In fact, we have here the story of the development of the electrical industry. The chapter, entitled "The Waves that Rule Britannia," traces the history of communication.

In The Conquest of Hunger and Disease are found such absorbing subjects as the discovery of micro-organisms, the development of asepsis and antisepsis; the use of anaesthetics in surgery; and the ascent of man or evolution controversy.

In The Conquest of Behavior is a chapter on Animal Magnetism and one on Nature and Nurture, with reference to "superstitions of our own times."

This volume consisting of more than 1,000 pages, illustrated by nearly 500 excellent illustrations, is much more than an encyclopedia. It is a most inviting textbook covering practically the whole field of science, and at the same time it is a fascinating history of science, written from the standpoint of social necessity. While the scientific considerations are somewhat more technical than the popular writings of Huxley and Tyndall in more restricted fields, the treatment may be compared favorably with that of these great popularizers of science.

CLYDE FISHER.

CANOE COUNTRY

- - - - - - - by Florence Page Jaques

Illustrations by Francis Lee Jaques

University of Minnesota Press, $2.50

"A THING of beauty is a joy forever," and here is one created by Jaques and Jaques, for it is impossible to dissociate the drawings and the text of fellow artist-naturalists who are also husband and wife.

The canoe country is in northern Minnesota and the adjacent parts of Canada, along the half-forgotten trails and portages of the trappers and *voyageurs*. On August 25th of a year not long gone, the canoe trip of these cheerful companions began, and the pages of journal and pictures tell of the crowded and everlasting adventures that befell them until they returned too soon from the wilderness on September 10th.

The book is a record of description and feeling, set down with delicate and whimsical charm. Mrs. Jaques writes:

"These voyaging days are translucent with joy. When we start out in the morning, the earth has such a before-Eden look that it seems a shame to shake the dew from the blueberries or strike our paddles into the sleeping water. Thrusting on into sunfilled channels; drifting into green-needled embrasures where chicadees are buoyant; landing on a beach to bathe and to read the overnight paw prints—it is all intoxicating."

But incidentally, the text teems with vivid natural history no less than with the joy of living: ". . . bears will not condescend to horry if they know you are watching them, but they make up for it as soon as they think they're out of sight." How true this rings for anyone who has become familiar with bruin in his own country!

"It was a porcupine, up in a cedar tree, with its head between its paws, crying and crying."

"One couldn't comfort a porcupine," adds Mrs. Jaques, but she could watch it and tell faithfully about its subsequent behavior, as also about that of the moose which, "when they finally did see us . . . didn't believe in us."

The illustrations are varied and beautiful, and since they reflect part of a common experience are peculiarly at one with the text. The landscapes are convincing, with powerful treatment of light and shadow on forest, bluff and water. The animals look alive and, although Mr. Jaques is best known as an accomplished painter of ornithological subjects, his mammals are, if possible, even more appealing than his birds. There is something inimitably faithful in the popping eyes of his woodmice and the twisted wiggle on the muzzle of his watchful doe.

This is a book for the shelf of special treasures.

ROBERT CUSHMAN MURPHY.

THE NATION'S FORESTS

- - - by William Atherton Du Puy

The Macmillan Company, $3.00

"IN some European countries no tree can be cut without permission . . . every twig is saved for fuel, and in some places even roots are grubbed out of the ground and burned." So graphically William Artherton Du Puy epitomizes the scarcity and value of forests, and brings home to Americans the grave realization that forests in the United States have been treated with a casualness almost unprecedented.

The timeliness of the subject-matter, its portent as a basic resource, its complexities, its vast economic and social ramifications, its personalized character since each citizen is entitled to one and one-third acres of the 175 million acres in our National Forests—all these various aspects are making the subject increasingly important to the lay reader as well as to the forest technician.

And here is described in fluent detail, and augmented by well-chosen photographs the nature of our forests; their history and beauty; the migratory growth of the lumber industry; the economic and social value of forests, including chapters on Cutting Selection; Planting Forests; Erosion Control; Fire Prevention—approximately ninety percent of all forest fires being caused by the carelessness of "nature-lovers."

Additional chapters discuss Recreation; Wild Animals in the Forest, Range Management; Wilderness Areas; Products of Wood; and finally, State and Private Forestry, concluding that as master-conservationist, the Government's most important timber task is to bring privately owned timberland under proper care and management.

Both descriptions and conclusions are the result of first-hand contact with forest conditions. In an interesting Introduction to the book Mr. F. A. Silcox, Chief of the U. S. Forest Service, says of Mr. Du Puy: "He has traveled from coast to coast; has seen floods, erosion, and the human exploitation that follows forest exploitation."

It is undoubtedly this first-hand, factual knowledge that has made the author a protagonist for conservation, believing that "if all the forestlands in the United States were working efficiently at their tasks . . . the wealth which they would be piling up would be almost beyond the measuring. Their failure to do this is just so much loss in national wealth and human well-being."

R. Neumann Lefebvre.

Field book of fresh-water fishes of North America north of Mexico

- - - - - - - - - by Ray Schrenkeisen

Edited by J. T. Nichols and F. R. LaMonte

G. P. Putnam's Sons, New York and London, $3.50

The late author of this work was an enthusiastic fisherman of wide experience, who set for himself the ambitious task of compiling a convenient field book of the fresh-water fishes of North America, north of Mexico. There was no lack of material to draw from. A less careful man than Schrenkeisen could have wrought a great deal of confusion merely by errors in copying and a less experienced and sagacious man would have been constantly getting lost in the details, especially those relating to nomenclature.

After his untimely death on July 6, 1936, his scientific heirs and executors, Mr. J. T. Nichols and Miss F. R. La Monte, both of the American Museum of Natural History, inherited, so to speak, his manuscript for the work, consisting of four very large notebooks written in pencil. It has been their pious and most useful labor, first, to check everything in the manuscript against the original sources, secondly, to preserve the author's own observations, thirdly, to supervise and check the preparation of a uniform series of text figures derived from all available sources and embodying the chief diagnostic characters of the leading types; finally, they have prepared a glossary of scientific terms and a very full index. Such labors of author and editors could be brought to this successful issue only by a deep and sustained love of the subject. From now on, no intelligent angler or others interested need wander hopelessly through several thousand pages of scientific text in order to identify his fishes. He can carry this little book in his pocket and identify his catch while waiting for the next strike.

W. K. G.

Frontiers of enchantment

- - - - - - - by William R. Leigh

Simon and Schuster, $3.00

William R. Leigh has chosen a marvelous title for his book, and the mere thought of learning the impressions of an able artist about such a wonderland as Africa is sufficient to bring great expectation. For those who know him personally, the book is a fulfillment of that expectation and to all others a great treat lies in store. In these pages, profuse with illustrations, he takes you with him to Kenya Colony and the Belgian Congo and then back again to Tanganyika.

Interspersed in the account of his own experiences while traveling and painting he relates tales of excitement from other sources, but the real interest comes when he goes into the Congo for the Gorilla background. The description of the scenery in this land of volcanoes is very convincing. It is hard to believe how steep the slopes of Mount Makino are and yet how plentiful the vegetation. Mr. Leigh's description of the still chill of night and the deep penetrating force of quiet rains in the moss laden forests takes me back to that land of beauty. Touching, too, was the description of the passing of Carl Akeley—a great character who had an idea that materialized into a magnificent memorial both to the man who lies in the land of his dreams and to the fauna of a continent he dedicated his life to.

One naturally expects much in the way of illustration from such a book. Here again the creator is personified. At first glance, it is reminiscent of Mutzel in Brehm's *Tierleben* and connotes the educational influence of years at München, a style surprisingly appropriate for one who has lived a long full life and now depicts the creatures of a continent with which we all first became acquainted from engravings of the same school.

GARDELL CHRISTENSEN.

THE FAMILY, A DYNAMIC INTERPRETATION

- - - - - - - - - by Willard Waller

Dial Press, $4.00

PERSONALITY development, the formation of habits, and the adjustment of the individual to his environment form the backbone of this broad treatment of family interrelationships. Every method of approach is utilized as the author delves into Freudian psychology, Watsonian behaviorism, anthropology, primitive folklore, and modern child study theory. Professor Waller's own analyses are colorfully presented against a background of interesting case studies which he has recorded.

Designed primarily as a text-book for students in a sociology course at Barnard, the material is arranged into compact sections with a long bibliography and a set of problems and projects at the end of each chapter. The author sets forth five normal stages of family experience: life in the parental family, courtship, the first year of marriage, parenthood, and the empty nest. Due to inadequate material, he has omitted discussion of the final stage but has added an interesting section on family disorganization including bereavement and divorce, the latter having been the subject of a previous work.*

The book is interesting both for its interpretation of the modern family and for the picture it gives of the frank, analytical way in which family problems and adjustments are being studied by undergraduates in several of the leading women's colleges. This realistic approach to marriage and family relationships, by those who are soon to start families, is a long step in the right direction and may prove more valuable in its way than the establishment of marriage clinics.

Through it all, Professor Waller views the institution of the family not as a moralist or sentimentalist desiring to preserve the patriarchal family, but as a sociologist who sees the necessity and inevitability of changing mores in a changing culture pattern.

J. J. B.

* Waller, Willard, *The Old Love and The New*, Liveright, 1930.

THE ORIGIN OF LIFE

- - - - - - - - - - - by A. I. Oparin

Macmillan & Company, $2.75

IN this book, the associate director of the Biochemical Institute of the U. S. S. R. Academy of Sciences develops the often discussed but never proved story of the origin of life. Professor Oparin describes an ancient period in the history of the world, when a gaseous mass separated from the sun and became the earth.

He conceives that the primitive atmosphere contained neither carbon dioxide nor nitrogen and that earthy carbon was either in its elementary form or as hydrocarbons. Although present-day volcanos belch forth carbon dioxide, this is supposed to be due to the incorporation of later sediments into the earth's interior. Professor Oparin assumes that the hydrocarbons gave rise to alcohols, aldehydes and organic acids. In time, relatively complex molecules formed in the presence of water. With the accumulation of these molecules colloidal phenomena began to play a part in the genesis of complex chemical systems capable of forming living material.

The most stimulating part of the book is the discussion of the genesis of oxygen-using organisms from the colloidal gels of these ancient times. The role of enzymes in the chemical organization of living matter is of interest in view of recent biological discoveries as to the nature of the gene or unit of heredity. The Russian and German points of view are developed most fully in the text, which opens up new fields of speculation as to the chemical origin of life.

G. K. N.

THE SOCIAL LIFE OF ANIMALS

- - - - - - - - - - - By W. C. Allee

W. W. Norton & Company, $3.00

PROFESSOR ALLEE and his students at the University of Chicago have played a leading role in analyzing the social hierarchies of animals. He has showed that it is of advantage for many animals to live in groups. There is an "unconscious cooperation" which is of survival value to these animals. Once this tendency to aggregate has become fixed by natural selection, social organization within the group can arise. This impressive study of the origin of social organization in the animal world Professor Allee has now summarized in book form.

Social growth reaches its climax in vertebrates and insects; consequently considerable space is devoted to the organization of these groups. Most of the analysis is drawn from the work of the "Ecological Group" at the University of Chicago to whom the book is dedicated. The book will serve as a handy resumé of the work done by this school of biologists.

The next to the last chapter of the book is devoted to "Some Human Implications." For years while analyzing the group behavior of birds, Professor Allee has refrained from comparing the "pecking order" of birds with the social hierarchies of the human species. In this resumé of his work he is equally conservative and restricts himself to enlarging on the value of "conscious cooperation" and the need for it in these days of increasing populations and intense national feelings. War is "nothing but an unmitigated disease of civilization." In all animal life "unconsciously or consciously, the innate urge toward cooperation appears even under circumstances where it would seem least likely to be fostered." G. K. N.

TECUMSEH AND HIS TIMES THE STORY OF A GREAT INDIAN

- - - - - - - by John M. Oskison

G. P. Putnam's Sons, $2.75

THE author of this book regards Tecumseh as by far the greatest Indian and greater than any white man of his time. A good deal of data about this Indian are given but so handled as to laud him rather than objectively appraise his work. One method the author uses to intensify the reader's sympathy is to treat William Henry Harrison as the villain in the piece. This is the method of fiction rather than history.

We are told that Tecumseh was born near Springfield, Ohio, in 1768, of Shawnee parents, and that his name meant "falling star." Tradition says he was present at the several battles preceeding Wayne's victory over the Indians at Fallen Timbers in 1794. There were no more major military operations until the fight with Harrison at Tippecanoe in 1811 at which Tecumseh did not function. The War of 1812 beginning soon thereafter, Tecumseh went to Canada, enlisted in the English army, and was made a brigadier general and killed in battle October 5, 1813. The book is well written and instructive, but contributes little that is new.

CLARK WISSLER.

BLACK KNIGHTS

Continued from page 310

in Asia as late as the 19th century. And despite the introduction of firearms, this type of garb served a more functional purpose in some Arab communities up to 15 or 20 years ago. Whatever the history of the military raiment of Rei Bouba, it was a spectacle before which the African traveler must rub his eyes, wondering in what country and what period he was.

We spent several days among this black nation, filming their customs and habits, before continuing our way southward the length of the Cameroons to the sea. We kept our promise to show some first-class magic to the Lamido by introducing him to ice cubes ("hard water that burned the hand") made in our kerosene-operated refrigerator, and by recording his voice and that of his court troubadors on records, which we immediately played back to them to their intense delight. When we left it was with real regret.

Africa is a vast continent, which contains in its millions of square miles things both strange and wondrous. We have traveled it over from Cairo to the Cape and from the Atlantic to the Indian Ocean, but never have we beheld anything more amazing than the Black Knights of Rei Bouba.

EXPOSURE METERS

By CHARLES H. COLES,

Chief Photographer,
American Museum of Natural History

THE Chinese are reputed to have preferred one picture to ten thousand words, but even the fastidious Orientals might have had their doubts if they had seen some of the under-exposed negatives that are common today. The advanced amateur has come to consider an exposure meter necessary to his best work, but it is usually the casual snap-shooter who needs its council more. Because of the infrequency with which he uses his camera, he never can remember what settings gave him successful results and he doesn't have the chance to become acquainted with his camera. Hence he makes the same mistakes again and again, fondly hoping that all his pictures will somehow come out.

The advanced amateur, on the other hand, is not satisfied unless each negative has all the quality the film is capable of producing. This result requires exact exposure, such as is generally impossible without a meter. You will never hear an experienced photographer scorn the use of a meter, and the results it makes possible should be the ideal of every picture-taker.

Types of meters

Exposure meters belong to two general types: visual and photo-voltaic. The first type of meter requires that the operator look at a series of consecutively fainter numbers in a dark tube. The dimnest number visible is a measure of the light on the subject toward which the instrument is pointed.

The photo-voltaic meter operates on the principle that light falling upon certain silver-copper oxide mixtures produces a flow of current in an electrical circuit. By metering the current produced, a measure of the light falling on the sensitive elements is obtained.

The advantages that are on the side of the visual type meter are quite important. The meter is lighter, smaller, sturdier, and less expensive than its electrical rival. The visual meter will operate in a much weaker light than will generate enough current to move the needle of an electrical meter. And its accuracy is sufficient to produce good negatives under normal circumstances once the operator has become acquainted with his instrument.

The photo-voltaic meter, since it is not subject to the variability of the human eye, has greater accuracy. With it a careful worker can produce the exact type of negative that he desires. While this degree of accuracy is not always absolutely essential in most kinds of photography, the most precise exposures are necessary for the finest results in color work and motion-picture photography with reversible film.

Continued on page 318

Who · When · Where

NOVEMBER CALENDAR OF ENTERTAINMENT

On these pages will be found a calendar of museum events in metropolitan New York for November. It is hoped that this list will enable those at a distance who contemplate a visit to New York to plan more efficiently, and that those who live in or near the city may be able to choose lectures and other activities that fit their needs or interests.

CHARLES RUSSELL,
Curator of the Department of Education, American Museum of Natural History

General Information

AMERICAN MUSEUM OF NATURAL HISTORY
Central Park West at 79th Street, New York City
Hours: Daily 9:00 a. m. to 5:00 p. m. Sunday 1:00 p. m. to 5:00 p. m. Open holidays 9:00 a. m. to 5:00 p. m. Admission Free.
Exhibitions of gems, human and animal habitat groups, prehistoric creatures, and fossil arrangements showing evolution.

AQUARIUM
Battery Park, New York City
Hours: Daily 9:00 a. m. to 5:00 p. m. Admission Free.
Collections of living aquatic animals; fresh-water and marine, principally fishes but including other groups.

BROOKLYN BOTANIC GARDEN
1000 Washington Avenue, Brooklyn
Hours: Daily from 9:00 a. m. until dark. Sundays from 10:00 a. m. Conservatories open from 10:00 a. m. until 4:00 p. m. Admission Free.
Rose garden; wild flower, Japanese rock, and wall gardens; horticultural displays; conservatories.

BROOKLYN MUSEUM
Eastern Parkway and Washington Avenue, Brooklyn
Hours: Daily 10:00 a. m. to 5:00 p. m. Saturdays and holidays 10:00 a. m. to 6:00 p. m. Sundays 2:00 p. m. to 6:00 p. m.
Admission Free except Mondays and Fridays, when charge is 25¢ for adults and 10¢ for children.
Arts of the world arranged in chronological and geographical order to illustrate the history of cultures.

THE CLOISTERS
Fort Tryon Park (190th Street Subway Station) New York City
Hours: Daily 10:00 a. m. to 5:00 p. m. Saturdays and holidays 10:00 a. m. to 5:00 p. m. Sundays 1:00 p. m. to 5:00 p. m.
Admission Free, except Mondays and Fridays, when charge is 25¢.
Branch of the Metropolitan Museum of Art devoted to European medieval art.

FRICK COLLECTION
1 East 70th Street, New York City
Hours: Weekdays 10:00 a. m. to 5:00 p. m. Sundays 1:00 p. m. to 5:00 p. m. Admission Free.
14th-19th century paintings, Renaissance bronzes, Limoges enamels, Chinese and French porcelains, period furniture.

METROPOLITAN MUSEUM OF ART
Fifth Avenue and 82nd Street
New York City
Hours: Daily 10:00 a. m. to 5:00 p. m. Saturdays and holidays 10:00 a. m. to 5:00 p. m. Sundays 1:00 p. m. to 5:00 p. m.
Admission Free, except Mondays and Fridays, when charge is 25¢.
Collections of Egyptian, Classical, Oriental, European, and American art—paintings, prints, sculpture and decorative arts.

MUSEUM OF THE AMERICAN INDIAN
Broadway and 155th Street
New York City
Hours: Daily 2:00 p. m. to 5:00 p. m. Sunday 1:00 p. m. to 5:00 p. m. Admission Free.
Anthropological collections from the aboriginal inhabitants of North, Central, and South Americas, and West Indies.

MUSEUM OF THE CITY OF NEW YORK
Fifth Avenue and 103rd Street
New York City
Hours: Daily 10:00 a. m. to 5:00 p. m. Saturdays and holidays 10:00 a. m. to 6:00 p. m. Sundays 1:00 p. m. to 6:00 p. m. Closed Tuesdays. Admission Free, except Monday, when charge is 25¢.
Exhibits of the chronological development of New York City life from earliest times to the present.

MUSEUM OF MODERN ART
11 West 53rd Street, New York City
Hours: Daily 10:00 a. m. to 6:00 p. m. Sundays 12:00 m. to 6:00 p. m.
Admission Free on Monday, other days 25¢.
Art of today—showing American and European painting, sculpture, architecture, industrial art, photography, motion pictures.

MUSEUM OF SCIENCE AND INDUSTRY
RCA Building, Radio City, New York City
Hours: Daily 10:00 a. m. to 10:00 p. m. including Sundays. Admission 25¢. Children 10¢. (Free to New York City teachers with classes)
Exhibits in transportation, communications, power, food, housing, electro-technology and other scientific and industrial fields.

NEW YORK BOTANICAL GARDEN
Bronx Park, Bronx, N. Y.
Hours: Museum and Conservatories open daily 10:00 a. m. to 4:30 p. m. Admission Free.
Extensive greenhouses, outdoor plantings, floral displays and museum collections of economic, drug and fossil plants.

STATEN ISLAND MUSEUM
Stuyvesant Place and Wall Street
St. George, Staten Island
Hours: Daily 10:00 a. m. to 5:00 p. m. Sunday 2:00 p. m. to 5:00 p. m. Admission Free.
Collections in science, art and history, especially relating to Staten Island.

WHITNEY MUSEUM OF AMERICAN ART
8-12 West 8th Street, New York City
Hours: Daily 10:00 a. m. to 6:00 p. m. Sunday 2:00 p. m. to 6:00 p. m. Closed Monday. Admission Free.
Collection of sculpture, painting, watercolors, drawing and prints by American artists.

NOVEMBER 1

AMERICAN MUSEUM OF NATURAL HISTORY
3:00 p. m.—Lecture and motion picture—"How Life Begins," by Grace F. Ramsey—Auditorium—Open to public.
8:15 p. m.—Forum—"The Origin of the Earth and Our Place in the Milky Way Galaxy," by Dr. Clyde Fisher—Roosevelt Memorial Lecture Hall, Fifth Floor—Open to Members.*

METROPOLITAN MUSEUM OF ART
11:00 a. m.—Lecture—"Room Character," by Miss Cornell—Classroom K—Open to public.
2:30 p. m.—Motion picture—"Tapestries and How They Are Made; The Making of a Stained Glass Window"—Lecture Hall—Open to public.
3:00 p. m.—Lecture—"Interior Design: Living Rooms," by Miss Cornell—Classroom K—Open to public.

NOVEMBER 2

FRICK COLLECTION
3:00 p. m.—Lecture—"Venetian Painting before Titian," by Mr. Arnason—Lecture Room—Open to public.

* *(Membership of $10 per annum and over)*

GUIDE SERVICE

The following institutions offer free lecture tours of their collections:

AMERICAN MUSEUM OF NATURAL HISTORY
Wednesdays, Fridays and Saturdays at 11:00 a. m. and 3:00 p. m. Meeting Place: 2nd Floor, Roosevelt Memorial.

METROPOLITAN MUSEUM OF ART
Tuesday at 12:00 m., Wednesday and Thursday at 2:00 p. m. Meeting Place: Main Hall.

MUSEUM OF MODERN ART
Daily at 11:00 a. m., 1:30 p. m., 3:00 p. m., and 4:30 p. m.

METROPOLITAN MUSEUM OF ART
11:00 a. m.—Lecture—"The Mohammedan Conquest" by Miss Duncan—Main Hall—Open to public.
4:00 p. m.—Lecture—"American Cabinetmakers; Transition in Furniture in 1700," by Mr. Busselle—Main Hall—Open to public.

MUSEUM OF THE CITY OF NEW YORK
3:30 p. m.—Motion picture—"King of the Rails"—Open to public.

NOVEMBER 3

FRICK COLLECTION
3:00 p. m.—Lecture—"French Painting, 19th century, in the Collection," by Dr. Ritchie—Lecture Room—Open to public.

METROPOLITAN MUSEUM OF ART
11:00 a. m.—Lecture—"The Labors of Herakles," by Mr. Shaw—Classroom D—Open to public.
3:00 p. m.—Lecture—"Italian Decorative Art," by Miss Cornell—Classroom K—Open to public.

NOVEMBER 4

American Museum of Natural History

10:30 a. m.—Lecture—"Birds of Winter," by John C. Orth—Auditorium—Open to public.

Frick Collection

3:00 p. m.—Lecture—"Furniture in the Collection," by Mr. Arnason—Lecture Room—Open to public.

NOVEMBER 5

American Museum of Natural History

2:00 p. m.—Motion picture and lecture—"In the South Seas," by John R. Saunders—Auditorium—Open to public.

4:00 p. m.—Lecture—"The Influence of Buddhism on Chinese Carved Jade," by Dr. Herbert P. Whitlock—Room 319, Roosevelt Memorial—Open to public.

Brooklyn Museum

2:00 p. m.—Lecture—"History of Music and Its Parallels in Visual Art," by David LeVita—Classroom A—Open to public.

3:00 p. m.—American Folk Festival—Sculpture Court—Open to public.

Frick Collection

3:00 p. m.—Lecture—"Velasquez, Court Portrait Painter," by Dr. Ritchie—Lecture Room—Open to public.

Metropolitan Museum of Art

11:00 a. m.—Lecture—"German Contemporaries of Dürer," by Miss Abbot—Lecture Hall—Open to public.

11:00 a. m.—Lecture—"The Pilgrimage Roads," by Mr. Grier—Main Hall—Open to public.

2:00 p. m.—Lecture—"Italy and Flanders: a XV Century Contrast," by Mrs. Fansler—Main Hall—Open to public.

2:30 p. m.—Motion Picture—"The Pottery Maker; The American Wing"—Lecture Hall—Open to public.

4:00 p. m.—Lecture—"Recent Excavations at Troy," by Carl W. Blegen, University of Cincinnati—Lecture Hall—Open to public.

Museum of the City of New York

1:15 and 3:30 p. m.—Motion picture—"Feeding New York"—Open to public.

New York Botanical Garden

3:00 p. m.—Lecture—"Some Important Drug Plants," by Prof. Wm. J. Bonisteel—Open to public.

NOVEMBER 6

Brooklyn Museum

2:30 p. m.—Organ Recital by Robert Bedell—Sculpture Court—Open to public.

3:00 p. m.—Motion picture—"Spinning and Weaving"—Classroom A—Open to public.

4:00 p. m.—Concert—New York State Symphonic Band—Sculpture Court—Open to public.

Metropolitan Museum of Art

2:00 p. m.—Lecture—"Italy and Flanders: a XV Century Contrast," by Mrs. Fansler—Main Hall—Open to public.

2:30 p. m.—Motion picture—"Firearms of Our Forefathers—Peter Stuyvesant" (Yale Chronicles of America Photoplay)—Lecture Hall—Open to public.

2:30 p. m.—Lecture—"The Art of the Cabinetmaker: Cabriole Types in the XVIII Century," by Miss Bradish—Main Hall—Open to public.

3:00 p. m.—Lecture—"American Small House Design: Early American: Dutch and Other Types," by Aymar Embury II—Classroom K—Open to public.

4:30 p. m.—Lecture—"Post-War Aesthetic Trends in Europe and America," by C. R. Ashbee—Lecture Hall—Open to public.

NOVEMBER 8

Metropolitan Museum of Art

2:30 p. m.—Motion Picture—"The Temples and Tombs of Ancient Egypt; Behind the Scenes in the Metropolitan Museum"—Lecture Hall—Open to public.

NOVEMBER 9

Frick Collection

3:00 p. m.—Lecture—"Goya, A Great Social Satirist," by Dr. Ritchie—Lecture Room—Open to public.

Metropolitan Museum of Art

11:00 a. m.—Lecture—"Temples and Shrines of India," by Miss Duncan—Main Hall—Open to public.

4:00 p. m.—Lecture—"American Cabinetmakers: Savery and Randolph of Philadelphia," by Mr. Busselle—Main Hall—Open to public.

Museum of the City of New York

3:30 p. m.—Motion picture—"Preview New York World's Fair"—Open to Public.

NOVEMBER 10

American Museum of Natural History

8:15 p. m.—Lecture—"Animals, Birds and Flowers of Colombia," by Arthur C. Pillsbury—(Motion pictures)—Auditorium—Open to Members.*

Frick Collection

3:00 p. m.—Lecture—"Frans Hals and the Dutch Way of Seeing," by Dr. Ritchie—Lecture Room—Open to public.

Metropolitan Museum of Art

11:00 a. m.—Lecture—"Adventures of the Greek Heroes," by Mr. Shaw—Classroom D—Open to public.

3:00 p. m.—Lecture—"Italian Decorative Art," by Miss Cornell—Classroom K—Open to public.

PLANETARIUM
Schedule for November

★

"The Sun's Family"

Weekdays—2:00, 3:30, and 8:30 P. M.

Saturdays—11:00 A. M., 1:00, 2:00, 3:00, 4:00, 5:00 and 8:30 P. M.

Sundays and Holidays—2:00, 3:00, 4:00, 5:00 and 8:30 P. M.

General Admission Afternoons	25¢
Reserved Seat "	50¢
General Admission Evenings	35¢
Reserved Seat "	60¢

General Admission for Children under 17, accompanied by adults, 15¢ at all times. (No reduced price for reserved seats occupied by children.) Children under 5 not admitted. Doors close on the hour. Special facilities for the hard of hearing.

NOVEMBER 11

Frick Collection

3:00 p. m.—Lecture—"Limoges Enamels in the Collection," by Dr. Ritchie—Lecture Room—Open to public.

NOVEMBER 12

American Museum of Natural History

10:30 a. m.—Nature Talk—"Animals and Indians in Song and Story," by Julia M. and Ernest Thompson Seton—Auditorium—Open to children of members.*

2:00 p. m.—Motion picture and lecture—"Precious Gems," by Marguerite Newgarden—Auditorium—Open to public.

4:00 p. m.—Lecture—"Modern Carvings in Chinese Jade," by Dr. Herbert P. Whitlock—Room 319 Roosevelt Memorial—Open to public.

Brooklyn Museum

11:00 a. m.—Concert—Gramercy Chamber Trio—Sculpture Court—Open to public.

2:00 p. m.—Lecture—"History of Music and Its Parallels in Visual Art," by David LeVita—Classroom A—Open to public.

3:00 p. m.—American Folk Festival—Sculpture Court—Open to public.

Frick Collection

3:00 p. m.—Lecture—"Venetian Painting Before Titian," by Mr. Arnason—Lecture Room—Open to public.

Metropolitan Museum of Art

11:00 a. m.—Lecture—"Holbein and Lucas van Leyden," by Miss Abbot—Lecture Hall—Open to public.

11:00 a. m.—Lecture—"The Dawn of the Gothic Style," by Mr. Grier—Main Hall—Open to public.

2:00 p. m.—Lecture—"Italian Painting of the High Renaissance," by Mrs. Fansler—Main Hall—Open to public.

*(Membership of $10 per annum and over.)

2:30 p. m.—Motion Picture—"Digging into the Past; The Daily Life of the Egyptians—Ancient and Modern"—Lecture Hall—Open to public.

4:00 p. m.—Lecture—"Egyptian Religion and Art in the Old Kingdom," by Hermann Ranke, University of Pennsylvania—Lecture Hall—Open to public.

Museum of the City of New York

1:15 and 3:30 p. m.—Motion picture—"A Day With the Sun"—Open to public.

New York Botanical Garden

3:00 p. m.—Lecture—"Alpine Flowers of Central Greece," by Prof. Clarence H. Young—Open to public.

NOVEMBER 13

Brooklyn Museum

2:30 p. m.—Organ recital by Robert Bedell—Sculpture Court—Open to public.

3:00 p. m.—Motion picture—"Daniel Boone"—Classroom A—Open to public.

4:00 p. m.—Concert—New York State Symphonic Band—Sculpture Court—Open to public.

Metropolitan Museum of Art

2:00 p. m.—Lecture—"Italian Painting of the High Renaissance," by Mrs. Fansler—Main Hall—Open to public.

2:30 p. m.—Motion picture—"The Etcher's Art; Drypoint—a Demonstration"—Lecture Hall—Open to public.

2:30 p. m.—Lecture—"The Art of Cabinetmaker: French and English Types: the Classic Revival," by Miss Bradish—Main Hall—Open to public.

3:00 p. m.—Lecture—"American Small House Design: Modern Types," by William Lescaze—Classroom K—Open to public.

4:30 p. m.—Lecture—"The Sea in Dutch Paintings," by Adrian J. Barnouw, Colombia University—Lecture Hall—Open to public.

NOVEMBER 15

American Museum of Natural History

3:00 p. m.—Lecture and motion picture—"The Life of Louis Pasteur," by John R. Saunders—Auditorium—Open to public.

Metropolitan Museum of Art

11:00 a. m.—Lecture—"Walls and Windows," by Miss Cornell—Classroom K—Open to public.

2:30 p. m.—Motion picture—"The Daily Life of the Egyptians—Ancient and Modern; A Visit to the Armor Galleries"—Lecture Hall—Open to public.

3:00 p. m.—Lecture—"Interior Design: Halls," by Miss Cornell—Classroom K—Open to public.

NOVEMBER 16

Frick Collection

3:00 p. m.—Lecture—"The High Renaissance in Venice," by Mr. Arnason—Lecture Room—Open to public.

Metropolitan Museum of Art

11:00 a. m.—Lecture—"Sculpture of India," by Miss Duncan—Main Hall—Open to public.

4:00 p. m.—Lecture—"French and English Cabinetmakers: The Jacobean Period," by Miss Bradish—Main Hall—Open to public.

Museum of the City of New York

3:30 p. m.—Motion picture—"Historic Governors Island"—Open to public.

NOVEMBER 17

American Museum of Natural History

8:15 p. m.—Lecture—"The World's Least Known Seacoast," by Dr. Robert Cushman Murphy—Auditorium—Open to Members.*

Metropolitan Museum of Art

11:00 a. m.—Lecture—"Loves of the Gods," by Mr. Shaw—Classroom D—Open to public.

3:00 p. m.—Lecture—"French Decorative Art," by Miss Cornell—Classroom K—Open to public.

Frick Collection

3:00 p. m.—Lecture—"French Painting, 18th Century in the Collection," by Dr. Ritchie—Lecture Room—Open to public.

NOVEMBER 18

American Museum of Natural History

10:30 a. m.—Lecture—"Primitive Homes the World Around," by Grace F. Ramsey—Auditorium—Open to public.

FRICK COLLECTION

3:00 p. m.—Lecture—"Italian Painting in the Collection," by Mr. Arnason—Lecture Room—Open to public.

NOVEMBER 19

AMERICAN MUSEUM OF NATURAL HISTORY

2:00 p. m.—Motion picture and lecture—"Life in the Past," by Robert R. Coles—Auditorium—Open to public.

BROOKLYN MUSEUM

2:00 p. m.—Lecture—"History of Music and Its Parallels in Visual Art," by David LeVita—Classroom A—Open to public.

3:00 p. m.—American Folk Festival—Sculpture Court—Open to public.

FRICK COLLECTION

3:00 p. m.—Lecture—"Goya, A Great Social Satirist," by Dr. Ritchie—Lecture Room—Open to public.

METROPOLITAN MUSEUM OF ART

11:00 a. m.—Lecture—"The Italian Baroque Style," by Miss Abbot—Lecture Hall—Open to public.

11:00 a. m.—Lecture—"The Age of Saint Louis," by Mr. Grier—Main Hall—Open to public.

2:00 p. m.—Lecture—"Dutch Painting of the XVII Century," by Mrs. Fansler—Main Hall—Open to public.

2:30 p. m.—Motion Picture—"Tapestries and How They Are Made; The Making of a Stained-Glass Window"—Lecture Hall—Open to public.

4:00 p. m.—Lecture—"The Amateur Considers the Museum of Art," by Frederick P. Keppel, Carnegie Corporation—Lecture Hall—Open to public.

MUSEUM OF THE CITY OF NEW YORK

1:15 and 3:30 p. m.—Motion picture—"Empires of Steel"—Open to public.

NEW YORK BOTANICAL GARDEN

3:00 p. m.—Lecture—"Origin and Improvement of Plants," by A. B. Stout—Open to public.

STATEN ISLAND MUSEUM

8:30 p. m.—Lecture—"North with Bob Bartlett," by Captain R. A. Bartlett—Open to public.

NOVEMBER 20

BROOKLYN MUSEUM

2:30 p. m.—Organ Recital by Robert Bedell—Sculpture Court—Open to public.

3:00 p. m.—Motion picture—"Wanderers of the Arabian Desert"—Classroom A—Open to public.

4:00 p. m.—Concert—New York State Symphonic Band—Sculpture Court—Open to public.

METROPOLITAN MUSEUM OF ART

2:00 p. .m—Lecture—"Dutch Painting of the XVII Century," by Mrs. Fansler—Main Hall—Open to public.

2:30 p. m.—Motion picture—"The Pottery Maker; The American Wing"—Lecture Hall—Open to public.

2:30 p. m.—Lecture—"The Art of the Cabinet-maker: American Variations of European Types," by Miss Bradish—Main Hall—Open to public.

3:00 p. m.—Lecture—"Interior Design: Styles and Periods," by Miss Cornell—Classroom K—Open to public.

4:30 p. m.—Lecture—"The Thought-World Behind Far Eastern Paintings," by Younghill Kang, Metropolitan Museum—Lecture Hall—Open to public.

NOVEMBER 22

AMERICAN MUSEUM OF NATURAL HISTORY

8:15 p. m.—Forum—"The Earth and Man's Development," by Dr. Frederick H. Pough—Roosevelt Memorial Lecture Hall, Fifth Floor—Open to Members.*

METROPOLITAN MUSEUM OF ART

11:00 a. m.—Lecture—"Furniture and Floors," by Miss Cornell—Classroom K—Open to public.

2:30 p. m.—Motion picture—"Tapestries and How They Are Made; The Making of a Bronze Statue; The Making of Wrought Iron"—Lecture Hall—Open to public.

3:00 p. m.—Lecture—"Interior Design: Dining Rooms," by Miss Cornell—Classroom K—Open to public.

FRICK COLLECTION

3:00 p. m.—Lecture—"Van Dyck, A Popular Society Painter," by Dr. Ritchie—Lecture Room—Open to public.

NOVEMBER 23

METROPOLITAN MUSEUM OF ART

11:00 a. m.—Lecture—"Decorative Arts of the Near East" by Miss Duncan—Main Hall—Open to public.

4:00 p. m.—Lecture—"French and English Cabinetmakers: The Periods of Louis XIV and Louis XV" by Miss Bradish—Main Hall—Open to public.

SPECIAL EXHIBITS

THE THIRTY-FIRST annual autumn exhibition of the Horticultural Society of New York will open in Education Hall of the American Museum on November 11 at 9:00 a. m. Open till 10:00 p. m. on this and the following day, and from 1:00 to 5:00 p. m. on November 13th, the show promises many beautiful varieties to those interested in fall flowers and plants.

•

"BUILDING the New York World's Fair" is the title of a special exhibition of photographs by Richard Wurts opening November 3rd at the Museum of the City of New York. Well known in international photographic circles, Mr. Wurts has taken as his task the study by means of camera of the transformation of the barren flatlands of that section of Queens into a planned scheme of beauty. The unusual designs he has captured among the scaffolding and half-finished buildings of the Fair will be of future interest as a contrast to the finished project.

•

NEARLY 100 herbs used in medicine and about 60 culinary herbs are growing in the Brooklyn Botanic Garden's new Herb Garden. Visitors may see it at the northeast corner of the grounds. A leaflet, which may be had upon request, has been issued by the Garden giving the uses of these herbs.

MUSEUM OF THE CITY OF NEW YORK

3:30 p. m.—Motion picture—"The Real New York"—Open to public.

NOVEMBER 24

FRICK COLLECTION

3:00 p. m.—Lecture—"Rembrandt, Brushwork and Personality," by Mr. Arnason—Lecture Room—Open to public.

NOVEMBER 25

FRICK COLLECTION

3:00 p. m.—Lecture—"Spanish Painting in the Collection" by Dr. Ritchie—Lecture Room—Open to public.

NOVEMBER 26

AMERICAN MUSEUM OF NATURAL HISTORY

10:30 a. m.—Nature Talk—"Nature Games and Stories," by Charles F. Smith—Auditorium—Open to Children of Members.*

2:00 p. m.—Motion picture and lecture—"This Changing Earth," by John R. Saunders—Auditorium—Open to public.

BROOKLYN MUSEUM

11:00 a. m.—Concert—Gramercy Chamber Trio—Sculpture Court—Open to public.

2:00 p. m.—Lecture—"History of Music and Its Parallels in Visual Art" by David LeVita—Classroom A—Open to public.

3:00 p. m.—American Folk Festival—Sculpture Court—Open to public.

FRICK COLLECTION

3:00 p. m.—Lecture—"The High Renaissance in Venice," by Mr. Arnason—Lecture Room—Open to public.

METROPOLITAN MUSEUM OF ART

11:00 a. m.—Lecture—"XIV Century Mannerisms," by Mr. Grier—Main Hall—Open to public.

2:00 p. m.—Lecture—"Spanish and Flemish Painting of the XVII Century," by Miss Abbot—Main Hall—Open to public.

2:30 p. m.—Motion Picture—"The Pottery Maker; The Puritans" (Yale Chronicles of American Photoplay)—Lecture Hall—Open to public.

4:00 p. m.—Lecture—"Problems of Sasanian Art," by Ernst Herzfeld, The Institute for Advanced Study—Lecture Hall—Open to public.

MUSEUM OF THE CITY OF NEW YORK

1:15 and 3:30 p. m.—Motion picture—"Declaration of Independence"—Open to public.

NEW YORK BOTANICAL GARDEN

3:00 p. m.—Lecture—"The Romance of Plant Names," by H. A. Gleason—Open to public.

NOVEMBER 27

BROOKLYN MUSEUM

2:30 p. m.—Organ Recital by Robert Bedell—Sculpture Court—Open to public.

3:00 p. m.—Motion picture—"The Puritans"—Classroom A—Open to public.

4:00 p. m.—Concert—New York State Symphonic Band—Sculpture Court—Open to public.

METROPOLITAN MUSEUM OF ART

2:00 p. m.—Lecture—"Spanish and Flemish Painting of the XVII Century," by Miss Abbot—Main Hall—Open to public.

2:30 p. m.—Motion picture—"Digging into the Past; A Visit to the Armor Galleries"—Lecture Hall—Open to public.

2:30 p. m.—Lecture—"The Art of the Cabinet-maker: Victorian Types," by Miss Bradish—Main Hall—Open to public.

3:00 p. m.—Lecture—"Small House Interiors," by Miss Cornell—Classroom K—Open to public.

4:30 p. m. — Lecture — "Eighteenth-Century French Dwellings and Their Furnishings," by Everett V. Meeks, Yale University—Lecture Hall—Open to public.

NOVEMBER 29

AMERICAN MUSEUM OF NATURAL HISTORY

3:00 p. m.—Lecture—"Autumn Activities in the Bird World," by Farida A. Wiley—Auditorium—Open to public.

8:15 p. m.—Forum—"The Earth and Man's Development," by Dr. Frederick H. Pough—Roosevelt Memorial Lecture Hall, Fifth Floor—Open to Members.*

METROPOLITAN MUSEUM OF ART

11:00 a. m.—Lecture—"Pictures and Accessories," by Miss Cornell—Classroom K—Open to public.

2:30 p. m.—Motion picture—"Firearms of Our Forefathers; The American Wing"—Lecture Hall—Open to public.

3:00 p. m.—Lecture—"Interior Design: Bedrooms," by Miss Cornell—Classroom K—Open to public.

NOVEMBER 30

FRICK COLLECTION

3:00 p. m.—Lecture—"The Art of the Late Renaissance," by Mr. Arnason—Lecture Room—Open to public.

METROPOLITAN MUSEUM OF ART

11:00 a. m.—Lecture—"Coptic Art in Egypt," by Miss Duncan—Main Hall—Open to public.

4:00 p. m.—Lecture—"French and English Cabinetmakers: The Period of Queen Anne and Chippendale," by Miss Bradish—Main Hall—Open to public.

MUSEUM OF THE CITY OF NEW YORK

3:30 p. m.—Motion picture—"A Modern Gas Plant"—Open to public.

*(Membership of $10 per annum and over.)

NOVEMBER RADIO PROGRAM

NOVEMBER 3

1:05 p. m.—Organ Recital—Station WNYC—Brooklyn Museum.

2:30 p. m.—"Riches in the Earth," Dr. Roy Chapman Andrews (School of the Air Series)—Station WABC—American Museum of Natural History.

NOVEMBER 4

1:05 p. m.—Organ Recital—Station WNYC—Brooklyn Museum.

5:15 p. m.—"Men Behind the Stars"—Station WABC—Hayden Planetarium.

NOVEMBER 5

10:00 a. m.—Organ Recital—Station WNYC—Brooklyn Museum.

12:00 noon—"This Wonderful World" (Question and Answer Program)—Station WOR—Hayden Planetarium.

NOVEMBER 7

1:05 p. m.—Organ Recital—Station WNYC—Brooklyn Museum.

NOVEMBER 10

1:05 p. m.—Organ Recital—Station WNYC—Brooklyn Museum.

2:30 p. m.—"Conquest of Space," by Dr. Roy Chapman Andrews (School of the Air series)—Station WABC—American Museum of Natural History.

NOVEMBER 11

1:05 p. m.—Organ Recital—Station WNYC—Brooklyn Museum.

5:15 p. m.—"Men Behind the Stars"—Station WABC—Hayden Planetarium.

NOVEMBER 12

10:00 a. m.—Organ Recital—Station WNYC—Brooklyn Museum.

12:00 noon—"This Wonderful World" (Question and Answer Program)—Station WOR—Hayden Planetarium.

NOVEMBER 14

1:05 p. m.—Organ Recital—Station WNYC—Brooklyn Museum.

NOVEMBER 17

1:05 p. m.—Organ Recital—Station WNYC—Brooklyn Museum.

2:30 p. m.—"The Life of a Tree," by Dr. Roy Chapman Andrews (School of Air series)—Station WABC—American Museum of Natural History.

NOVEMBER 18

1:05 p. m.—Organ Recital—Station WNYC—Brooklyn Museum.

5:15 p. m.—"Men Behind the Stars"—Station WABC—Hayden Planetarium.

NOVEMBER 19

10:00 a. m.—Organ Recital—Station WNYC—Brooklyn Museum.

12:00 noon—"This Wonderful World" (Question and Answer Program)—Station WOR—Hayden Planetarium.

NOVEMBER 21

1:05 p. m.—Organ Recital—Station WNYC—Brooklyn Museum.

NOVEMBER 24

1:05 p. m.—Organ Recital—Station WNYC—Brooklyn Museum.

NOVEMBER 25

1:05 p. m.—Organ Recital—Station WNYC—Brooklyn Museum.

5:15 p. m.—"Men Behind the Stars"—Station WABC—Hayden Planetarium.

NOVEMBER 26

10:00 a. m.—Organ Recital—Station WNYC—Brooklyn Museum.

12:00 noon—"This Wonderful World" (Question and Answer Program)—Station WOR—Hayden Planetarium.

NOVEMBER 28

1:05 p. m.—Organ Recital—Station WNYC—Brooklyn Museum.

EXPOSURE METERS

Continued from page 314

Meter errors

The human eye is such an adaptable organ that it serves us on a moonlight night, when there is about 1/100th of a foot-candle of illumination, as well as on a bright day at the beach, where as much as 10,000 foot-candles is not uncommon. As this range of one to one million indicates, the eye is not a very dependable instrument for measuring the small changes in brightness that affect a photographic emulsion. That is why we need a meter.

Most meters are built to measure the average over-all illumination of the subject toward which they are pointed. The assumption on which the use of the instrument lies is that the average of the integrated brightness lies halfway between the brightest object and the darkest shadow. That this assumption is faulty is quickly recognized if a scene is visualized of a white cat sitting upon a large coal pile. The meter would indicate a level of exposure that would expose the coal properly but would over-expose the cat, because most of the light entering the meter would come from the large black coal mass. The small area of the cat would not affect the meter appreciably. It is only because of the enormous latitude of the film that such errors of exposure do not ruin the film hopelessly.

A test

Another example will make the common exposure meter's errors clear. Suppose there is one heap of white sand and another heap of dark gray cement. If we stand back and measure the two heaps together with our exposure meter we will get a value that will expose both adequately. Now if we walk close to the dark heap with the exposure meter we find that we should increase the exposure somewhat over what we gave before. We make the picture and move to the white sand pile. Here the meter tells us to give an exposure less than we originally gave the scene. Again a picture is made and the film developed.

When the processed negatives are compared, we will find that the scene of the two heaps is well exposed, with one heap appearing darker than the other, just as they looked. The two separate pictures of the heaps look practically alike, however, with the white sand and the dark cement both similar in density on the negatives. Actually there was no reason to change the exposure when the heaps were approached because the illumination on them did not change. It merely means that the exposure meter gives you the integrated average illumination of the whole scene.

Using a meter

The modern film has sufficient latitude to take care of any reasonable differences in illumination, but it is a mistake to let the brilliant light of the sky affect your reading too strongly. To obtain the really consistent results that the meter manufacturers claim to be possible with their instruments, it is helpful to carry a white card about six inches square, which is placed near the subject, the meter being brought close to it for a reading. The exposure indicated for the white card is used for the whole scene after being reduced from one half to one quarter, depending upon what experiment has shown to produce the best results. A companion's white shirt is a very acceptable substitute for a white card.

An even more convenient method is to carry a card of a medium gray. This card will represent an average brightness that depends only upon the incident light. Measure the light on this card before you snap a scene, making sure that the light that falls on your subject falls fully and unobstructedly on the gray card. By this method Kodachrome films will be obtained that will appear more true in color and brilliancy than by any other method. Someone suggested that a gray felt hat is a good substitute for a card, but a folded gray paper is no hardship to carry.

If either the white or gray card is left home and the exposure meter must be used directly on the scene, hold the meter so it points somewhat downward to minimize the effect of the bright sky. Experience will indicate the correct angle. For close-ups, of course, approach as near to the principal object as possible without obstructing the light.

* * *

Correct Answers to Questions on page 308

1. (a) Wears chain mail today. See page 256
2. (b) Commensalism. See page 249
3. (b) The Portuguese Man-of War. See page 252
4. (a) Epiphytes. See page 291
5. (a) Fungi. See pages 298 and 309
6. (c) Eighty feet. See page 288
7. (c) It turns the tips of its fronds downward to root in the soil, generation after generation. See page 290
8. (b) The fresh-water hydra. See page 247
9. (a) Drug merchants. See page 265
10. (a) A giant bovid that lived several hundred thousand years ago. See page 265

Unusual Services

A FRUIT CAKE that is really made from fruit—just fruit and nuts—makes a health food that is delicious and wholesome. A box of **FRUITNUTS** made of fruit made into rolls and filled with nuts—just fresh fruit and nuts—is a tasty and unique confection. We on the magazine staff know, because the Canoga Farms sent us a box of each of these and you have our assurance that both were excellent and thoroughly enjoyed. Such wholesome fruit and nut oddities make excellent Christmas gifts. The price is reasonable. Send to the Canoga Farms for these delicious fruit products.

•

With Christmas drawing near we suggest a trip to Fred Leighton's Shop at 15 East 8th Street, New York. You will find a selection of authentic **INDIAN CRAFT** which will make your shopping a pleasure. There are gifts for every one. This Christmas you can make some boy happy with a drum covered with real bear hide, or a collection of prehistoric arrowheads. Girls will love a bracelet or a doll made by Indians and dressed in their manner. Drop in and be an "Indian giver" this Christmas in the true spirit of the first Americans.

•

Garret Thew of Westport, Conn., has created a fascinating line of sponge rubber **ANIMALS**. In addition to the angels featured in the ad appearing on this page, are rabbits, Scotties, elephants, a hound and a donkey. These small rubber animals make unique Christmas greetings, for they may be sent through the mail without wrapping. Just address the card attached. They also make place cards or a stocking gift for the youngsters. Send your order to Garret Thew, Westport, Conn.

•

Those who have the time and desire for peace and quiet in the outdoors should write Jack Speiden at the Jay Six Cattle **RANCH**. This ranch stays open all year round for those who wish to relax amid beautiful surroundings and live the healthy outdoor life. There you may go hunting or take a swim. So write Mr. Speiden and get the full particulars.

•

"The Sidewalk Superintendents Club" is the name put on a low shed next to the latest excavation at Rockefeller Center. Usually filled to capacity with those passersby whose inquisitive minds find delight in watching the work being done. Rockefeller Center is one of the high spots in New York that always delights the visitor. On the Observation Roofs one may have New York in panorama below. A thrill awaits you there. Take a trip to the Roofs on your next visit to this city.

"I'm Glad You Called"

This very hour, millions of words are being spoken by telephone. Friend talks to friend and two lives are happier because of it.

Greetings and best wishes are exchanged—holiday visits arranged—affairs of business transacted. A doctor comes quickly in answer to a hurried call.

And day and night, the country over, these oft-repeated words reflect the value of the telephone ... "I'm glad you called."

BELL TELEPHONE SYSTEM

NATURAL HISTORY

The Magazine of the American Museum of Natural History

FREDERICK TRUBEE DAVISON, President — ROY CHAPMAN ANDREWS, Sc.D., Director

VOLUME XLII—No. 5 ★ ★ ★ ★ ★ DECEMBER, 1938

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

EDITOR: Edward M. Weyer, Jr., Ph.D.

ASSOCIATE: D. R. Barton.

PRODUCTION: Frederick L. Hahn.

ART: Charles Curtis Hulling.

Manuscripts should be sent to the Editor, The American Museum of Natural History, N. Y.

SUBSCRIPTIONS: NATURAL HISTORY is sent to all members of the American Museum as one of the privileges of membership. Membership Secretary, Charles J. O'Connor.

ADVERTISING DEPARTMENT: Sherman P. Voorhees, Manager. W. Ware Lynch.

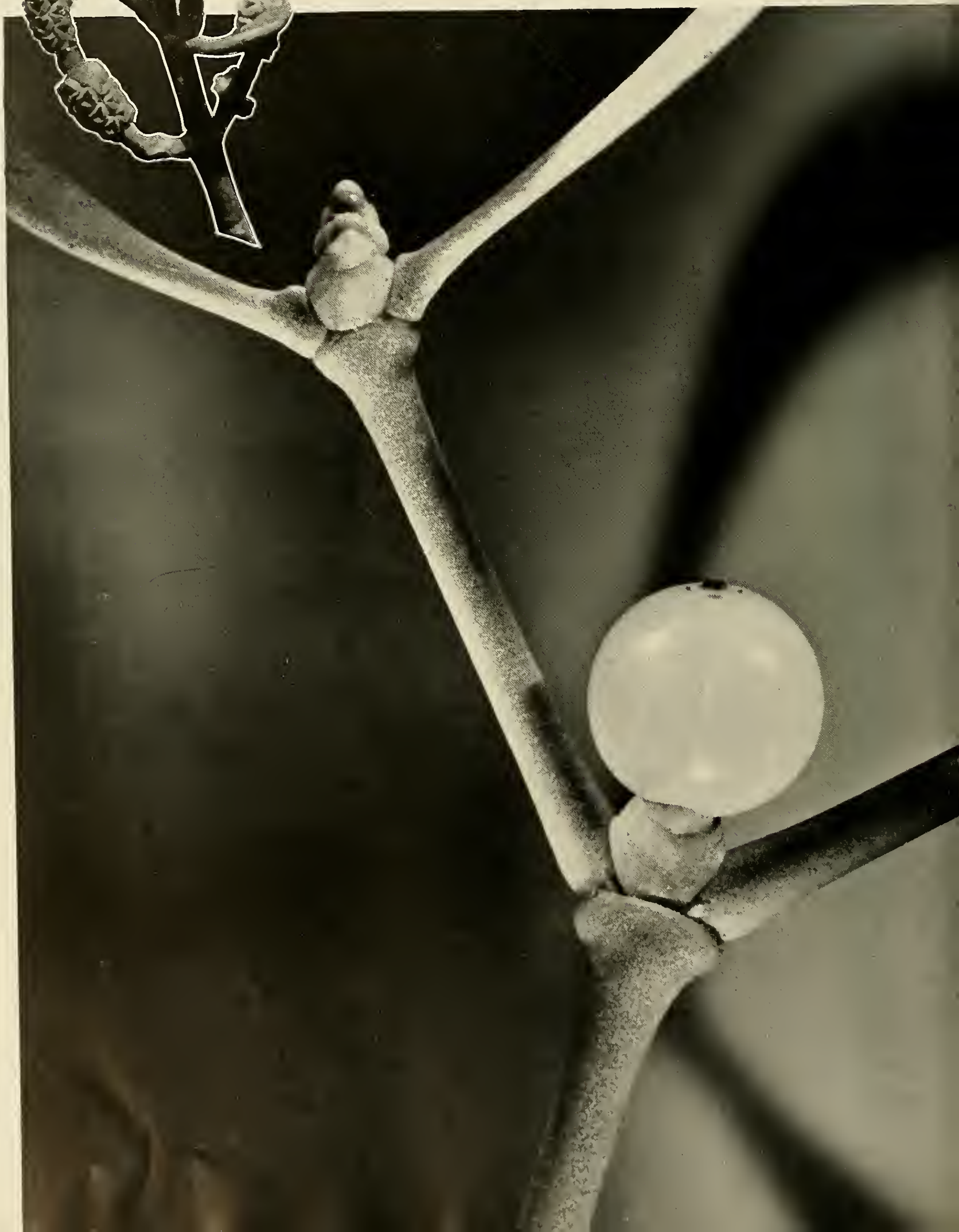
REPRESENTATIVES:
Frank S. Whitman, Chicago, Ill.
Warwick S. Carpenter, Santa Barbara, Calif.

The American Museum of Natural History wishes to express gratitude for the assistance in the promotion of the interests of NATURAL HISTORY that has been rendered by the Works Progress Administration.

NATURAL HISTORY is published monthly (except July and August) at New York, N. Y., by The American Museum of Natural History, Seventy-ninth Street and Central Park West. Subscription price $3 a year, single copies fifty cents. These rates also apply to Canada, Newfoundland, and all foreign countries. Entered as second class matter March 9, 1936, at the Post Office at New York, New York, under the Act of August 24, 1912.

Flowering twig *(left)* and matured berry of mistletoe *(magnified below)*. This ancient parasitic plant, once worshipped by Druidic Celts and later regarded by other northern peoples as a charm against epilepsy, nightmares and witchcraft, still commands our light-hearted respect to this day, retaining just enough of its superstitious aura to make our Christmas season a merry one

Photo Courtesy University of Texas *Black Star, Photo by Croy*



THE ROMANCE OF MISTLETOE—*Once hung in Druid huts to lure wood spirits indoors, this richly storied parasite still keeps its festive place in our homes and hearts*

By CLYDE FISHER
Curator-in-Chief, Astronomy and Hayden Planetarium

THE custom of decorating our homes with mistletoe goes back to the ceremonials of the Druids of ancient Gaul and Britain, about which we learned in Caesar's *Commentaries*, and even back to the ancient Norsemen or Scandinavians. It is reminiscent of the winter custom of the Druids of bringing green things indoors as a refuge for the spirits of the woods, in the hope that they would come into their houses for protection against the severity of cold and snow.

It is easy to understand how a plant of such peculiar aspect and of such remarkable habit should attract the attention of primitive peoples and come to influence their religious ceremonials—in the prevention and cure of mental and bodily diseases, in the warding off of misfortune of diverse kinds. Here is a plant that has no roots, whose seeds will not germinate in soil as ordinary seeds do; an evergreen plant that grows on various deciduous trees, thus seeming to be the ever-living spirit of the host-tree. The old Saxon name, *mistl-tan*, means "different twig," from the fact that it differs from the twig of the tree upon which it grows.

This magic plant, the mistletoe, figures in old Norse mythology in the story of Balder, the White Sun-god, and his mother, Frigga, whose worship is still commemorated in the name of the sixth day of the week. Frigga, one of the three wives of Odin, loved her son Balder so much that she asked all of the things of earth and air to cherish and protect him. She exacted the promise from fire, water, iron, stones, earths, diseases, beasts, birds, insects, and poisons—everything except a small, inconspicuous plant of mistletoe growing on the branch of an old oak on the eastern side of Valhalla. This plant she hardly noticed even when its berries whitened.

In the shadow of the oak, Balder dared the other gods to harm him, as he stood offering himself as a target at which they hurled stones and spears and shot their arrows, while others hewed at him with their swords and battle-axes. Even Thor threw at him his mighty hammer which rebounded without harm to the youthful god. Through it all he stood unmoved and unhurt.

Loki, the Dark Spirit, jealous of the favor and beauty of Balder, the Apollo or Day-god, disguised himself as a woman and attended this rough but worshipful sport. Here he asked Frigga why her son never suffered pain. Frigga told him it was because the creatures and things of the earth and air and water had promised her to be kind to him, and that consequently nothing would bruise him or cause his blood to flow.

"And there is nothing that can harm him?" Loki asked.

"Nothing," replied Frigga, "except the mistletoe,—but that is so small and weak that it could hurt nothing."

Loki went back to the wood, threw off his disguise, and cut the stoutest twig of mistletoe he could find, trimmed off its leaves and berries, and sharpened one end to a point, shaping it into a light lance or spear.

Soon after, the gods again assembled about Balder on the plains of Asgard to test his invulnerability against their bows and slings and other weapons. Hoder, the blind one, was standing apart, and Loki went to him.

"Why don't you take part in the sport?" he asked.

"I cannot see, and, besides, I have nothing to throw," answered Hoder.

"You can at least play at the game," urged Loki. "Here, throw this little spear."

He put the weapon which he had fashioned from the mistletoe into Hoder's hand, and turned the blind one so that he faced the spot where Balder stood. Hoder threw the tiny lance, his hand guided by Loki, and the point pierced the breast of the young god who fell lifeless to the ground.

By the combined power of all the gods, who were enraged by this tragedy, Balder was restored to life. Then they made the mistletoe promise never again to lend itself to harm; and, to make sure that it would keep its vow, they dedicated it to Frigga, and gave her special authority over it. The mistletoe promised never to do harm to any so long as it did not touch the earth. And, it is said, that is why—thousands of years after—people, who have never heard of Balder and Frigga and Loki and Hoder, "hang mistletoe in their houses in the season of

Photo by Paul Hodley

THE MISTLETOE'S SEEMINGLY miraculous growth without root in the soil led the Druids to regard it as supernatural, and Norse legends credit the dainty twig with the death of the White Sun-God. After this calamity, the penitent mistletoe promised the angry brother-gods never again to do harm as long as it did not touch earth. Hence, even today its presence overhead serves as a symbol of good luck and felicity as well as a spur to bashful swains

(Below) MISTLETOE HUNTERS in the Santa Inez Valley of California climb trees to satisfy the vast holiday demand —mute testimony of the plant's continued vitality in our folk rites. The entire mistletoe family contains some 500 species, found all over the world, but most plentiful in tropical regions. Since the leaves are brittle and the berries which ripen in December are easily shaken off, the twigs must be cut from the sustaining limb and then lowered by rope as safeguard against injury

Devereux Butcher Photo

L. W. Brownell Photo

(Above) A VIGOROUS PLANT of American mistletoe fruiting copiously. The leathery, evergreen leaves make the parasite stand out in conspicuous clumps, as shown below, in fall and winter. Birds are believed to spread mistletoe by eating the berries and wiping their bills on tree-bark to remove the sticky seeds. The seeds, protected by viscid pulp, then germinate and send sucker-roots through the bark, establishing connection with the tree's vascular tissue from which the nourishment is derived

Photo Courtesy University of Texas

(Above) CLOSE-UP of one twig of the plant which has almost entirely clothed the branches of the California sycamore shown below. Slow in growth, the plant is a hardy parasite and dies only with the death of the tree

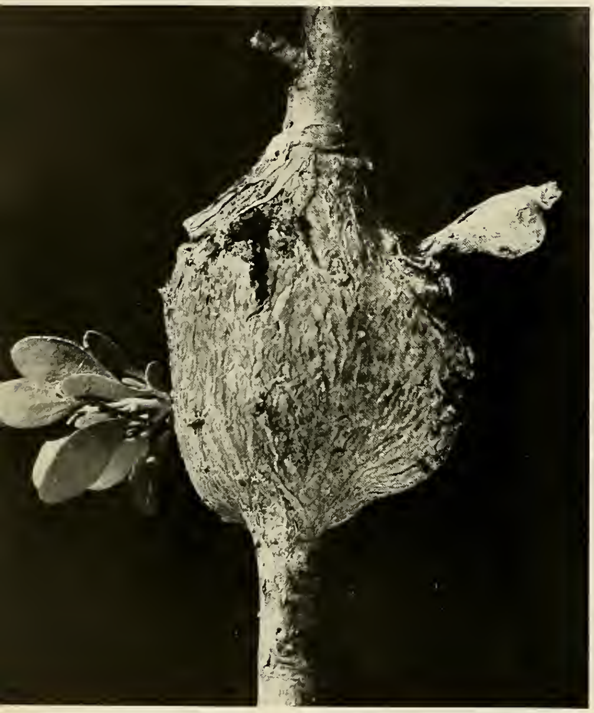
Black Star, Photo by Croy

Devereux Butcher Photo

SEEDS of mistletoe, shown above and at bottom of page, are hidden in the berry's sticky interior

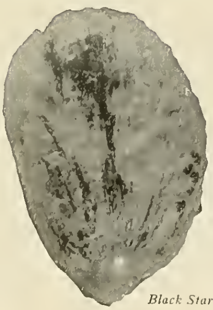
Photo by Poul Hadley

(Above) AT HOME in the forest and *(below)* tied up with tinsel, mistletoe represents the survival of ancient superstitions. Long banned from church decorations because of its worship by pagan Druids, it has passed through the years in many guises, but its most long-lived attraction is the ritual that allows the salutation of a kiss to one who passes beneath its green leaves and waxen berries



(Above) ROOTED on a black gum tree, this mistletoe may have influenced the limb's swelling, although trees in only a few sections suffer from the plant's parasitic attachment

Black Star, Photo by Croy



Black Star, Photo by Croy

gladness, and kiss one another as they pass beneath it, for it brings happiness, safety, and good fortune so long as it is not beneath our feet."

The ceremony of decking houses and churches with evergreens at Christmas is of great antiquity, but for a long time mistletoe was not included in Christmas greens in churches. It was thought to be too much tainted with heathenism to be a fit ornament for the House of God.

In *The Sketch Book*, Washington Irving tells of an experience, illustrating this feeling, in his story of "Christmas at Bracebridge Hall." "On reaching the church porch, we found the parson rebuking the gray-headed sexton for having used mistletoe among the greens with which the church was decorated. It was, he observed, an unholy plant, profaned by having been used by the Druids in their mystic ceremonies; and though it might be innocently employed in the festive ornamenting of halls and kitchens, yet it had been deemed by the Fathers of the Church as unhallowed and totally unfit for sacred purposes. So tenacious was he on this point that the poor sexton was obliged to strip down a great part of the humble trophies of his taste, before the parson would consent to enter upon the service of the day."

In early medicine

As one might expect, mistletoe played a prominent part in early medicine. Among the Druids, a decoction of mistletoe which had grown on oak was thought to be a remedy for or protection against all sorts of nervous maladies, such as epilepsy, convulsions, neuralgia, hysteria, delirium, and irritations; it was believed to give tone to the nerves if taken morning and evening, and to re-establish the circulation of the blood. In fact, it was thought to have curative qualities for many other diseases as well.

> Excellent herbs had our fathers of old,
>   Excellent herbs to ease their pain,
> Alexanders and marigold
>   Eyebright, orris and elecampane,
> Basil, rocket, valerian, rue
>   (almost singing themselves they run),
> Vervain, dittany, call-me-to-you,
>   Cowslip, melilot, rose-of-the-sun.
> Anything green that grew out of the mould
> Was an excellent herb to our fathers of old.
>
> —Kipling.

It came to be a general "good luck" plant in many parts of the world. In Germany a sprig was worn about the neck of a child in the belief that it would keep diseases away, as asafœtida has been used in more recent times. It is stated that in Sweden, persons afflicted with epilepsy carried about with them a knife having a handle of oak mistletoe to ward off attacks. In Wales it was placed under the pillows of sleepers to induce dreams of omen, both good and bad. In Austria a twig laid upon the threshold was believed to be a preventive of nightmare. In many places it was thought to afford protection against sorcery and witchcraft. This magical plant was also believed to cure barrenness in women, and to stimulate fertility in animals and among the crops of our fields and gardens.

A parasite

Botanically it belongs to the Mistletoe Family *(Loranthaceæ)*, which contains some 500 species, growing mostly in the tropical and sub-tropical regions and widely distributed over the world. The original is the European Mistletoe *(Viscum album)*, which played a conspicuous part in the mythology of the Norsemen, the Celts, and the Druids. It is a tree parasite—as are nearly all the other species—gaining its sustenance from the host plant. Although the European Mistletoe is evergreen, it grows upon deciduous trees, perhaps commonest on apple, but seldom on pear; also on ash, maple, hawthorn, lime or linden, black poplar, elm, willow, walnut, and seldom on oak.

The plant has leathery, opposite leaves, and small inconspicuous flowers with no petals. It is diœcious, that is, the male and female flowers occur on separate plants. The exquisite, globular, smooth, white berries ripen in December and are eaten by birds, who are said to spread the plant by wiping the sticky seeds from their bills upon the branches of trees where they germinate, and penetrate the bark.

The Latin name for the genus, *Viscum*, signifying sticky, was assigned to it from the glutinous juice of its berries. The well-known Missel Thrush of Europe gets its name from the fact that it feeds largely on mistletoe berries.

The common American Mistletoe *(Phoradendron flavescens)* grows from the pine barrens of New Jersey to southern Ohio, Indiana and Missouri, south to Florida, Texas and New Mexico. Its hosts include a great variety of deciduous trees—ash, oak, maple, pecan, sweet gum, mesquite, cottonwood, hackberry, elm, sycamore, osage orange, willow and many others. In West Florida it grows by far most commonly on Water Ash *(Fraxinus caroliniana)*. The seeds are spread by Robins, Mockingbirds and Cedar Waxwings, and probably by various other birds.

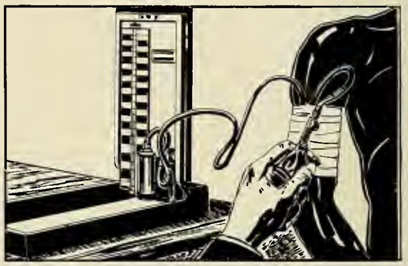
Besides the common species of American Mistletoe *(Phoradendron flavescens)*, two other species of the genus are recognized in Florida and at least three others are known in western United States. An inconspicuous plant, the Small Mistletoe *(Ra-*

Continued on page 378

CIVILIZATION AND SUDDEN DEATH

A lesson from the "savage" on how to live long

By WILLIAM HALL HOLDEN, M.D.



TWENTY-THREE percent of us who are past 50 die of a malady which medical science has lately suspected of being a direct result of the nervous tension of modern civilized life. Drugs, diets and departments of health are powerless to curb this disease—high blood pressure—and it devolves upon the citizen himself to take notice of the measures which promise to forestall it.

It is a long jump from the hurry and worry of modern life to a little-known tribe of Indians in the interior of South America, but if civilization is responsible for this serious disease, perhaps we can learn something from "savagery" regarding its prevention. That is why it became one objective of the Terry-Holden Expedition to measure the blood pressure of people who had made no contact whatever with civilization.

In a remote range of mountains in northern Brazil there is a tribe of Indians unknown to the outside world. They live in one of the densest jungles on earth, undisturbed by man. It is a country of peace and quiet, a literal "lost world," a tropical fairyland. The people we would find here would, therefore, offer significant information on the relation of this disease to mode of life. It is a subtle malady which attacks our most useful and active citizens, often progressing beyond medical aid before given proper attention and involving kidney degeneration and heart trouble, especially in persons past middle age. Another name for the underlying condition is essential hypertension, indicating the chronic "tightening up" of the arteries which sends the mercury high in the blood pressure apparatus when your physician gives you this test. The complications involving the kidneys and other organs have long been treated separately, particularly through diet, but this offers no solution to the basic problem. If the disease is nervous in its origin, we must study the nervous causes. And so to the "unnervous" Waiwais (pronounced *Y—Y's*) in South America.

To my knowledge they had never been studied before, although their presence had been noted twice previously. Schomburgh in his travels one hundred years ago mentioned certain tribes in this region of the Sierra Akarai Mountains. Apparently he did not think of taking blood pressures, as he was in that country for botantical specimens and for surveying. Doctor Farabee, who conducted an expedition into this region in 1913, mentioned some of the Waiwais, but his reports do not mention anything so far as blood pressures are concerned. I, therefore, decided to try to locate this tribe, at the headwaters of the Essequibo River and on one of the upper tributaries of the Amazon in Brazil.

Our expedition staff consisted of a botanist, a zoölogist, a photographer, two radio men and myself, and was conducted under the auspices of the American Museum of Natural History in cooperation with the New York Botantical Garden. We were to make for the first time a complete botanical and zoölogical collection in British Guiana, and were to complete the first successful broadcasts from the interior of that country, through the courtesy of NBC and RCA.

We left Georgetown, British Guiana, on the 18th of September, 1937. For many days we paddled up the Essequibo River, which is the main drainage system of that country, combating numerous rapids and waterfalls. After 20 days, on the 7th of October, we reached a point 300 miles in the interior where we were unable to go further because of very high waterfalls. Here we turned off the Essequibo and paddled 150 miles up the Rupununi until we reached the savannah country. From this point we made an overland detour of about 200 miles around the Kanaku Mountains to the headwaters of the Kuyuwini River, which joins the Essequibo farther upstream. This was accomplished with the use of bullock carts and horses. Here, at what is known as the bush mouth, we set up our base radio station, for it was impossible to carry this equipment further into the interior. At this point, and on the banks of the Kuyuwini about 25 miles away, we spent some three weeks constructing dugouts, for beyond this we were to travel again by river. We shoved off on the 20th day of November, leaving our two radio men behind to operate our base station. The rest of us traveled on down the Kuyuwini and up the Essequibo for several weeks until we reached the point on the Essequibo where the Onoro River meets it.

Here we established a camp and remained for two weeks making botanical and zoölogical collections. It was at this camp that we first had any real contact with the Waiwai Indians, among whom we wished to make our blood pressure studies. They had come over the mountains from Brazil and established two settlements near our camp.

While here our work was facilitated by the opportunity to treat one of their medicine men, or *pei* men, who had had his hand torn by an alligator. Through this they developed great confidence in us and permitted us to enter their villages and make whatever photographs and blood pressure studies we wished.

We found only a few of these people living in British Guiana, but they told us that we would find several villages after we crossed the Akarai Mountains and reached Brazil. This was accomplished after many days of pushing our way up the Essequibo River and one of its tributaries called the Shodikar. This was a particularly difficult task because the Shodikar was only a small stream and was filled with many fallen trees. The water was particularly low as it was now January and the rainy season had not yet set in in full.

Beyond the Akarai Mountains

It was at the base of the Sierra Akarai Mountains, the headwaters of this river, that Mr. William Hassler, the expedition photographer, and I finally said goodbye to our botanist, Dr. Albert Smith of the N. Y. Botanical Garden, and our zoölogist, Mr. Robert Snedigar of the American Museum of Natural History, who remained in that country for some time collecting specimens. We labored on for many days crossing the Akarai Mountains, which consist of a series of high ridges and ravines, covered with very heavy vegetation. We had sixteen Indians with us, but after arriving at the headwaters of the Rio Mapuera, on the other side, we sent back twelve of them.

We had hoped to contact an outpost of the Brazilian Boundary Commission, but the place was a complete wilderness. Not even an Indian village was to be seen. Now we had to create a conveyance to take us down this small river, called by the Indians the Mapuera-wau. This meant cutting down a big tree and building a dugout, and after five days of hard work we finally completed a boat 27 feet in length.

Food shortage

By this time we were reduced to very scant rations, with only a small amount of flour and rice left for Mr. Hassler and me and our four Indians. The rivers upon which we were traveling were a series of waterfalls and rapids. Day in and day out we were shooting these rapids or portaging our equipment around falls which could not be navigated. Game was scarce in this region, and our only hope lay in finding some village where we could get a few supplies.

On January 18, 1938, after paddling a few miles downstream, we came upon our first Waiwai village. Here we found people living in the most primitive manner. As nearly as we could make out, they were not far removed from the Stone Age. They had managed to get a few knives by trading their stone cassava graters with the Wapisianni Indians, but we could find absolutely no other traces of civilization among them.

They were living in large communal houses, circular in shape, with a conical roof. These houses sheltered anywhere up to 25 or 30 people, and 40 to 50 dogs. Fortunately we were expected. The medicine man whom I had treated had gone on ahead and told them all about us.

We secured some food from this first village—cassava bread, bush bananas and a few buck yams, which are a form of potato. However, this certainly would not last long, and the natives did not have a great deal of food, even for themselves. We wanted to stay longer among these friendly people, but we did not know how long it would be before we might reach the Amazon and more food, so we pushed on after two days, having recorded a few blood pressures among the older Indians. We discovered that the latest maps of this region were likely to be anywhere from 50 to 100 miles off in any direction. In fact, we were in an unexplored wilderness.

We found the second Waiwai village a distance of about a day's paddle from the first. Here we recorded more blood pressures among the older inhabitants and pushed on to the next village, which we reached on the 28th of January.

Our most memorable visit came as we neared the Rio Mapuera, weary from long travel. Our Waiwai Indian guides informed us that the last village lay back from the river, but when they say "a short walk" it may be anything from miles to days. These Waiwai Indians think nothing of starting off and traveling on foot for weeks. A "mile" does not exist in their vocabulary. After we had walked for five hours through a dense forest we finally arrived at a clearing, in the center of which was a large palm-thatched circular house. There were a few similar but smaller structures about, which were apparently used as guest houses and places where the women prepared their cassava bread.

In the men's house

An amusing but baffling incident occurred here which threatened my confidence in the tests I had previously made. We were greeted by various members of the tribe in a most friendly manner. Most conspicuous were two Indians entirely concealed in grass costumes. Over their heads was a sort of fiber hood through which they peered at us. At first we thought that they were the medicine men, but we noticed that they soon disappeared inside a circular house which was apparently set apart for the men.

As soon as the formalities of greeting were over, Mr. Hassler got busy taking moving and still pictures. The Waiwais had never seen a camera before and had not the slightest idea that their likenesses were being recorded. Therefore they were not the least bit camera shy.

Our interpreter explained to the Indians as well as he could that we wished to make some experiments among them, and they consented. I set up my blood pressure apparatus and went to work. I had recorded a number of the older inhabitants of the village when it started to rain. Picking up my equipment, I rushed into the nearest hut, where I continued my recordings. I noticed that there seemed to be only men in the hut, and that several of the grass costumes we had noticed upon entering the village were hung up on the wall, but I attached no particular significance to this.

I was soon absorbed again in recording more blood pressures, and before long asked them to bring in the older women of the tribe. There was some hesitation at this request, but finally one woman was led in by the ear, her eyes closed. This was certainly unusual, but I took no further notice and proceeded to test her. To my surprise her blood pressure was unusually high. Up to this time I had found none higher than what might be expected in a young woman of 25. I was somewhat at a loss to explain this. Another older woman was brought in, and a third, and in each case the blood pressure was abnormally high.

By this time I was sure something unusual had happened. Turning to my interpreter, a half Scotch and half Wapisianni Indian, I asked him what the trouble was.

"Why," he said, "nothing much—except that you have violated one of their most sacred taboos. Women have never been permitted in this house before. These young men are being initiated into the tribal rites of warriorship, and during that time no woman is permitted to look upon them. Whenever these young men are in the presence of women they must conceal themselves in those grass costumes you noticed earlier. And here you bring women into this sacred hut! It's no wonder their blood pressures shoot up."

After this episode, needless to say, I recorded no more women's blood pressure in the warriors' hut. These three were the only instances I found of abnormally high blood pressures and were the direct cause of emotional stimulation.

In all three of the villages which we visited the Indians were very cooperative and showed no fear when we tested them. I tried to determine their ages as nearly as possible, but found this to be very difficult. Their years are gauged from one rainy season to another and are based on their observations of the celestial bodies. But we determined their ages as closely as we could. We recorded the systolic and diastolic pressures with a B. D. mercury type manometer, in both males and females, and took the pulse at the same time. We did not record many of the younger people, but tried to select the oldest inhabitants of each tribe.

No high blood pressure

We found them to be uniformally low in their systolic pressures, averaging 121. Their diastolic pressures averaged 74. We did not find a single case of high blood pressure or so-called essential hypertension. Nor were there any indications of arterio-sclerosis, or hardening of the arteries, among these people. In other words, these people apparently have a circulatory system free from the diseases of this nature which are so serious among our people.

Here one never hears of a person stricken suddenly dead as a result of heart failure or coronary occlusion. Cerebral hemorrhage and high blood pressure are unknown to these Indians.

Under way for the interior: the Terry-Holden Expedition leaving Bartika near the coast of British Guiana on a difficult journey to one of the least known tribes of South America. Among other scientific results, the expedition was to secure important information on the opposite effects of civilization and primitiveness on human blood pressure

(Left and below) Higher on the Essequibo River which rises in the Brazil-Guiana borderland, rapids defeated the outboard motors and paddles combined, and days were spent pulling the boats through by long warps

(Below) The coiffure of a well-dressed Waiwai male. (The neck chain was contributed by the expedition.) Note how the women carry their children in a sling made of bark

Photos by William G. Hassler

William G. Hassler Photo

READERS may have heard the Christmas broadcast sent out last year from the radio station shown above, over the NBC network. This program from the junction of the Essequibo and Onoro Rivers was the first broadcasting ever done from the interior of British Guiana. Primitive Waiwais visiting the expedition here enjoyed their first introduction to radio, and the expedition spoke at the same time with the MacGregor Expedition far away in North Greenland. The shelter shown here illustrates the camping methods of the expedition. A frame of poles, cut from the jungle, was erected and bound together with bush rope. Over this a tarpaulin was thrown, and the hammocks were slung beneath. Beyond this point, near the outskirts of the Waiwai territory, progress became increasingly difficult, especially in crossing the Akarai Mountains on foot, a series of high ridges and ravines covered with heavy vegetation

William H. Holden Photos

William G. Hassler Photos

(Left) FOUR WAIWAI MAIDENS. These women are modest even though their only dress is a small apron, sometimes beaded

(Right and below) WAIWAI GIRL making a cassava grater from fragments of flint-like rock, which are set closely in a board

(Left) THE INDIANS live in these palm thatched houses, usually hidden some distance from the river

THE WAIWAI CHIEF submits to examination in the search for the causes of essential hypertension. The absence of this disease among these primitive people gives new evidence that its serious ravages are due to the nervous strain of modern life, as discussed in the text

(Above) HIDDEN FROM FEMALE EYES: a young native undergoing initiation to warriorhood. It was during this ceremony that the author, inadvertently examining women in the men's house, was at first baffled by the only high blood pressures he found in the tribe

(Below) WAIWAI WOMAN, painted with native plant pigments, prepares to have her blood pressure recorded

(Below) SHOOTING RAPIDS on the Mapuera Wau in Brazil in a dugout constructed in the jungle

(Below) THE AUTHOR presents a native belle with a gold plated chain from New England

All photos by William G. Hassler

UNTOUCHED BY CIVILIZATION, the Waiwais yielded evidence on a disease which kills almost a fourth of all civilized people past 50, namely, high blood pressure

The native above is holding a cassava sieve. The tight arm band is believed to increase strength. *(At right)* Two well-dressed Waiwai chiefs

(*Below*) NATIVE GUIDES: two Waiwais who traveled with the expedition down the upper tributaries of the Rio Mapuera in Brazil, pointing out many treacherous channels. The Waiwais hunt with bows seven or eight feet long, using six- or seven-foot arrows. They frequently have strong faces, are intelligent and have an excellent sense of humor

All photos by William G. Hassler

The Waiwai does most of his fishing with bow and arrow. A few minutes after this picture was taken his arrow sped on its way, well aimed. Good-sized fish are obtained in this way.

Note that all Waiwai men wear their hair in a queue. These natives wear no clothes except a loin cloth

William G. Hassler Photos

(Above) Beyond the Waiwai country, the Mawoians also liked the neck chains brought by the explorers but were less dignified: the boys went through their pockets in search of trinkets

(Right) Farewell to primitive life: the expedition, on its way out, bids goodbye to the Mawoian Indians on the upper Rio Mapuera in Brazil

The Waiwais never have to worry how they will pay their rent or their grocer's bill. There are no telephones to drive them to distraction. A husband never worries about how he can buy his wife a new hat or dress. Their personal adornments are procured from the brilliantly plumaged birds which fly overhead; and as for clothes—they wear none.

There is no stock market to send one's blood pressure skyrocketing. These fortunate people are not forever dodging automobiles or watching red lights in their hurry to keep this appointment or that. There are no such things as being "late for work" or punching the time clock. There are no moving picture thrillers to throw them under emotional tension. The noise element which keeps our nerves constantly on edge in this country is entirely eliminated. These Indians live in a peaceful world surrounded by the beauties of nature.

Their domestic life is free from the trials and tribulations which account for so many divorces in this country. The Waiwai male is the master of his house. His wives, of whom he has usually five or six, are under perfect control. Woman suffrage has never been heard of. In fact, the women are happy in working for their husbands. Divorce courts are unknown.

A peaceful existence

At sundown these Indians string their hammocks wherever they may find themselves, be it in their communal villages or in the midst of the jungle. They build a small fire to keep them warm, for, in this humid region, it becomes very cool as soon as the tropical sun sets. There is no blaring alarm clock to waken them in the morning, only the first glimmers of dawn and the chirping of the birds. During the heat of the day they frequently sling their hammocks and rest, so that their sleep is adequate, which is not the case with most of us.

Their diet is simple. Food is not abundant in their country, and the Indians must work hard for whatever they get. As a result they are seldom gorged by excessive amounts of food and they get plenty of exercise. Therefore digestive disturbances are rare.

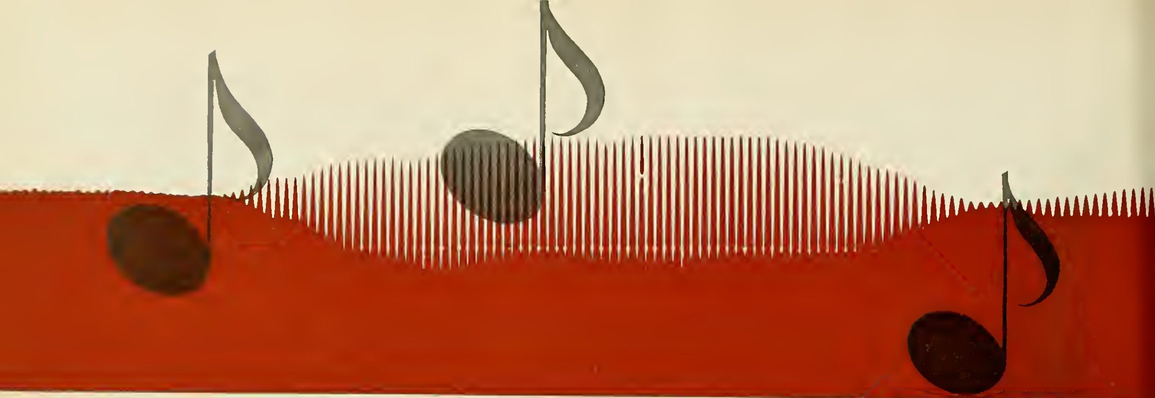
We have departed so far from the lives of our primitive ancestors that the average person today has no conception of the artificiality of his life until he takes time to compare it with the lives of such people as these Waiwai Indians. In the relatively short time since our ancestors were primitive people, our social and economic system has developed far more than our physical constitutions. High blood pressure and nervous diseases are often some of the ways in which we pay for this progress. A mind free from worry and anxiety allows the sympathetic nervous system to function as nature intended. The result is that our involuntary organs can carry on their normal function and biochemistry. We have no control over these vital organs except by proper mental hygiene and habits.

The Indian in civilization

The Indians we had with us on this trip, four of whom we carried out to civilization when we emerged at the mouth of the Amazon, showed decided mental changes when placed in civilization. They became depressed and despondent. It was only with the greatest difficulty that we could persuade them to emerge into the city life. They were not at all adaptable to such a change in environment, and I could hardly wonder. Even we ourselves were perplexed at this sudden change after having been in the interior for so many months.

When we consider the many complexities of our life, it is little wonder that we have developed so many nervous ailments and our insane asylums are filled with thousands of inmates, with many borderline cases roaming our streets. We found no cases of insanity among these Waiwai Indians.

Can we not learn from this simple example in "natural history" why we have so many diseases of the nervous system today? Is it too late to learn that by slowing down our pace and living more in accordance with the designs of nature we may not only prolong our own lives and preserve our nervous systems, but probably save those who are to come from having nervous systems which will make their lives miserable?



The Insect Glee Club at the Microphone

By FRANK E. LUTZ

Curator of the Department of Insect Life, American Museum of Natural History

Before ever birds sang, possibly insects had developed noise-making mechanisms. Indeed, the friction of cricket wings and those of allied species probably sent the first land-animal sound waves vibrating over this earth. Today man's magic recording devices enable him to study the "songs" of these primordial musicians, many of which range beyond the limits of the standard piano or the skill of the nimblest fingered violinist

INSECTS are the birds of the invertebrate world. Beauty of color and form is even more common among them than is generally recognized. They are the only flying invertebrates. In mastering the art of flight they have done better than birds in that they have acquired wings without losing the original function of any of their legs. And—the thing that concerns us here—many insects of several diverse groups make sounds that are usually both loud and characteristic of the species, an unusual thing among invertebrates. Perhaps there is no harm in calling these sounds "songs" even though they are neither made with vocal cords nor come out of the creatures' mouth. However, "instrumental music" might be a more strictly accurate term.

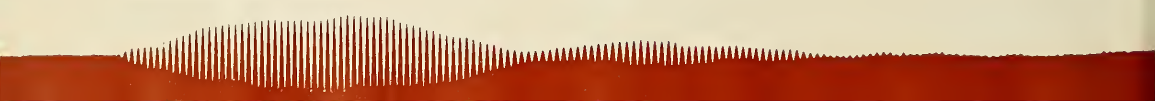
Divesting this discussion of certain technical details, exceptions and other things, we may say that sounds are vibrations of air. If there are less than about a dozen of these vibrations per second they give us the sensation of hearing each separately. If there are more per second, we do not distinguish them individually but hear them as a continuous sound which rises in pitch as the number of air-vibrations per second increases. If there are about 250 vibrations per second, we hear a note that is about the pitch of middle C of our pianos. The highest note on our pianos is about 4000 c.p.s. ("cycles per second," a better expression than "vibrations"). As a matter of fact, doubling the c.p.s. raises the pitch one octave. Thus, the C above middle C is about 500 c.p.s.

What happens when sounds are recorded on photographic film, as in the "talkies," is that each air-vibration, or "sound-wave," affects a little light in front of which the film is traveling at the rate of eighteen inches per second. Of course, the negative film, when developed, is black where this light shone on it. In one of the methods of sound-recording the light is dimmed and brightened as a result of the sound-waves, making a lesser and greater darkening of the film; and so it is called the "variable density" method. It is the one that we used some years ago to record the chirping of a cricket.* Another method employs an illuminated mirror that swings with each air-wave: the stronger the wave the more the mirror swings, making a higher line on the film; and the longer the wave (the fewer per second) the slower the swing and, hence, the broader the line. This, then, is called the "variable area" method. It is the one that Mr. Albert R. Brand has been using so successfully in recording the songs of birds. In either method, each sound-wave is represented by a mark on the film. By counting the number of marks per unit length of film, translating that length into seconds, and doing some simple arithmetic, we can learn the pitch of the sound. Still other physical characteristics of the sound can also be learned, some of them only by people who are very expert in such things.

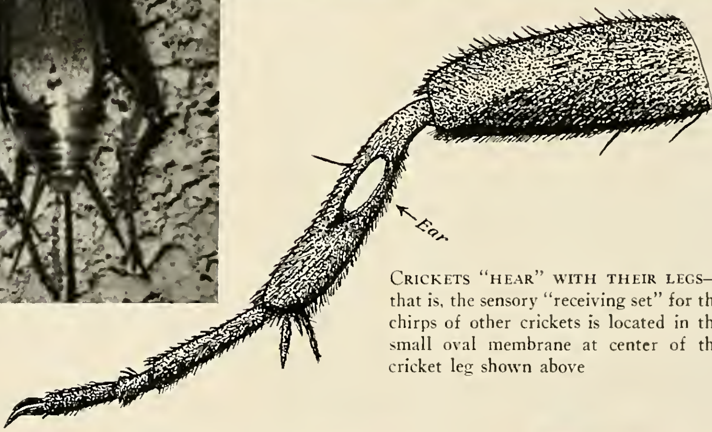
It is not a very long step from recording bird-songs to recording the sounds made by insects; and,

*Lutz and Hicks, 1930, Amer. Mus. Novitates, No. 420.

BELOW and at bottom of next page are two enlarged strips of sound film recording about one-half the single chirp of a large, black American field cricket. Each strip represents the sound made in 1/24 of a second while each vertical line indicates an individual vibration

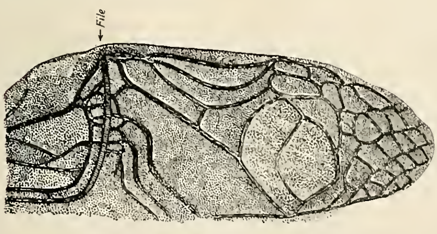


SEEMINGLY the world's oldest ventriloquist as well as one of its early sound-makers, the pale green Temperature Cricket is difficult to locate either by chirp or by sight. Bent on recording its "song" on a sound film, Doctor Lutz *(right)* used his "cricket divining rod"—an ordinary stethoscope fitted with a sound-gathering funnel—to find the elusive source of sound in his backyard hedge. Below, a black field cricket who also performed for Doctor Lutz's microphone, poses with his mate *(right)*. Male crickets do all the chirping; females confine themselves largely to depositing eggs with their needle-like "tails"

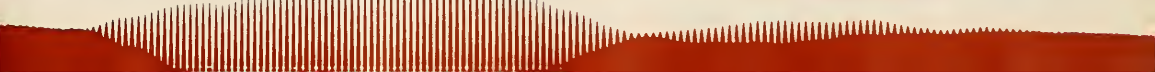


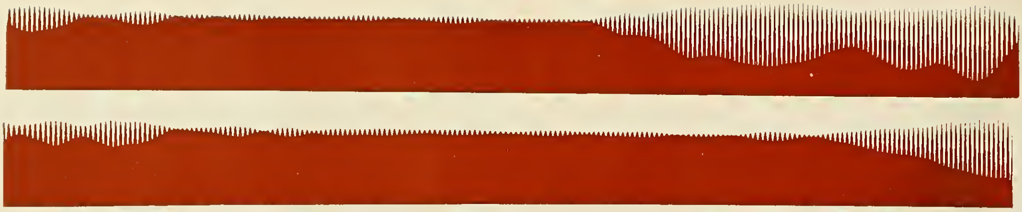
CRICKETS "HEAR" WITH THEIR LEGS—that is, the sensory "receiving set" for the chirps of other crickets is located in the small oval membrane at center of the cricket leg shown above

CRICKETS "SPEAK" WITH THEIR WINGS. Below is a section of a male cricket's wing. Note the heavy "vein" or "file." This file is scraped across a spot on the other wing, producing the chirp



(Right) WHAT A CRICKET'S CHIRP looks like on the sound track of a "talkie" film. Each strip *(at right)* shows what happened in 1/12 of a second





IMMIGRANT: the brown house or hearth cricket *(rgiht)* of Dickensian fame is no 100% American. He reached these shores by transatlantic steamer. Of slightly higher pitch, his song differs from that of our native field cricket mainly in rhythm. As shown on his sound track *(magnified at top of page)* it is more trill than chirp

since insects are most active at times of day when birds are least vocal, the two tasks nicely fill out the day—and night. At any rate, Mr. Brand kindly and most generously joined me in collecting insect sounds. Furthermore, he has patiently helped me in interpreting the records.

Let us start with crickets. They and their relatives, the "long-horned grasshoppers," including our famous Katy-did (or Katy-didn't), make their sounds by rubbing their front wings together. That is, the males do. Among insects it is the males that make most of the noise.

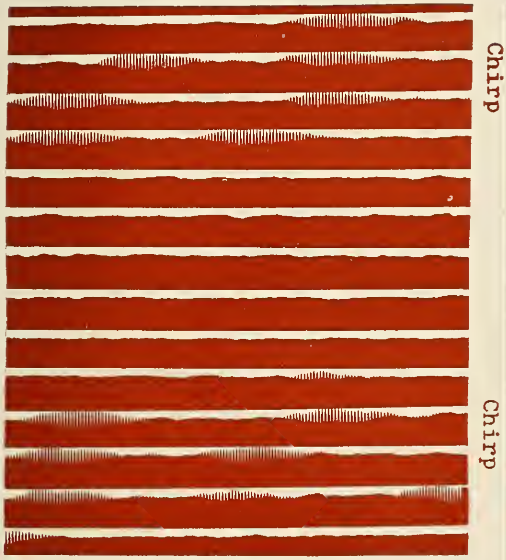
If you will carefully examine the front wings of a male cricket, either a big, black field-cricket or a brown house-cricket, you will see that there is a relatively heavy, transverse "vein" near the front of each wing. On the under side of this there is a series of very fine teeth, somewhat like a file. When the front wings are rubbed together the file on one wing rubs against a hard spot on the other wing, setting both wings into vibration. Each vibration of the wings starts a vibration or wave in the surrounding air and these waves, striking our ear-drums, gives us the sensation we call sound. You will probably notice that just back of the middle of each front wing of the male cricket you are examining there is a clear area, somewhat like the head of a drum. We are not definitely certain as to the effect of this on the sound. Probably it at least increases the effectiveness of the apparatus. In spite of much that we do not yet know about this subject it seems certain that the more teeth of the "file" that are scratched per second, either because the wings move faster or because the teeth are closer together, the shriller the sound.

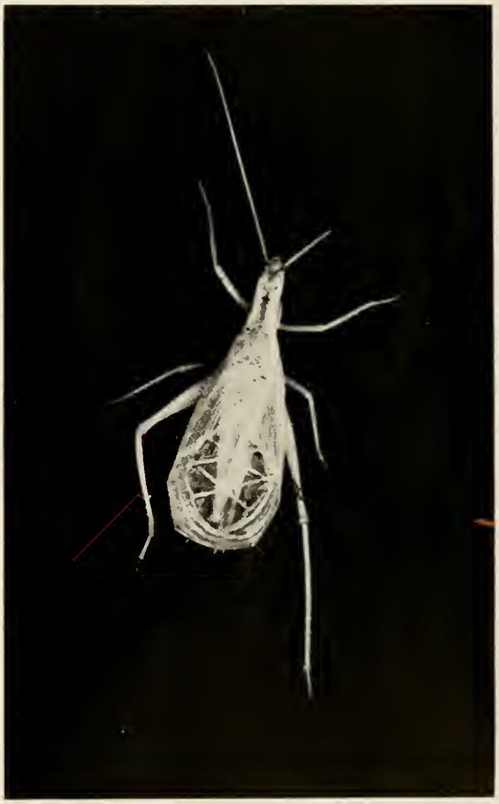
The illustration on page 339 *(lower right)* is a portion of a record of the song of the ordinary black Field Cricket *(Gryllus assimilis)*. It is slightly magnified, each successive strip showing what happened in that particular one-twelfth second. By looking closely you will probably recognize four "pulses" of sound at the start of this record and another four at the end. If so, you will be seeing a record of two chirps and of the intervening silent period. As that

individual cricket was singing at that particular time the chirps were about 0.18 seconds long and the average interval between chirps was about 0.5 seconds. Our ears can easily notice such a long interval but the "rests" between the pulses of sound making up an individual chirp are too short for our ears to distinguish them clearly. Across the bottom of pages 338 and 339 you will see two pulses more highly magnified, the strip on each page representing what happens in a twenty-fourth of a second.

The slightly irregular wavy top of the "sound track" usually has no connection with the insect's song but represents low-pitched extraneous sounds such as the wind blowing or the rumble of a passing automobile. When the song of the insect reaches the microphone the recording apparatus jiggles vigorously. It is this vigorous jiggling that is recorded in the sharp vertical lines looking like the teeth of a comb. Remembering that each of these lines represents one air-vibration and that the length of strip on each page represents one twenty-fourth of a second, you can determine that the chirp of this cricket was close to 4600 c.p.s. or about the first D above the highest note on a piano.

Gryllus domesticus, the celebrated European Cricket on the Hearth, now occurs in many American homes, sometimes unwelcome in spite of the tradition that "to have a Cricket on the Hearth is the luckiest thing in all the world; it's sure to bring good fortune." Perhaps the catch is that most American homes have no hearth. Ours has a sort of one, and through no effort or design on our part our sort-of-a-hearth had a *Gryllus domesticus* in one of its crevices when Mr. Brand was visiting us. So, we collected its music. Looking at the records of this music, we note the strong resemblance to that of its





THE "TEMPERATURE CRICKET": a tree cricket of the genus *Œcanthus (right),* so-called because his number of chirps per minute definitely varies with temperature. The latter may be computed roughly by dividing the number of chirps per minute by four and adding 40. Pitch also is probably affected by temperature; in the sound track above it shows only 1700 vibrations per second, a low mark for insects. Enlarged strip across bottom of both pages represents about one-third of the Temperature Cricket's chirp

Above are three strips of sound film showing the songs of (1) the Small Ground Cricket *(Nemobius)*, (2) the Tail-less Cricket *(Anurogryllus)* and (3) *Gryllodes*

American outdoor relative. However, the differences are definite. The enlarged reproduction at the top of page 340 shows a slightly different "pattern" of individual pulses of sound. The intensity is more wavering and the pitch is, on the whole, slightly higher: about 5000 c.p.s. But it is in the rhythm that they differ most. The silent interval between groups of pulses is shorter. In fact, it is often so short that the sound is almost a trill instead of a succession of distinctly spaced chirps.

Most of the crickets that live on the ground in our yard are small brown ones belonging to the genus *Nemobius*. We collected several of their musical scores. In the one of which a part is shown at the top of this page faily long pulses of sound (average 0.03 secs.) are separated by silent intervals averaging 0.06 seconds. Since most of us can appreciate intervals of that length the result, so far as we are concerned, is a trill of excessively rapid chirps (more than 600 per minute), each chirp being only a single pulse of sound. The pitch is high, normally varying between 6000 and 9000 or more c.p.s.; in other words, reaching an octave above the normal range of a piano.

It is rather difficult to locate these small brown *Nemobius* trilling in the grass and flower beds; and it is still more difficult to locate the pale green *Œcanthus* in the bushes. They seem to be almost ventriloquistic. However, a very simple device has been a great help in this. I secured a stethoscope from our family physician and fitted it with a narrow funnel. Wearing it, I move the funnel back and forth, up and down, until I find the direction from which the sound is strongest. Then stepping to one side or the other I repeat the direction-finding. Where the two lines, pointed out by the funnel, cross is the insect.

During Mr. Brand's visit our yard was the happy home of several species of *Œcanthus*, the Tree Crickets. One of them *(Œ. latipennis)* makes what sounds to us like a continuous note kept up for many minutes at a time without resting, and indeed the record shows that there are no actual pauses between the pulses. The pitch is about 2700 c.p.s. There are about 45 pulses per second or 2700 per minute. It seems certain that each pulse is caused by one rub of the wings. Since the little fellow sings for hours night after night we must at least marvel at his industry.

Another was *Œcanthus niveus*, the Temperature Cricket. It sounds its pulses in groups that we hear as distinct chirps. The number of these groups or chirps per minute varies so definitely with temperature that the little creature is an animated thermometer. A simple and fairly satisfactory formula showing the relation is as follows. Count the number of chirps per minute, divide by four and add 40 to learn the temperature (Fahrenheit) where the

Photograph of an enlarged model made by Miss Alice Gray

(Right) MOLE CRICKET: such crickets live in burrows that they dig with their greatly modified front legs. The sound film *(part of which appears at bottom of opposite page)* shows that this insect burrower apparently can rub his wings together 7500 times in one minute. See how often you can snap your fingers in the same length of time

CONE-HEADED GRASSHOPPER *(right)*: his song, like that of the other "long-horned" grasshoppers recorded here, is more complicated than that of crickets. Three "bars" of his musical score are shown above

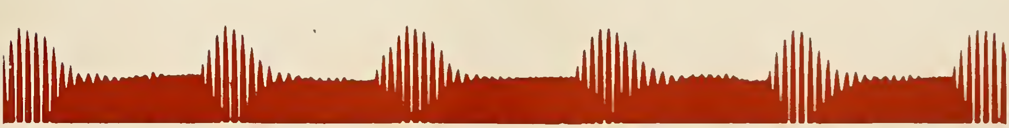
insect is making merry. Do not be too critical as to the exact accuracy of this formula. When we made the record of which a portion is shown on pages 340-1 the cricket was playing at rate of 75 chirps per minute and, according to the formula, the temperature "should have been" about 59°. It was. The pitch of the song probably also varies with temperature. In this record it is only about 1700 c.p.s. or in the third octave above the middle of piano range—very low for insect songs.

As an interlude in the concert of the insect glee club at our home near New York City, let us look at the records of cricket sounds that we secured when I was the guest of Mr. Brand in Florida. There are some very interesting forms there that we do not have at home.

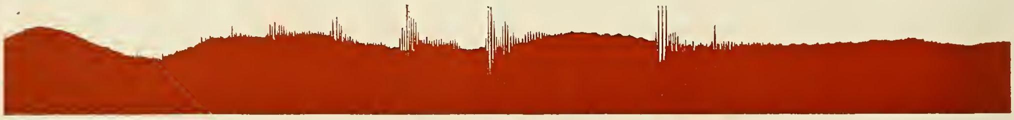
One of these is the genus *Anurogryllus,* which means in English, Tailless Cricket. The "tail" that is missing is the long needle like ovipositor ("egg-placer") possessed by females of, for example, *Gryllus.* This cricket lives in burrows that it digs in sandy soil without the benefit of any specialization of its legs. It comes out at night to eat leaves, some of which it takes into its burrow for eating there. Mating is done above ground at twilight, the males trilling at a pitch of about 5000 c.p.s. each pulse of sound being at intervals of about 0.003 seconds and not grouped in chirps.

In the same general region are two genera of "mole crickets." Their front legs are highly specialized, resembling the front legs of moles and used in the same way. The males do a great deal of chirping in their burrows and my modified stethoscope was extremely helpful in locating these underground songsters. The record shows a continuous succession of short pulses at the rate of about 125 per second. This apparently means rubbing the wings 7500 times per minute. It outdoes even *Œcanthus.* How does it compare with the most nimble-bowed violinist?

A cricket that was chirping under the edge of a concrete sidewalk in Florida has an interesting musical score. It uses groups of two (or sometimes three) short, quickly delivered pulses, the groups separated by intervals of about 0.1 seconds (405 chirps per min.). Apparently its normal wing movements in chirping are: open, shut, stop; open, shut, stop; and so on. After recording its music we tried to catch it but it rapidly retreated under the concrete and we had to give up. From what I saw of it, I think that it was *Gryllodes sigillatus.*

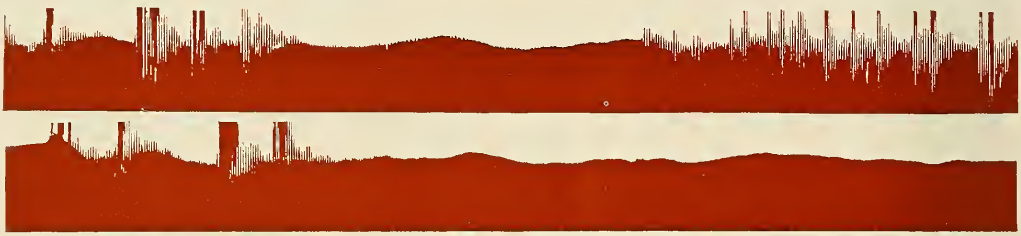


Above: start of the Larger Meadow Grasshopper's song



The song at end of first second

The song at the end of third second

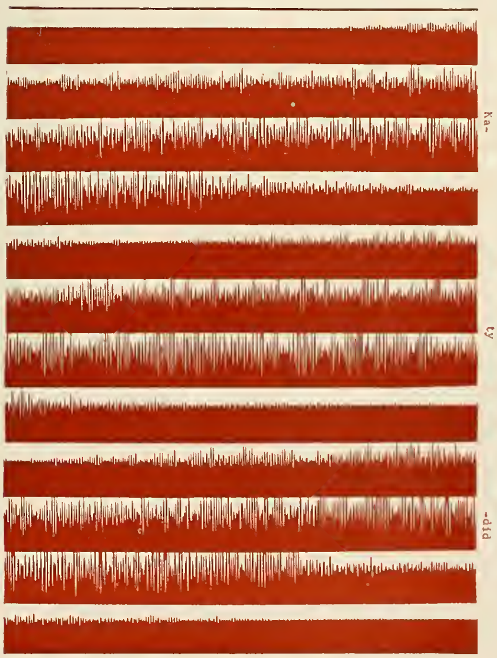


The six-second song ends

MEADOW GRASSHOPPERS: a species of *Orchellimum (below)* that is found in most suburban yards has a song *(above)* that lasts for six seconds or more, starting slowly and working up to a climax

KATY-DIDS *(left)*. In contrast to crickets, the refrain of these famous "dogmatists" is far from pure in tone, as can be readily seen by the irregular lines on the sound track below. The syllables "Kay" "ty" and "did" are indicated on the right border of the sound track series

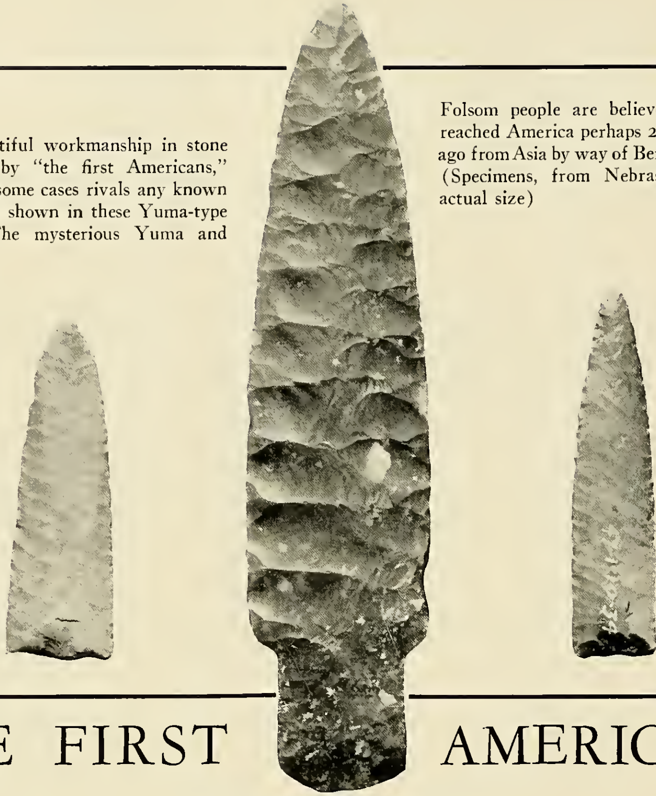
We have collected still other cricket sounds, but these are probably sufficient to justify the following tentative conclusions. The chief difference among them is in the rhythm caused by differences in the timing of the pauses between wing-strokes. The average number of air-vibrations per second in each pulse varies at least from 1700 c.p.s. for one of the Tree Crickets to about 9000 c.p.s. for *Nemobius*. In other words the fundamental pitch ranges nearly three octaves in our musical scale. Each species has its own characteristic combination of rhythm and pitch. However, in all of the pictures of cricket sounds, if we may speak of "pictures of sound," the air vibrations are regularly spaced and the changes in intensity (as shown by height of the lines) are gradual. The pictures indicate pure tones. This is in contrast with the pictures we have of the sounds made by some of the "long-horned grasshoppers," although these close relatives of crickets make their sounds in the same way, namely, by rubbing the "file" of one front wing against the other front wing.



Let us now return to our own yard in a New York suburb for some music by Long-horned Grasshoppers. An occasional resident there is a species of *Neoconocephalus,* a long-horned grasshopper with a cone-shaped head. As may be seen by the picture of his song at the top of page 343, it contains intervals of about a twelfth of a second or quite sufficient for us to discern. There is a relatively short, weak bit of sound before the main part of each burst of sound and a possibly distinct short but strong ending. Whether or not these each represent separate strokes of the wings I do not know. However, note that, in place of the beautiful simplicity of all of the cricket chirps that we have studied, the air vibrations here make a complicated pattern. What such a pattern, apparently characteristic of long-horned grasshoppers, means in terms of harmonics and other factors has not yet been worked out and, even if it had, it would probably be too technical to be discussed here.

One of the common long-horned grasshoppers in our yard is *Orchelimum vulgare*. The males have a

Continued on page 378



The beautiful workmanship in stone achieved by "the first Americans," which in some cases rivals any known to man, is shown in these Yuma-type points. The mysterious Yuma and Folsom people are believed to have reached America perhaps 20,000 years ago from Asia by way of Bering Straits. (Specimens, from Nebraska, shown actual size)

THE FIRST AMERICANS

By C. Bertrand Schultz

Assistant Director, Nebraska State Museum, University of Nebraska, and Director of Field Parties

Revolutionary discoveries which have pushed back man's known occupation of this continent many thousand years and enabled scientists to reconstruct his struggles under climatic conditions differing radically from those of the present

Scarcely more than a decade ago most scientists agreed that the earliest men came to America only a few thousand years ago. The notion that people might have lived here before the last glacial advance of the Ice Age contained far-reaching implications but received little support. Now we have proof that a mysterious people lived in America in reasonably large numbers possibly as long as 20,000 years ago and apparently many thousand years before the earliest known Indians. Perhaps even more surprising is the fact that these ancient people fashioned spear-points which exhibit some of the finest workmanship in chipped stone known to man.

Piecing together the story of their struggles on a continent whose climate differed radically from the present, we deduce that they migrated from Asia via the trans-Bering land bridge which perhaps existed during the Pleistocene or Ice Age. While the exact date is, of course, unknown, we can say that they probably lived here between the two last glacial advances during the latter part of the Wisconsin glaciation.* Across this land bridge many species of animals wandered back and forth. While the mammoth, bison and muskoxen were migrating from Asia, the horse and camel crossed in the opposite direction. Man had been in Asia since the middle of the Pleistocene and it is logical to believe that he, also, migrated over the Arctic wastelands to America, perhaps following herds of his game animals. Even a partial list of the extinct animals known to have existed when these first Americans roamed the prairies and the foothills of the Rockies gives a graphic impression of the changes that have occurred.† Probably 83% of the large mammals known to them have since vanished from the earth. In a single cave some 80 different species of animals have been found directly or indirectly associated with man.

Concerning the appearance of this first American we know far less than about the animals he feasted on. His presence on the continent is known chiefly from an abundance of the so-called Folsom and Yuma-type weapon points and tools. Contrary to what many have thought, it is not necessary to find a fossil "ape-man" in order to have an "Ice Age Man," for man had presumably already progressed far from his ape-like ancestors of the Old World.

The skulls and skeletal parts from Minnesota which were reported by Dr. A. E. Jenks seemed to be the most primitive ancient remains yet discovered in America. More bones are necessary before we can be sure what our first Americans looked like. But we may look forward with reasonable hope to further discoveries.

What happened to these makers of the now well-known Folsom and Yuma points? They may have become extinct on this continent along with many of the animals of their time. On the other hand, they may have been driven south by unfavorable conditions to Central or South America, and perhaps later returned north.

The first finds

The first of the recent discoveries which pushed back man's horizon in North America notably farther than the few thousand years encompassed by the American Indians occurred in 1926 when Mr. J. D. Figgins of the Colorado Museum of Natural History reported finding several flint implements associated with the bones of extinct bison at Folsom, New Mexico. The following two years an American Museum of Natural History expedition under the direction of Dr. Barnum Brown cooperated with the Colorado Museum in the excavations of the remaining bison skeletons and twelve additional dart-points. Doctor Brown estimated that the deposits containing these remains were fully 20,000 years old. The Folsom stone-chipper's workshop recently uncovered in northern Colorado by field parties from the Smithsonian Institution has done much to clarify the "Folsom complex."

Yuma points unique

In 1928 the limelight was thrown on a collection of points belonging to Messrs. Perry and Harold Anderson of Yuma, Colorado, when Dr. A. E. Jenks recognized the Yuma points as being unique and different from the implements of the American Indians. Dr. A. E. Renaud of the University of Denver later applied the term "Yuma" to these points. This celebrated collection contains nearly 1000 Folsom and Yuma points.

The collectors of today were not the first to take notice of the artifacts of our earliest Americans. The American Indian also found them. Yuma artifacts were picked up and used as pendants and charms by the Indians, who, in some instances, notched them in order that a cord or rawhide thong could be attached. One "Yuma" was in a Sioux Indian's medicine bundle, which was found at the site of an Indian battle in western Nebraska. Perhaps the Indians were attracted by the unique and beautiful chipping which distinguished the points.

In distinction to the modern Indians, the Folsom and Yuma people were able to chip with equal skill quartzite, flint, agate, jasper and chalcedony. But not all of the ancient Yuma and Folsom artifacts show the characteristically beautiful workmanship; and later points are found which resemble them in some respects and are apt to be wrongly identified.

A typical Folsom point *(see photograph on page 355)* may be described as a leaf-shaped blade which has a varying base that is neither barbed nor stemmed. It is grooved on one or both sides. These longitudinal grooves may differ in length. Marginal retouching occurs along the edges of the point.

Yuma points are more variable in form and may be triangular, parallel-sided or leaf-shaped. The base may vary and is often stemmed but never notched. Beautiful, parallel, diagonal chipping some-

*This was the last American glacial stage and may have included the Iowan glacial advance as well as four sub-stages.

†All the following were familiar to these primitive hunters: several species of horse *(Equus)*, the large camel *(Comclops)*, the llama-like camel *(Tanupolama)*, the southern mammoth *(Parelephas columbi)*, the ground-sloth *(Nothrotherium)*, the giant beaver *(Castoroides)*, the peccary *(Platygonus)* the giant cave bear *(Arctotherium)* the giant bison *(Bison antiquus)*, the four-horned antelope *(Tetrameryx)*, and the two muskoxen-like mammals *(Preptoceras* and *Euceratherium)*.

(Left) THE FIRST PROOF that man lived in the State of Nebraska at a time when extinct animals roamed the country: Yuma-type dart-point found by the writer in Custer County in 1929. (Slightly larger than actual size)

Two small boys led to this important discovery when they reported finding some "elephant knuckles" in the side of a bank, 16 feet below the sod. The "elephant knuckles" proved to be the fossilized bones of an extinct bison. But of greatest importance was the uncovering of this prehistoric dart-point in association with them, for this added definite proof to a theory only beginning to receive notice, namely, that man lived in North America before the close of the Glacial Period. Relics of the ancient Folsom and Yuma people are now numbered in the thousands. Amateur scientists have made some of the most important discoveries

DUST STORMS have been kind to paleontologists and archaeologists in western Nebraska, uncovering many valuable relics of "the first Americans." Once deeply buried, the skillfully chipped tools are found in the foreground soil zone of this typical blow-out

AN ISOLATED BUTTE juts above the blown-out area. Excavation reveals original depth of artifact-bearing soil layer. Prehistoric dust storms, probably far more severe than ours, are believed to have been instrumental in the extinction of some prehistoric animals

(Right) COLLECTORS AT WORK at the foot of the "high terrace" along one of the tributaries of the White River in western Nebraska. Though depth beneath the surface is one of the first indications of age that the archaeologist examines, no absolute time-scale is possible. Some of the relics here are buried beneath as much as 25 feet of earth, half as deep as the celebratd *Pithecanthropus* bones from Java, which are among the oldest known human remains. But the Folsom and Yuma people lived far more recently, possibly 20,000 years ago. The rapidity of deposition varies greatly; and even locally the deepest specimens may not be the oldest

From "Early Man," courtesy J. B. Lippincott Co.

In their search for more information about the first Americans, paleontologists and archaeologists turned to the caves of the Southwest. Though work there is more difficult than in the sand hills, owing to inaccessibility and the man-made "dust-storms" caused by digging *(see photo)*, the work has been even more rewarding. The most interesting and important cave in the Guadalupe Mountains from the standpoint of human occupation is Burnet Cave, at right. The dust of ages, so evident here, has yielded 80-odd different species of animals, many of them associated with the fire-places of ancient man. It is now known that the early Americans were familiar with very few animals living today, hunting instead an extinct species of horse, a camel, long-horned bison, musk ox, four-horned antelope, cave bear and a caribou-like animal. Twelve years ago few scientists believed man lived in North America prior to the close of the Glacial Period. Scientists estimate that the Glacial Period ended some 10,000 years ago

Three masked explorers, whose grotesque appearance might have startled the early Americans who inhabited this cave, possibly 20,000 years ago. *Left to right:* Edgar B. Howard, R. M. Burnet, and C. Bertrand Schultz

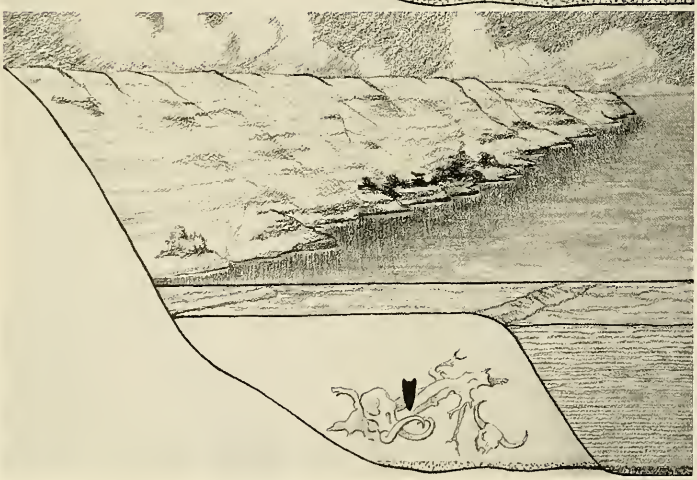
Taut strings are customarily used as datum points for measurements, as above in the thick cross-section of débris at the cave mouth. Note large rocks which periodically fell from the roof in ancient times

Modern collectors were not the first to find the artifacts of the first Americans. The American Indian, possibly attracted by the beautiful chipping of the points, sometimes picked them up and used them as pendants and charms. The black Yuma-type dart-point at right was found in an Indian medicine bundle evidently lost by a Sioux warrior in the battle of Ash Hollow in 1855. The modern iron piece found with it dates the medicine bundle. (Reproduced ¼ larger than actual size)

(Above) "THE FIRST ROUND-UP": an assemblage of some of the extinct animals now known to have been hunted by "the first Americans," much earlier than man was previously supposed to have reached the western hemisphere.

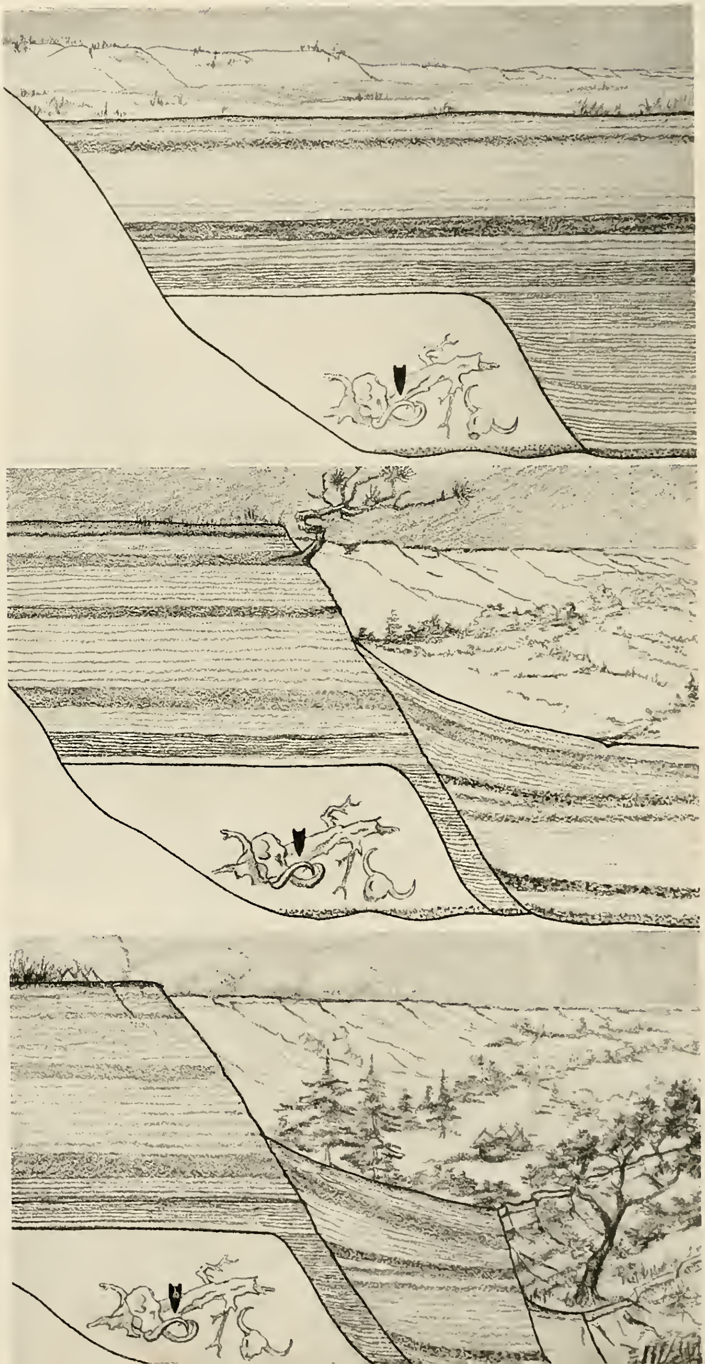
The ensuing six drawings tell the story of earth changes in the White River region of Nebraska since the time when man hunted these extinct animals, possibly 20,000 years ago. The landscape at left represents the country as it appeared at an interglacial period prior to the close of the Ice Age

(Left) THROUGH THE ENSUING CENTURIES the bones of the extinct animals and parts of trees were buried beneath accumulating deposits of earth and preserved for modern scientific diggers. These deposits were laid down by wind, not by water, and suggest that desert conditions may have prevailed. Dust storms similar to the recent ones in the region but of greater severity may indeed have helped to exterminate these animals. Flowing water, however, in time returned to the site and cut away much of the accumulated earth, leaving the terrace formation shown in the next drawing



GREAT CHANGES are shown at left, for after the terrace preserving the fossils was carved, the process was reversed. Instead of cutting away the earth, the water proceeded to build it up by depositing sediment. At first these deposits *(represented by narrow lines)* were laid down so precisely in accordance with seasonal climatic changes that it is actually possible to count the years in them. These well defined bands of sediment, known as varves, are characteristic of the latter Glacial Period, when great quantities of ice were melting each summer. Above the last of these varves, no extinct animals are found here

ALL DRAWINGS BY
JOHN C. GERMANN

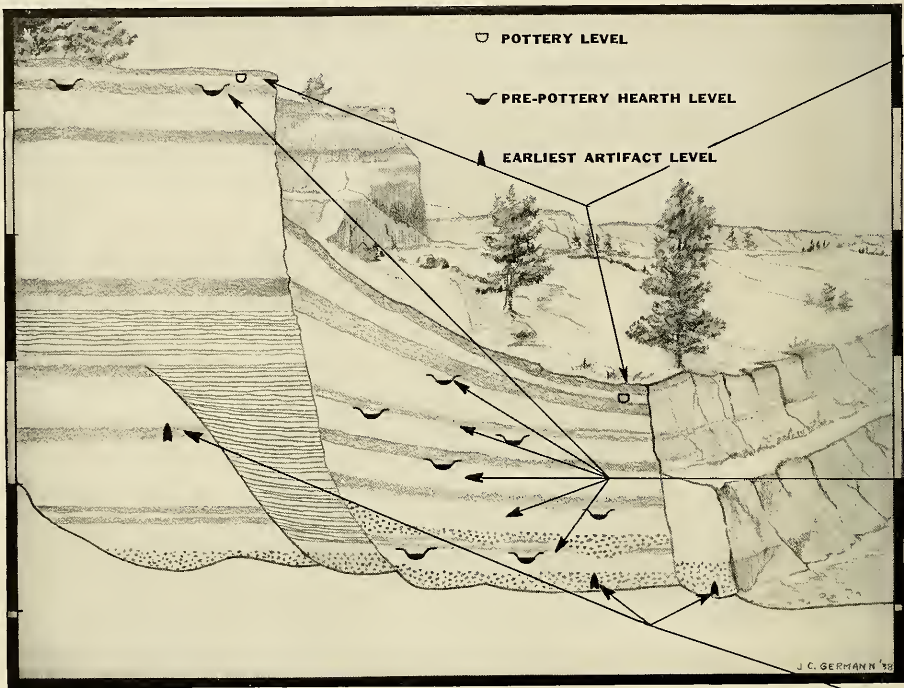


The body of water which laid down the seasonal layers of sediment ultimately vanished, and on top of them was deposited an almost equal thickness of earth, mostly wind-borne. How long a time may have been required for the accumulation of these deposits cannot definitely be said. But no human relics are found throughout the layers shown here, indicating a lapse of probably several thousand years between the time of "the first Americans," whose relics are buried in the terrace as shown, and the earliest known Indians. These were the contemporaries of the so-called Basket Makers who arrived in the Southwest about the beginning of the Christian era

Near the top of the deposits *(level with the tree)* traces of people contemporary with the Basket Makers are found; and above these, relics of the modern Indians. The Basket Makers were until a few years ago believed to be the earliest inhabitants of North America. The length of time that separated them from the Folsom-Yuma people is further emphasized by the fact that a whole new terrace was carved down through the wind deposits and varves as shown at right, a vertical distance of 40 feet. The layers of earth at extreme right roughly correspond to the top few layers of the high terrace, having merely been deposited in greater bulk at the base of the escarpment

These latter deposits were in turn cut into by winding streams, which formed the escarpment shown at extreme right. The sun rises today on a landscape differing radically from that which was viewed by "the first Americans" as they roamed the plains of western Nebraska, hunting their Ice Age animals. Vicissitudes of climate and food supply intervened. What became of these mysterious people, no one can now say; but their discovery is of far-reaching importance

(Left) A typical scene along the White River, Nebraska, rich paleontological and archaeological country represented in the foregoing six charts. Note the well developed terraces which are so important in tracing the age of the various levels. The man standing in the center is pointing to a hearth in the "lower terrace." The "higher terrace" is shown in the background. The nearest terrace was cut recently by the river, but here archaeological material even near the surface is sometimes quite old, having been buried deeply in the past under earth now carried away



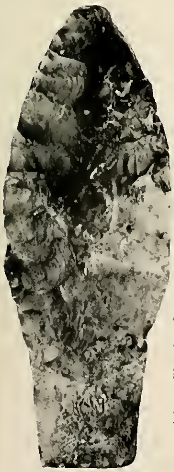
Ideal section in region represented above, showing culture zones and soil layers as found today. Note that the earliest artifacts are found beneath 25 feet of earth barren of artifacts except very near the top. This and similar evidence in the caves of the Southwest, indicates that there may have been no direct blood relationship between these people and the American Indian.

(Left) Twenty-five feet of earth separates the modern horizon from a hearth which is being examined by the man at lower right. The man above is examining a much later artifact layer containing pottery. (Site northwest of Crawford, in Sioux County, Nebraska. From "Early Man," by George Grant MacCurdy, courtesy J. B. Lippincott Co.)

(Right) Implements made by prehistoric man and animal bones were found in each of five soil layers exposed in the trench shown at right. This was dug in the lower terrace in the Crawford area and illustrates a typical method of the geologist for tracing levels

Pottery, a development which came after the time of the Basket Makers, is found just under the grass roots at the top of the high terrace and above typical hearth levels in the low terrace. The four stone points shown here represent styles in stone work found in association with this pottery. Resembling the common types of Indian arrow-heads, these points are distinguished from the Yuma and Folsom points by their general shape and workmanship, particularly by the presence of notching *(center point)* and the absence of the longitudinal groove, characteristic of Folsom points

(Above) Points representative of a people somewhat older than those above. These come from the hearth levels below the pottery zone in the low terrace and near the top of the high terrace. With them are found miscellaneous artifacts including bone awls, "hammer stones," knives, etc.



Yuma-type points representing the earliest known inhabitants of the region and found in association with many species of extinct animals near the base of the high terrace

The point at right exhibits the beginning of the lengthwise groove on the side, which is characteristic of the Folsom points

In distinction to the modern Indians, the Folsom and Yuma people worked with equal skill in quartzite, flint, agate, jasper and chalcedony. Upon these impersonal but durable substances science builds its slowly unfolding panorama of America's early people

times occurs on the sides. The classification of these two kinds of artifacts is based entirely on design and workmanship, not on age as indicated by geology.

There has been much discussion as to the comparative age of the ancient Folsom and Yuma artifacts. Geologically speaking, the artifacts appear to be of the same age; and their close association in some sites indicates that if any time did elapse between the two types, it was a comparatively short period. But there is one hint that the Yuma may be older. In the sand-hill areas where the wind has exposed successively older and older levels, the Folsom points are revealed first and only after continued weathering are the Yuma specimens uncovered.

My own introduction to artifacts came in 1919 while visiting my grandparents who lived in Yuma County, Colorado, near the type locality of the Yuma points. There I found my first arrow-heads and from that time on I was an ardent collector of Indian material. As time went on, my interests turned to collecting fossils. In 1929, Dr. Erwin H. Barbour, Director of the Nebraska State Museum, sent an expedition to Custer County, Nebraska, to collect some mammoth and bison bones.

On the trail of the first Americans

While on this trip I made my first discovery of an artifact definitely associated with bones of an extinct animal. Two small boys reported to us the finding of some "elephant knuckles" in the side of a bank, but we were so busy digging out fossil bison and mammoth material that we were unable to go to the locality at once. The boys finally insisted that we should at least glance at their discovery, which lay only a few rods from the sod house in which they lived. So, out of curiosity, we went to see what the "elephant knuckles" could be.

There we found a few large bison bones. They were buried in a bank 16 feet below the sod and were well fossilized. We decided to determine how much of the skeleton was in place. After a few minutes of digging my pick struck something hard. Another stroke exposed a piece of black flint. Upon inspection of the flint, we discovered that it was a finely chipped arrow- or spear-head. We then concluded that the bison must have been a modern species after all, and it seemed useless to dig any further. Had not most of the authors of textbooks and other publications for years discredited all finds of this nature? It was taught that man simply had not lived in America before the close of the Glacial Period. Little did we realize that the point we had uncovered was not the "arrow-head" of a modern Indian but rather the dart-point of a race of people that lived here perhaps 20,000 years before our Indians and long before the bow and arrow was used. The artifact later proved to belong to what is now known as the Yuma type, and the bison to be an extinct species.

From that time on new finds were made annually by the Nebraska Museum field parties. Two of these finds were outstanding. The first was made in 1932 in Scotts Bluff County, Nebraska. Four Yuma-type dart-points, four knives and scrapers, numerous chips of flinty chalcedony and pieces of charcoal were found scattered among more than 30 skeletons of *Bison antiquus*. This intermingled mass of fossils, in a gravel layer of an old stream bed, was covered by from 12 to 27 feet of windblown material. Four indicators of great age were present; the geologic story, the species of bison, the type of point, and certain fossil shells. Previous to the Scotts Bluff find, many Yuma points had been found in "blow-outs" where the wind had carried away quantities of soil material, but there was much discussion as to whether these might not be the products of the recent Indians. The Scotts Bluff Bison Quarry, therefore, became noted as the first important buried site yielding Yuma implements and the bones of extinct animals. Here, too, were tools other than dart-points, of early man.

In the "bad lands" of northwestern Nebraska near the towns of Crawford and Harrison, the second important artifact locality was found. While exploring for fossil bones in this area in 1933, we found several "Yumas" in the washes. Days were spent searching for the source of the points. Several farmers reported that they had found numerous arrow-heads in the nearby region. One small collection contained 50 to 60 arrow-heads and other stone implements. The members of our field party examined this collection and noted that there were eight dart-points of the Yuma type. We were more than surprised when the farmer pointed to the Yuma-type points and announced that they were much older than the common arrow-heads. This was his own observation. He had never read anything on the subject. The points, according to him, were from "old gravel beds."

We have contacted numerous other arrow-head hunters who have similar stories. Even these men who collect as a hobby have discovered that there is a great difference in age between the common arrow-heads and the Folsom and Yuma points. Due credit should be given these amateur scientists, for they have made many of the most important finds so far reported. Also, their keen interest in the problem of man's antiquity has done much to stimulate the research work of the scientist.

Some of the objects of human manufacture have been found buried by as much as 25 feet of earth. The time that this deposition would have taken under normal conditions taxes the imagination of one not used to reckoning in geologic units. But depth alone does not give an absolute measure of antiquity, for many things influence the rate of deposition, and when the forces of nature are destructive instead of constructive, the surface is, indeed, often deeply worn. The celebrated *Pithecanthropus* bones from Java, which certainly represent one of the oldest human types ever discovered, were excavated from a depth only twice as great as some of our material, but *Pithecanthropus* is many times as old as our Yuma and Folsom men. Some of the oldest finds have been made only a few feet below the surface, the overlying material having been eroded away, chiefly by running water. On the other hand, a very deep site may be only a few thousand years old.

Frequently our best discoveries have been made where winding rivers have worn their way through the layers of material that have accumulated since man first occupied the region. A more comprehensive explanation of a typical site is analyzed in the charts on page 350 representing the Crawford-Harrison area, where an astonishing number of deeply buried artifact sites were found between 1934 and 1938.

Caves yield treasures

Elsewhere in the world caves have contributed so much to our knowledge of the life of early man that it seemed a good policy to search in caves in the Southwest. Among other institutions participating in work there, the Nebraska State Museum has lately chosen particularly the Guadalupe Mountain region of New Mexico and Texas. There the slopes of the mountains are literally honey-combed with caves ranging in size from small shelters to enormous caverns such as the well-known Carlsbad Caverns and the newly discovered cave described by Mr. R. M. P. Burnet in NATURAL HISTORY for May, 1938.*

Work in the cave areas is in many ways more difficult than hunting fossil bones in the high plains of

*The work in the caves has been carried on in cooperation with Dr. Edgar B. Howard of the Academy of Natural Science of Philadelphia and Mr. Burnet of Carlsbad, New Mexico.

SPEAR-POINTS *made by people who lived in America before the close of the Ice Age: Yuma-type points found with the fossilized remains of over 30 skeletons of an extinct species of bison, in Scotts Bluff County, Nebraska. (Slightly less than actual size)*

TYPICAL SPEAR-POINTS *of the Folsom people, who apparently preceded the earliest known Indians by several thousand years. Whether or not the Indians are their descendants is not known. Note that the typical Folsom point is grooved lengthwise on one or both sides. The blade is leaf-shaped, with a varying base that is neither barbed nor stemmed. (Slightly less than actual size)*

western Nebraska. There are no roads or even trails to some sections, and a number of caves are located at such a height that it requires a day of walking and climbing to reach them. The slopes are even too steep to explore on horseback, which necessitates carrying all provisions, water and tools on one's back. Most caves are so dry and dusty that respirators or "dust masks" are needed while working. Finally, it seldom rains in the Southwest but when it does, dangerous floods are apt to occur in the canyons.

The earliest of the Indians in the Southwest cave region were the Basket Makers. This interesting group of people arrived in southwestern United States about the beginning of the Christian era and continued to live there for almost 1000 years. As their name suggests, they excelled in basketry rather than pottery. Their cultural remains are commonly found on or near the surface in the caves. But below this there appears to be a definite zone of some thickness containing no evidences of man. Beneath this we find the relics of the much older Folsom and Yuma people.

The most interesting and important cave in the Guadalupe Mountains, from the standpoint of occupation by early man, is Burnet Cave. The 80-odd different species of animals which have been found here comprise the largest cave fauna so far found in America. Many broken and charred bones of extinct animals were found around the hearths, especially the horse, which brings up an interesting point.

It has been commonly believed that the Spanish explorers first brought the horse into America, whereas in reality they only reintroduced it. Before the Spanish Conquest the Indians had never seen a horse. But long before, America was the ancestral home of the horse. Horses had lived here for millions of years. They had evolved from small forms no larger than a fox-terrier to large horses similar to those of today. The last of the American horses disappeared fifteen to twenty thousand years ago. The makers of the early Yuma and Folsom artifacts arrived in America in time to see these horses and to feed upon their flesh.

Climate changed

In Burnet Cave the bones of many other extinct animals were also found near the fireplaces—camel, four-horned antelope, cave bear, two strange musk-oxen-like mammals, and a large caribou. In addition, many forms were found in the cave which today live only farther to the north or in higher mountains, indicating that the climate was comparatively cold when early man lived in Burnet Cave. Marmot or woodchuck remains, for example, were very common in the lower levels of the cave while today marmots of this type are known only from northern New Mexico in the Arctic-Alpine zone of the high mountains.

No recent marmots have been reported from the Guadalupe Mountains. This past summer while on an exploring trip, I was certain I caught a glimpse of one near the entrance of a cave. I hurriedly adjusted the movie camera and ran over to within 25 feet of the animal. I was so startled upon discovering that it was a large-sized mountain lion, that I missed several feet of good movie shots before I finally aimed the camera. By that time it was running for the underbrush. The finding of a marmot would in a sense have been even more exciting, for it would have done much to destroy our theory of a decided climatic change in that vicinity.

Relics of man have proved to be so commonly associated with extinct animal remains that Folsom or Yuma man may even have had a part in the extermination of these creatures. This is not a new thought, however, because in 1881, Dr. C. D. Wilber who was an inspector of mining lands in the West wrote, "The sudden disappearance of the mammoth tribes, whose remains are so abundant as to indicate that they existed in great numbers, has caused several conjectures, or theories, regarding the cause of their exit. Professor Aughey of the University of Nebraska says they became so numerous in Nebraska and the upper Missouri region that the primitive race of man combined in armed forces and utterly destroyed them. He cites the fact that arrows are found beneath their huge bodies as proof of contemporaneous existence." Such great heaps of elephant bones recently found associated with artifacts at Miami, Texas, at Clovis, New Mexico, and Dent, Colorado, would cause one to think that Professor Aughey's theory may be correct.

Disease and drought

There were, however, other causes such as disease and climatic conditions which probably had a great deal more to do with the actual extinction. Some of the prehistoric droughts were of utmost importance and the great dust storms which accompanied these droughts must have driven many of the animals to more livable climates to the south, or even caused their extinction. During the current cycle of dust storms in the Dust Bowl, many animals have choked and died because of dust. The Pleistocene storms were many times as severe as those of today. This

Continued on page 378

INFORMATION TEST

A few informational high spots that may be gleaned from this month's NATURAL HISTORY

Score 5 points for each correct answer. Correct answers on page 394

1. The earliest known inhabitants of North America left

....*(a) celebrated cave paintings*

....*(b) spear-points exhibiting some of the finest workmanship in stone*

....*(c) mummies of their chiefs*

2. The Waiwai Indians in South America, whom Doctor Holden found free from high blood pressure,

....*(a) avoid all forms of exercise*

....*(b) practice eugenics*

....*(c) live under markedly little nervous strain*

3. The color of snake eggs

....*(a) corresponds almost exactly to color markings of the adult snake*

....*(b) is governed for protective purposes by the color of the nest*

....*(c) shows practically no variation*

4. Leeches resemble camels in that both

....*(a) have curious deformations of the spine*

....*(b) are adapted to living in arid regions*

....*(c) have multiple stomachs*

5. Which of the following creatures is known to migrate between France and Japan?

....*(a) eels*

....*(b) bats*

....*(c) leeches*

....*(d) crickets*

6. Digger wasps provision their nests with

....*(a) honey*

....*(b) pollen*

....*(c) surfeited leeches*

....*(d) paralyzed grasshoppers*

7. Mistletoe is

....*(a) an epiphyte*

....*(b) a parasite*

....*(c) a specialized fungus*

8. The revolutionary discovery of the first Americans has been helped by

....*(a) a new arrow-point "magnet"*

....*(b) early Spanish records*

....*(c) dust storms*

9. Essential hypertension is

....*(a) a characteristic of certain alloys*

....*(b) a disease*

....*(c) the tendency of fluids to rise in capillary tubes*

10. Most snake eggs hatch out

....*(a) when the baby snake "pecks" through the shell with its "egg tooth"*

....*(b) after the shell has expanded so greatly that it bursts*

....*(c) after the shell has slowly disintegrated*

11. A leech can be made to let go its bull-dog grip instantly by

....*(a) a sudden loud noise*

....*(b) gentle pressure of its thorax between the thumb and finger*

....*(c) sprinkling salt on its back*

12. Female crickets

....*(a) sing "soprano"*

....*(b) sing more frequently than males*

....*(c) do not sing at all*

13. The first land-animal sounds on this earth were probably made by

....*(a) dinosaurs*

....*(b) birds*

....*(c) insects*

....*(d) leeches*

14. Farmers would do well not to shoot hawks because

....*(a) their migration habits are perfect weather indicators*

....*(b) fear of them stimulates fertility in hens*

....*(c) they keep down harmful rodents*

15. Mistletoe seeds are believed to be spread

....*(a) by the wind*

....*(b) by the bills of birds*

....*(c) by tree grubs*

16. The horse

....*(a) had its ancestral home in America*

....*(b) did not exist in America until brought by the Spaniards*

....*(c) appeared simultaneously on all continents*

17. Parental devotion is

....*(a) never found in any snakes*

....*(b) occurs in a few species who guard their eggs tenaciously*

....*(c) marks snakes off as among the most responsible parents*

18. Crickets make their chirp by

....*(a) rubbing their wings together*

....*(b) vibrating a diaphragm in their abdomen*

....*(c) vibrating their antennae*

19. Mistletoe was first used ceremonially by

....*(a) the Druids*

....*(b) the early Christians*

....*(c) the Celebes Islanders*

20. Cricket "ears" are located in

....*(a) their head*

....*(b) their abdomen*

....*(c) their legs*

ROUTING

MIDWAY in the vast colonial archipelago known as The Netherlands East Indies lies the equatorial island of Celebes, across whose rugged terrain Mr. and Mrs. J. H. Bekker of Batavia, Java, led a photographic expedition. Among the several native ceremonies of which they brought back a permanent record, the Feast of Satan *(described here)* sheds interesting light on the spiritual beliefs of the Sa'ädang Toradjas, an interior tribe never before photographed.

Despite the creditable artistic and cultural level of these primitive people, they have not completely abandoned their ancestral custom of head hunting. This practice is of course discouraged in every way by the colonial administration; but only three days before the Bekkers arrived in the region a head was taken. The motive was probably the age-old one among the Toradjas of providing a chief at his death with a spiritual escort from another tribe to accompany him to the after-world.

Nevertheless, the Sa'ädang Toradjas are rated by Mr. Bekker as the most pleasant people to work among of all the tribes he has visited in this region.

1

THE NAME TORADJA, meaning "man of the mountain," appropriately describes these people. Their thatched huts *(above)*, never clustered in a valley clearing, are scattered up the steep slopes, half-hidden by thick-topped coconut palms. Inside these homes live a simple, friendly people, whose semi-civilized garments but thinly cloak their pagan beliefs, rituals and social system. Cheap sweaters and calico betray the penetration of traders, lured by the primitive industries of expert wood carving and the weaving of cloth from ananas fiber

2

WHEN HARVEST TIME IS OVER the Toradjas have money to spend and time on their hands. They seize this opportunity to hold lengthy ceremonies, most striking of which is the Ma-maroh (from *Ma,* meaning "feast," and *maroh,* meaning "satan"). This festival is a study in primitive therapeutics based on the belief that sickness and health are the result of an eternal battle between Maroh (the devil) and the Dewatas (good spirits). This is a mass festival and natives *(above)* from outlying villages gather in a mood of awed excitement to watch their witch-doctor expel the devil from ailing neighbors

5

(Above) CHANTING AN INCANTATION, the witch-doctor *(in center)* covers up the huddled sick with a blanket. This is the first step in his treatment, which is not performed directly by him but by the Dewatas who have the power to drive out the evil spirit in response to the witch-doctor's invocation

6

(Above) THE BLANKET is swept off. Whether or not the Dewatas have triumphed, the patients may at least have been psychologically cheered by the incident. Perspiring copiously from the covering and the hot sun, they will now dry their bodies. The woman's mouth at center top bulges with betel nut—a mild native narcotic

THE DEVIL

By fire, sword and ceremonial magic, the Celebes Islanders dance the devil away and cure the sick

By MR. AND MRS. J. H. BEKKER

All photos by the authors through Ameri-Candid

3

4

(Above) THE WITCH-DOCTOR (in checkered cloth) approaches a group of sick men to "smell out" the evil spirit. Note the remarkable wood carving above. Painstaking construction and lavish decorative detail are characteristic of Toradja architecture.

Great importance is attached to ornaments such as the mounted buffalo head, for the buffalo is considered a sacred animal

(Above) THE HALT, THE LAME AND THE BLIND crouch in a circle to await the witch-doctor's devil-dispersing ministrations. The man at center is evidently harboring Maroh in one of his molars

(Below) SPIRIT, SPIRIT, who's got the evil spirit? The sick form a line along which the medicine man rushes, sawing with a rocking motion at their naked torsos with a long sharp knife. The witch-doctor has first tried the knife on himself. If he bleeds, the Dewatas have not granted him the power to exorcise and he must wait and try again. The object in cutting his patients is not curative surgery, but to ascertain if anyone still has the evil spirit in him. If the knife draws blood, the spirit is still there

7

(Above) FIRE IS RESORTED to if the knife reveals the presence of the devil. Seizing a long firebrand of twisted palm leaves, the medicine man passes it rapidly along in front of the line of the sick, who then turn around while their tribal physician carries his supposedly curative torch back again along their rear. After this, Maroh is assumed to be irrevocably expelled

(Above) STUBBORN CASES of devil-infection stand on a bamboo platform under which the same torch is placed. Children follow the adults; each patient or two children at a time remaining from two to three minutes. All the while the Maroh song continues with relentless monotony in the offing. In foreground, resembling diplomas ready for distribution, are bamboo tubes of sago wine

THE ASSISTANT medicine man is shown rolling the knife blade on a patient's back to discover whether the cure has been complete. Cuts are attempted on the legs, arms, and shoulders of the sick as well as in the abdominal region

AT THIS POINT an intermission is called during which the entire assembly devours a meal of raw chicken and half-cooked red rice. Nearly 500 chickens were butchered. Above, men are shown slitting the throat of one of these while holding a hollow bamboo pole ready to catch the blood, which is evenutally dribbled from his cylinder as a much relished gravy for the dish of rice

(Above right) GARNISHED with leaves, the dishes of chickens and rice are placed in front of the matting on which the natives sit down to eat. The medicine man gets six chickens for his work, the assistant four. All others, together with the sick, get a half chicken, rice, and a bamboo tube of sago wine

(Right) LOUD BEATING on a tattered buffalo skin drum is the signal for the second half of the ceremony, which consists of a dance by the women. The sexes are segregated during the ritualistic dances which are comparatively uninspired

(Right) WOMAN IN A TRANCE. The Toradjas set great store by trances which they believe automatically place them in communication with the spirit world. The medicine man will decide whether this and other performers of the shuffling monotonous dance are under the spell of a good or evil spirt. If the latter, he will drive it out by much the same methods used on the sick

(Right) AUTO-SUGGESTION alone has caused this woman to put her neck between the blades of these crossed knives. The Toradjas believe this to be a specific instruction from Maroh who communicated his wish while she was in a trance. The assistant medicine man is watching to see whether or not she draws blood. If she does, Maroh is still lurking near

(Left) Maroh has spoken again. While under his spell, this woman has been told to climb a tree. She must obey him or great misfortunes will befall not only her but the whole tribe. Although drowsy and limp from the trance, she has attempted to clamber up a slender sapling which has given way. Friends immediately rush to help her carry out the command while two youngsters, possibly her own, look on in horror

(Left) This man's message from Maroh involves sticking a knife point in his head. A neighbor helps him put the ordinance into effect. Assistance is always readily given because the misfortunes will fall on all alike if a trance communication from Maroh is disobeyed

(Left) The next day the entire population marches to the river bank to offer a sacrifice to Maroh. The living sacrificial rooster is borne aloft in a globe-shaped wicker cage, while the medicine man carried a vessel of rice, and a helper a tube of sago wine. These are all food for the devil

(Left) A hole is dug well away from the village near the river, and the pole is planted, leaving a rooster aloft in its cage to starve and rot. Here at the river all the bad spirits are supposed to reside. Maroh has now been appeased and sent out of the village. Good has triumphed over evil and the people dash exuberantly back to the village

(Left) Blood samples are being taken from the foreheads of these two women who are believed to be entranced by good spirits. The fluid thus secured is mixed by the assistant medicine man with blood taken from his own tongue. The concoction is believed to supply the Dewatas with the makings of a medicine which is rubbed on the upper bodies of the sick by the assistant medicine man. The latter is holding strands of hair *(above)* to let the blood flow freely. He closes the cut by means of a certain leaf which when munched in his own mouth gains a collodion-like property.

For another year the important ceremony to cure sickness is over; all have fed festively and return to their normal life feeling that Maroh has been accorded the attention that he requires

LOOK, MAN!—*The only price of admission to Nature's living theatre is a pair of good eyes and the secret of using them*

By ROY L. ABBOTT
Professor of Biology, Iowa State Teachers College

JUST across my back alley, my neighbor was feeding her fowls. One of her remarks, seemingly addressed to a pair of ducks who were crowding each other at the trough, caught my attention.

"Now, Sarah," she was saying, "you get over and let Katy have some." From my garden I called:

"Neighbor! Why don't you say: "Tom, you get over and let Dick have some?' "

She looked up, laughing.

"What do you mean?" she asked.

"Why, that's just the kind of ducks they are. Both drakes," I said. And as I saw her stare of incomprehension, I added quickly, "Haven't you ever noticed that pretty little 'marcel' of feathers on the top of each of their tails?"

Power of observation

No, she hadn't. She was fifty years old and had seen animals of all sorts but never had noticed that casual fact about barnyard ducks. I longed to tell her of the woman who, while I was in the agricultural department of a great university, had written to us for a sitting of White Leghorn eggs. In her letter she also asked how long it took for the eggs to hatch. We informed her that the incubation period for chickens was three weeks and for ducks four weeks. About a month later we received this astonishing statement from her:

"I set those eggs you sent me and hatched ten chickens. I threw the rest of the eggs away, for I didn't want any ducks."

But I didn't tell my neighbor that story. Instead, we chatted across the fence about nature in general, and I was not long in discovering that here was a person like many another who, although possessed of two perfectly good eyes, had gathered most of her nature lore by hearsay. To her, snakes were slimy though she would never think of picking one up to discover that their skins are really dry; bats were blind though she had never looked for their bright eyes; toads would certainly cause warts, but she had never been willing to handle one to prove the falsity of that statement.

No wonder, I mused, as I went on with my gardening, that people continue to believe that horsehairs placed in water may turn into snakes, that snakes swallow their young to protect them, that if a turtle bites you he won't let go till it thunders, that thunder sours milk, that lightning never strikes twice in the same place, that milk-snakes habitually milk cows, that the age of a rattlesnake equals in years the number of its rattles, that porcupines throw their quills, and that skunks go about desecrating the atmosphere just for the fun of it.

Routing superstition

On reflection, however, I recalled that I, too, once believed most of these superstitions and would probably have gone right on believing them had I not got into the habit of looking at things for myself instead of letting the other fellow tell me all I was to know about them.

I believe my grandfather first started me off on this fascinating and endless game of seeing things. The old man was as ignorant as a sign-post of books, but he held a "degree" or two so to speak from the school of nature, and I often fretted as he stood watching the honey-bees tumbling over the pink smartweed spikes or following them with his watery old eyes as they spiralled upward before taking off for their home tree.

One morning we were squirrel hunting. It was one of those soundless days in October, with the ground and fallen leaves wet from the rain of the night before. We were passing under a big oak, when grandfather remarked casually:

"There's a squirrel up there. I heard his toenails scratch as he turned 'round the trunk." He jerked his finger toward the treetop. I snorted my unbelief, for I hadn't seen or heard anything.

"All right, young man," he cackled. "Move out there a little piece, and I'll show you."

I did as directed, and up went his old muzzle-loader and down came a fine fox squirrel. Many a squirrel has betrayed himself to me since that time by careless handling of his toenails against the bark. I believe that little lesson really started me looking. But I must not forget one other bit of his teaching. We were standing by a radish bed in his garden.

"What do you suppose I'll find in there, sonny?" he inquired, pointing to a slightly broken, hand-size area in the thin crust of the bed. My face expressed no comprehension, so bending over he thrust his hand nearly to the wrist in the soil and came up with it full of toad—an enormously fat old female weighing perhaps a quarter of a pound. But her bulging, golden eyes, blinking in the bright sun, were not popping as were mine in astonishment.

"Grandfather!" I yelled. "How'd you know that thing was in there? Don't you know you'll get—" He stopped me with a gesture.

Mining toads

Yes, he knew all about that wart-foolishness; and a hundred times since I've had fun mining toads from the earth in similar fashion and watching the faces of my friends as I seemingly conjured the creature from nowhere. But there is no mystery to it. Almost any home garden can muster one or more toads, and a little watching of a morning will discover madam toad's method of hiding herself in the earth after a night's hunting. She simply squats upon the soft soil and wriggles until she sinks below the surface and is thus gradually covered as the dirt trickles in from the sides. Simple, isn't it? Yet not more so than a thousand every-day creatures and happenings that may be seen and enjoyed, if we will only learn to stop, look, listen, and ask ourselves questions.

For example, several years ago one hot morning as I rounded the corner of a building near my office, my eye caught the glint of a gold and black something on the ground. It was a large wasp busily engaged in making her nest by digging a hole with tooth and claw in the hard-packed soil. Others of her kind had nested there for years, I am told, but that was the first time they had caught my attention. I stopped and watched. I had read of digger wasps and their ways, but here was the first time I had seen them on the job. I was fascinated. For the next 30 days I found myself spending every spare hour with my "golden diggers" as I called them. I watched them provision their nests with paralyzed grasshoppers and even dug up some of their nests to find out how this living provender was packed away—with the wasp's egg always laid in the same secure place under a grasshopper's chin where it couldn't be kicked off. And yet for years I had missed seeing all this!

As another example, I have for several years been paying attention to the number of kinds of birds and other animals killed on our highways. Exclusive of domestic fowls, the red-headed woodpecker appears to be the commonest victim. This aroused my curiosity. Why the red-head? I began to watch this bird—a common frequenter of dead trees and telephone poles. I soon noticed that this fellow had the habit (he's the only woodpecker that does) of chasing and catching insects on the wing; saw him in fact, follow them right down to the road. Once down on the road, it's just too bad, for he's slow on the take-off.

In the case of the mammals, aside from the cottontail rabbit, skunks appear to be most commonly killed by automobiles. Not long ago I counted 20 dead skunks on less than that number of miles in Rhode Island. And the answer to this, as I see it, is that skunks haven't kept up with the times. Long used to shooing off any enemy by the mere threat of raising the tail, they haven't learned—and how can they when dead?—that an automobile cannot be shooed.

Unnoticed wonders

Sometimes I am amazed how long it takes me to discover some of the most commonplace things. As a boy I often noticed flickers or golden-winged woodpeckers on our lawn or pasture so busily engaged in doing something they often almost allowed me to step upon them before flashing away in a blaze of white rump and yellow wings. It never occurred to me what they were doing on the ground until my dog happened to kill one, and then a casual examination showed me its gullet full of ants, and a tongue—well, I'll never forget its amazing length, with its long bony base actually curved up over the top of the head under the skin, and the tip even extending into the nostril.

I used to spend hours with a noose of string snaring all the little striped squirrels on our farm. For to us they were pests whose chief business in life was to dig up newly planted corn and watermelons. Not long ago while playing golf I happened to see one of these little squirrels spring into the air and pull down a flying grasshopper. With this as a clue I watched them after that and soon found that perhaps half their food was grasshoppers and other insects—that they probably do more good than harm. But I should have discovered that fact years ago.

Much the same may be said for my general misunderstanding and mistreatment of snakes and hawks and owls. To me then, as still is true with most people, a snake was something to be killed on sight. Shivers always chased themselves up my back when I came suddenly upon any snake, especially the little hog-nosed snake or "spreading viper" as we called him. I now know that this little clown among the serpents cannot be induced to bite, although he can put on a great show with his head and neck by spreading the upper ribs in the manner of a cobra. Most snakes, as I know them today, are like most humans—chiefly concerned in getting something to eat, raising a family, and keeping out of harm's way.

With respect to the hawks and owls: who hasn't seen their bodies spread-eagle against the farm fence or barn as a warning to others? My neighbors and I never took the trouble to inquire whether the blanket accusation "chicken killer" was true or not. To watch the chickens run for cover when old madam red-tail called from the sky was proof enough. We shot her and her cousins, the owls, on sight. We didn't even know of the existence of their pellets, those peculiar masses of hair and bones and feathers which owls and other birds of prey eject after a meal and which tell us almost as accurately as a printed menu what they had for dinner. But I for one quit shooting them as soon as I found their pellets largely composed of the remains of field mice.

Stop, look, listen

There is one thing that the beginner at this game of seeing things must learn early, particularly if he is trying to watch animals, and that is to do a great deal of listening and looking but very little moving. For in spite of the keen noses of some, a thing not moving is a thing not to be feared by most creatures, and especially is this true of birds. I have had ducks almost alight on me when I was quiet although in very little cover; I have even crawled or "bull-snaked" upon them as a friend expressed it, over perfectly open ground by moving very slowly. And conversely, what hunter hasn't seen more than one flock of wary old mallards go a-climbing heavenward to his huge disgust because he couldn't keep his head down as they circled the "blind?"

This waiting or "possum" game, as I sometimes call it, is, of course, older than man himself. For long before our first human ancestor lay in wait to hurl his spear into the unwary cave bear as it shuffled sleepily from its den, the mountain lion squatted on a projecting ledge awaiting a deer to pass below, the osprey and the kingfisher poised expectantly above some fish-filled pool, and the pike and the snapping turtle waited for something to move within sweep of their jaws. But old as it is, it still works, and I get an enormous thrill out of it. One shadowy thrusting of a groundhog's head from his burrow is worth an hour's discomfort to me.

Just last week, for example, in one of my favorite haunts, a fox squirrel slid down a thick bole some fifty feet from where I sat with my back to a big elm, and came straight toward me as if bent on discovering what sort of new buttress had grown on that tree. I never batted an eye as he sniffed at my shoes and then walked half the length of my leg, his sharp toenails digging in as he came. His black eyes fairly bulged with curiosity, and his nose twitched so comically I finally exploded with laughter. Needless to say, he almost exploded, too. Every hair on his tail stood straight out as with a chattering shriek he took off, leaving several long, red claw-marks on my leg as he went. But I wouldn't have missed him for anything.

A tree-top brawl

Another time I watched a pair of fox squirrels engage in some sort of brawl high above my head. Like two alley cats they threatened each other for a time, then suddenly came together in a vigorous scuffle. Then I had the surprise of seeing them fall like rocks into the creek below where both sank, only to come bobbing up again a few feet apart and swim to shore. But the cold plunge seemed to have taken all the fight out of them, and each was seemingly interested only in making his toilet in the sun.

That they sank didn't surprise me, for a dead squirrel will sink at once in water; and as I saw them go under, I recalled the discomfiture of one of my dogs who swam out to retrieve a squirrel which I had unthinkingly shot from a limb over a creek. For a long time he circled the spot where the squirrel had fallen but he couldn't seem to understand what was wrong.

Usually as I sit quietly waiting and watching, the things I see are only a new acting of an old play, some creature doing the thing I have seen many times before. But now and then when I am least expecting it Mother Nature presents something brand new, at least to me.

Such a thing happened a while ago, as I stood at the edge of a long back-water slough trying to decide whether it was too deep to wade. Suddenly I heard a swift patter of small feet behind me, and like a flash a cottontail burst out of the low weeds and dived into the water. With astonishingly swift, plunging strokes it swam the slough and vanished up the opposite bank before I could believe what I was seeing. I had often seen cottontails floating on logs in a floodtime, but although I had always assumed they could swim, as can most wild animals—

Continued on page 377

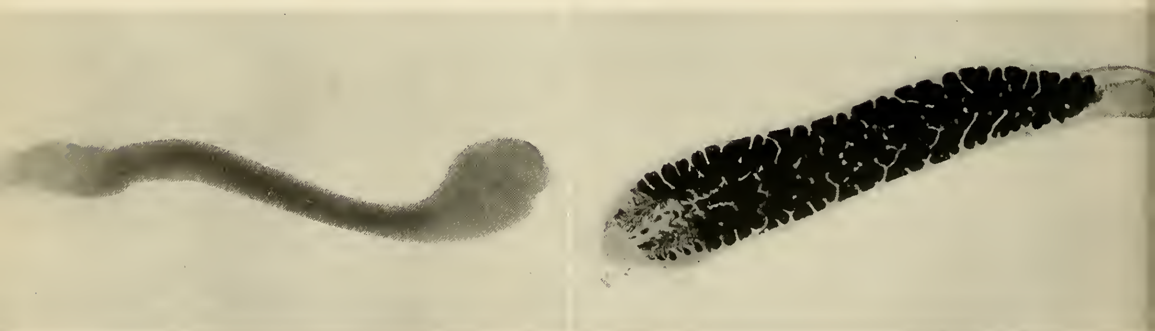
(Left) LEECH URN used by 18th century Staffordshire "leeches" (doctors) to house the small fresh-water annelids upon whose triangular incisions in human flesh physicians were formerly so dependent. Perforations in the urn's lid allowed circulation of air, and fresh water kept the leeches comfortable. Once used to bleed all manner of ills, leeches in their heyday were the basis of a thriving industry (over 57 million were imported by France in 1832). Poets sang their praises and dressmakers used them as patterns. With the advance of medical science, the curative powers of bleeding were questioned and the use of leeches declined. During the World War, however, leech saliva was discovered to contain hirudin, which prevents blood from clotting over a wound. Since hirudin was in great demand by army surgeons in their battle against infection, the leech trade was briefly revived

Photos courtesy de Zemler Collection

(Right) BLEEDING TOOLS carried by 19th century physicians. In lid, a 17th century Persian bleeding knife; *(left to right)* a glass bleeding cup; a set of capping knives used on the larger areas of the body; another glass cup inverted; a smaller set of knives for legs, arms, neck, etc.; and an alcohol lamp. The glass cup was heated by the lamp and then clapped over the incision. When the cup cooled, the resulting contraction of air inside caused a mild vacuum which aided in drawing out the blood

(Below) BEFORE AND AFTER: the leech at left (secured from a Manhattan pharmacy) was X-rayed while hungry. The same leech at right is shown after eating, its distended multiple stomachs made visible by a solution opaque to X-rays. Though extremely tenacious, leeches let go if salt is sprinkled on them. Each leech is both male and female.

Photos by Seymour Fiske



A LEECH AND HIS LEECHES—*Napoleonic France was bled white by the triangular jaws and multiple stomachs of this strangest of Man's "domesticated" animals. His heyday in both dress design and surgery is long past, but the engaging distinction of being able to change his sex remains*

By Mabel Lorenz Ives

Leech is an old-time name for doctor, sometimes a man of high degree, sometimes low. He was associated more with medicine than with surgery, and he leaned heavily on herbs and leeches to work his cures.

We do not know whether doctors were called leeches because they used leeches or whether they were called leeches from the Middle English *lechee*, meaning physician, but the doctor of yesterday usually carried the obedient little creatures around with him to help with his healing.

The leech is everywhere known for its feats of blood sucking. Its one overmastering impulse is to hold fast. It has all a bulldog's tenacity, scaled down to size. If you say, "Sticks like a leech," you have said everything. You cannot go beyond the ultimate.

A creature with a past

From the time when the first man met his first leech, back in the days before history began, man has never been able to ignore the leeches. Either as pest or supposed panacea, as scourge or as surgical agent, leeches have filled an important niche of their own.

In the Near East, Themison at Laodicea put an exhausted cup over the bites of leeches to encourage bleeding, as early as the first century before Christ. In India and Arabia they have been used in blood letting since at least the beginning of the Christian era. In Europe they were introduced at Rome in the reign of Augustus Caesar, and Pliny's Natural History is full of references to their use.

Cupping and bleeding early caught the imagination of healer and patient, but here was a tiny creature that nature had adapted to do the task and save man's need for skill. The cupping and bleeding of eighteenth-century healing was accompanied by torrents of blood splashing into the barber's basin or drawn off into glass cups from shoulder or side. But the leech moves on the scene a little later, with its slow deliberate grace. It drew men's blood invisibly into its many stomachs and, when it was full, it rolled off and went to sleep like a baby. This was far more calming to the patient. There was something almost engaging about the creatures.

Leeches had their heyday during the early nineteenth century. This mode of blood letting, so refined, so inoffensive, then reached its zenith, and leech farming was a recognized industry. In scarlet fever, leeches were applied to the region of liver, throat and temples. They were considered good for mumps, for gout since the time of Pliny, for rheumatism, asthma, pleurisy. Half a dozen leeches on each temple would cure a heavy cold, it was said. Twenty to thirty were put at the pit of the stomach for gastritis, while to lessen high fever French doctors sometimes ordered "a cordon of leeches" all around the patient's head.

In dress design

Dressmakers took them up and made them the fashion. They were embroidered life-size on women's wear—"a delicious harmony of reddish browns and greens and black and yellows, a beautiful soft symphony of velvety orange and olive and black." One favorite mode was to sprinkle them, larger than life size, over a ball dress or to trace a chain of leeches, like a ribbon, across a gown.

By 1824 two or three million leeches were annually needed to supply the demands of the doctors, apothecaries and midwives of France. Then along came Francois-Joseph-Victor Broussais the Breton, who swung a cutlass as a privateersman in 1798 and who for three years was an army surgeon under Bonaparte. His medical methods were Napoleonic and his therapeutics sanguinary in the extreme.

Life depends on irritation, he argued. In health, the irritation is suffused throughout the body, in disease it settles locally in some organ. The perfect cure is to deprive the patient of food—which only furnishes fresh strength, hence fresh irritation—and to leech him long and thoroughly. Broussais favored leeching all over the body. In extreme debility five to eight leeches sucking away might draw off enough blood, but for a rousing fever he applied 30 to 50 leeches all sucking at once.

What with Broussais and others who were like-minded, the demand for leeches grew by leaps and bounds. Far from imports of two or three million leeches being ample, by 1832 fifty-seven and a half million leeches came into France, while only nine or ten million were exported. France was bled white by the cost of Napoleon's armies and also by the triangular jaws of the humble leech.

Huge quantities were brought in from Russia, Bessarabia, Astrachan and Trans-Caucasia, where the czar's sectarian exiles could make a living by raising the little creatures. In 1848 the Russian government even passed a "game-law" to protect them, forbidding their collection in May, June and July.

Sackfuls of leeches

Those that came from villages near Budapest used to reach Paris in a fortnight, sackfuls of leeches in their native marsh grass suspended in hammocks for the long trip. Spring and fall were the best seasons to ship them and a rest at Strasburg helped to keep them in good shape. Now the marshy regions of Hungary give a good supply.

Leeches occupied the thoughts not only of doctors, exporters and legislators but of poets as well. Wordsworth wrote a fine poem about The Leech-gatherer, who as an old man could only make a slow and tedious subsistence by gathering wild leeches from lonely streams and pools but who nevertheless persisted in trying to earn his own living.

They were artificially grown in many places, and special ponds were made or set apart. There are still villagers in Heacham up in Norfolk who remember the artificial leech-ponds where they were bred. One way to gather them that was practiced in Ireland was to sit on the edge of a pool and dangle the legs in the water till the leeches fastened on. Leech-gathering had this advantage over fishing, that a row of braw boys on the banks of Loughmask with its subterranean outlet would be quite sure of getting a bite for their pains.

Leeches live in practically every part of the temperate and tropical world. They attack the skin of bathers in fresh water, especially in the steaming forests and low-lying grasslands of Asia, Oceania, Madagascar and South America. Their wounds are not usually painful but afterwards they bleed for a long time—sometimes as long as 48 hours—and this can prove extremely weakening.

In Ceylon the bite of the common land leech is likely to become badly infected. The German biologist Haeckel (1834-1919) has strong things to say about them. "In some of the forests and particularly near the river banks, and the marshy jungles of the highlands and the lower hills, it is impossible to take a step without being attacked by them. Not only do they creep along the ground seeking what they may devour—they are on every bush and tree, from which they frequently drop on the neck and head of the passer-by: while they always creep up his legs, nay, they can even spring to meet their victim." His account is borne out by all who are well acquainted with conditions in tropical forests, but one would like to see a land leech on the jump.

Tiny fresh-water leeches in Southern Europe, North Africa and the Near East attach themselves to the lining of nose, mouth and upper air passages of people drinking water in which the young leeches live. They thrive in their warm, moist and nutritious surroundings and cause considerable damage, setting up a constant hemorrhage. Anemia is the simplest symptom. Coughing, blood-stained sputum, even asphyxiation, may ensue. The remedy is to remove them one by one with forceps, if forceps will reach them, or to shrivel them with salt or acid solution.

Napoleon's Egyptian expedition suffered greatly from these leeches, as also did the forces in Palestine during the World War.

Some land leeches of the Orient attach themselves

Sixteenth century cure for overweight: the unhappy Denis Heracleot, who became so fat that leeches had to be used. From "Histories Prodigeuses," 1567 in the eye with unpleasant consequences. Bleeding results, sometimes causing a scar or inflamation of the cornea, but this is a rare danger. A leech bite is not in itself a source of poison, and infection at the wound can be avoided by the usual precautions. Leeches also affect man adversely in a less direct way by causing a considerable drain on American fisheries.

Yet the individual leech is a beautiful creature, with its 33 body segments flowing into each other without the let or hindrance of neck, waist or tail. The leech that was dear to medicine is a highly specialized fresh-water annelid with fore-and-aft suckers. It swims with a characteristic motion, while on land it reaches its dim destination by a gentle, sure progressive pull and haul. The forward disc fastens down and the rear-guard comes up close, then the fore part stretches out and clamps down far ahead, so that the creature alternately stretches and humps itself in rhythmic oscillation until it has covered its inches or its miles.

The leech has three jaws, which meet in the form of a tiny triangle, each jaw set with close-set, fine, sharp teeth. The incision it makes is thus triangular, and a triangular opening is harder to heal than a gash.

Leeches that were most commonly used in medicine were the gray and the green. The gray European leech of marshes and running water may be anywhere from two to four inches long, with six lengthwise stripes down its back. The African leech is a fine light green, varying to deep green, and often

Man wading with leeches sticking to his legs. From a 14th century manuscript in Lisbon

(Courtesy of Wellcome Historical Museum, London)

inclined to red, while its broad streaks of bright orange-yellow grade to black underneath. The leeches from Algiers are prettily called "dragons" in the trade.

The American leech has not the draft of its continental or African relative. Its deep pistachio-green back is decorated with three lengthwise rows of square dots, 22 in number, while its belly is spotted with black. Since it does not make so large or so deep an incision, it draws less blood and was less prized medically.

The leech sucks blood only during the breeding season, like the female mosquito. But there is no definite he or she among the leeches. Each leech is both; the two sexes occur in the same individual. The earliest form of reproduction is by fission: by a chip of the old block breaking off and setting up for itself. Next higher in the scale is perhaps this indeterminate existence when each individual is now father, now mother, as chance wills.

Usually the father-mother leech retains the eggs within the folds of the body until they hatch out. The young then hold to the parent's body with their small suckers—they get practice in suction from the start—or else turn into strap-hangers, anchoring themselves to their parent by a viscous thread.

Eating habits

While young and living in natural surroundings, leeches live on smaller ones of their own kin and on eggs and larvae of other water creatures. The blood-lust comes with a rush at the breeding season. It is then that they drop from the trees to the passing shoulder; it is then that they even "leap" at their prey in Ceylon.

Once the multiple-stomach pouches are filled with blood, the leech can live many months before its next meal. The only observable change is a gradual shrinkage of the body back to normal. Another saving of effort is that cold weather makes them torpid. Breathing on them is then a quick way to get them to work.

Those who have had much to do with leeches say that they take some skill to keep, since they are liable to sudden and great mortality. The barber used to keep them on a shelf close at hand in a leech-jar with a perforated lid. Clean soft water changed twice a week in cold weather, on alternate days in summer, would usually keep them comfortable, provided they were covered with a linen cloth or punctured cover, and were not subjected to sudden changes of heat and cold.

The technique of leeching was plain and simple. All you did was shave the hair, if hair there were, cleanse the part first with soap and water, then with pure water, open your jar or box and take out your leech. If when you placed it gently on the afflicted surface, the leech did not readily take hold, then you put on the spot a drop of blood—it need not be human—or a drop of milk and water to start the leech off. Sugar-water was what the French leech got, and the English leech responded to a drop of porter. Once started, it would suck and suck till it could suck no longer. The leech always stops just this side the bursting point. Then off it drops and lies gorged and contented, a good square meal within its rounded bulk.

Need no coaxing

Usually leeches need no coaxing to start them, but get down to business quickly of their own accord. If half a dozen are applied from a tilted tumbler, they attach themselves at the drop of the hat with unanimous purpose, so that only a single bite is felt.

A special leech-glass was a convenient accessory, especially for cases where the leech must be applied at a given point. A typical leech-glass is a tube four or five inches long, into which a leech is inserted with its head at the opening. The pleasant warmth of the patient's skin invites it to step out and suck. Some leech-glasses are straight, some enlarged to a tiny cup at the opening so that the creature can quickly "get its feet on the ground." In either case, this is just the device to land a leech exactly on a gum-boil or on a painful pimple inside the outer ear.

How much blood will one leech draw before repletion? There are individual differences here as elsewhere. As two camels will not take the same quantity of water into their four stomachs to see them safe across Sahara sands, so different groups of leeches have different cubic contents. As a rule, six American leeches are equal to every fluid ounce of blood withdrawn. A single European leech can draw from half an ounce to one ounce of blood before it is sated.

If a leech has stayed on too long by inadvertence it can be easily persuaded to relax its hold at any instant; merely drop on its back a little salt. Indeed after a leech has rolled off and is lying helpless after its Gargantuan feast, a sprinkle of salt will make it disgorge its intake—equivalent to tickling the throat with a feather after a more-than-ample Roman feast.

Though no longer part of the paraphernalia of the modern barber and no longer essential to the surgeon today, leeches continue to serve the cause of science. Their saliva contains a hemolysin known as hirudin which when mixed with the blood of a wound keeps it from clotting and thus from starting to heal over before its time. When this substance came in demand during the World War, leeches had long been out of style in most of Europe and doctors could not lay hands on hirudin enough, so they had to send to a land that still uses leeches. Since certain Hindu practitioners lean heavily on leeches for their copious blood letting, India became the main source of supply. Hirudin is still a commercial product, a powder made from leeches' heads, used in solution and injected.

Leeching has lingered in Europe, especially in eastern Europe, longer than on this side of the Atlantic. Chemist shops in the East End of London, the drug-stores for the foreign-born, still regularly keep on hand a supply of leeches. It is not unusual indeed for an English hospital to send in an order for leeches, so that by sucking out the blood from a contusion a better underlying diagnosis can be made.

American physicians here and there use leeches in certain cases. One favors them to draw off the "bad blood" from a boil. Another uses them for rheumatism. A third applies them for early mastoid, in the hope of removing enough of the germy blood. And those who live in the world of fisticuffs and bruises claim that nothing so restores a man to the realm of the normal as putting three leeches promptly on his black eye.

HOW SNAKES ARE BORN—*Not yet broken of their age-old egg-laying habits, those snakes which seem to be progressing toward the mammalian method encounter difficulties in bringing forth their young which sometimes can only be relieved by Caesarean operation*

By CARL F. KAUFFELD
Curator of Reptiles, Staten Island Zoological Society

THE American Museum's seven-foot bushmaster from Trinidad deposited an egg on the night of August 3rd. Being the first bushmaster to lay eggs as a captive in the United States, hopes were high in the Museum that this mother would produce more eggs and that young bushmasters might be hatched out in captivity for the first time. She did indeed lay more eggs, but unfortunately all of them proved infertile. Once more the prospect of raising a brood of this, the most deadly venomous snake of the American tropics, could not be realized.

However, the incident of the bushmaster eggs has attracted popular attention to snake births in general, one of the more fascinating subjects in the evolution of animal reproduction.

Eggs swell

The eggs of birds are familiar to all of us. Even dinosaur eggs are no longer shrouded in mystery. But the eggs of living reptiles, particularly snakes, share the prejudice which exists against the creatures themselves, and many people consequently have been prevented from learning some of the more interesting facts of natural history. It is not generally known, for instance, that snake eggs increase in size during the period of incubation, or that the young snake is provided with a special tooth at the time of hatching which enables it to free itself from its encasement.

The essential difference between snake eggs and bird eggs is the leathery covering as distinct from the hard calcareous shell of the latter. At the time of laying, the flexibility of this membranous shell facilitates their extrusion by the mother. They are forced from the vent in the same manner as a partially inflated balloon can be pressed through the fingers encircling it. The glutinous quality of the shell at the time of laying causes the eggs of some species to adhere to one another in one mass, although they are deposited individually. The eggs of our common hog-nose snake and of the whip snakes are exceptions to this rule. After exposure to air or moisture, the skin-like shell drys and toughens.

Again, unlike bird eggs, the eggs of snakes are capable of absorbing moisture; in fact, this is essential to the development of the embryo. Most snake eggs show a noticeable increase in size from the time of laying to hatching, sometimes as much as one third their original size.

Snake eggs show no great diversity of structure. Unlike bird eggs there is no variation in color—all snake eggs are white or cream colored. They may become discolored from substances coming in contact with them during the period of incubation, but at the time of laying they are immaculate.

Some eggs, such as those of the common blacksnake and related species, and those of the gopher snake, *Drymarchon*, are covered with granular excrescences which give them a decidedly rough surface.

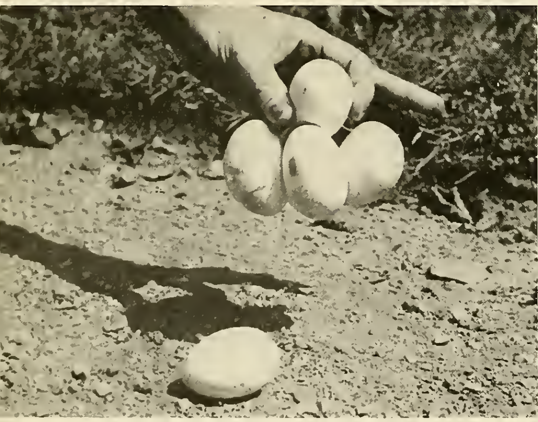
The number as well as the size of eggs deposited varies with the species. Pine snakes lay from four to a dozen, and bull snakes (of the same genus, *Pituophis*) lay as many as 22. Hog-nose snakes, common to most sandy regions of the United States, lay as many as 30. Large pythons have been known to lay more than 100.

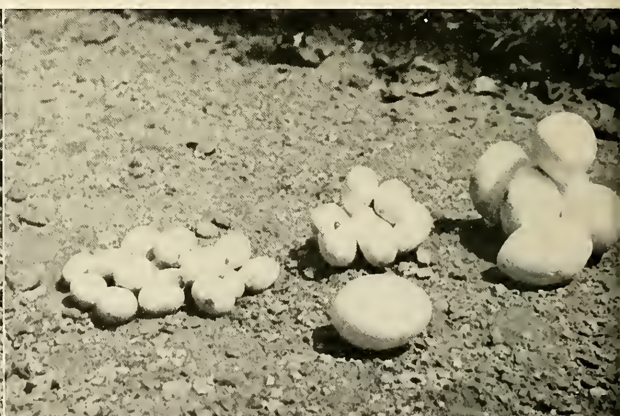
Laid in transit

At the Staten Island Zoological Park we were astonished once upon opening a crate containing a 25-foot regal python from Singapore to find that the snake was coiled about a huge mass of eggs. They had been laid during the long journey and the mother was brooding them in characteristic python manner. She so completely hid the eggs that only a few were visible at the top of her coils. We tried to remove her and the eggs from the crate in such a way that she would not be disturbed, but our efforts were of no avail. She forsook the eggs, which proved to be clinging together in a solid hemispherical mass

A MOTHER BLACK SNAKE *(above)* laying her eggs. Two have already appeared; a third, bulging near the tail, is on its way. Their somewhat elastic, leathery covering makes snake eggs less fragile than those of birds and easier to lay since the mother snake can compress the egg like a rubber balloon at the moment of extrusion. Most snake eggs grow (sometimes one-third original size) from the time of laying to hatching. Though roughly 70% of all species are egg-layers, some types are now tending to retain the eggs in the body until the young are ready to be hatched without further brooding.

(Above) THE THIRD EGG is emerging from the captive specimen. Wild black snakes, like many other species, defy cameras by laying in an underground "nest." Snake fanciers cannot cultivate semi-wild pets by proffering the bird lover's "bribe" of nesting sites. Rarely approaching the domesticity of birds, most snakes pay no attention to their eggs once they are laid, abandoning them to mechanical incubation by natural heat and moisture. However, certain species do brood their eggs, and the famed King Cobra is particularly dangerous when guarding its nest





PINE SNAKE EGGS *(above)* have the sticky shell common to many species at "birth." They can thus form an adherent cluster although each is delivered singly. Unlike birds', snake eggs absorb moisture from the damp earth or decaying wood in which they are usually buried. This moisture is necessary to embryonic development and its lack in cold or dry climates seems the chief reason why northern snakes are tending to abandon the egg-laying method

VARYING MARKEDLY in size, and sometimes departing from the usual capsule-like shape, snake eggs differ little in color. Above *(left to right)* are the clustered eggs of the hog-nose, king, and pine snakes compared to the hen's egg in foreground. Snakes that issue living young are not strictly live-bearers, rather they brood the eggs internally. Roughly the proportion of live bearers increases with the distance separating their habitat from the equator

Photos 1, 2 and 3 by Alexander Klots

(Above) THE FOURTH EGG has been almost completely expelled, and the fifth is bulging toward the vent. The number of eggs laid varies with the species. Pine snakes lay from four to a dozen, large pythons, 100 or even more. Eggs will develop in the laboratory at room temperature if kept in a slightly moist medium. But too much moisture will result in rotting or attacks of fungus. In the wild, the hazards are increased by predators who destroy the eggs of species leaving unguarded nests. However, predators are often thwarted by brooding species like the pit-viper who defends its eggs so tenaciously that it suggests a maternal instinct comparable to a bird's

Photos by Staten Island Zoological Society

(Right) THE TWO PICTURES show baby bull snakes concentrating on the important task of getting out into the world, a performance that often takes them about two days. An egg tooth on their snouts enables them to rip the shell from the inside, after which the tooth becomes superfluous and is soon lost. The youngster in the first picture has just used the tooth to get his first breath of air. This tooth survives for no earthly purpose among some of the live-bearing snakes, indicating that they are not yet quite "broken" of their egg-laying habits. But further evidence of incomplete adjustment lies in the fact that some fatalities occur from obstetrical obstructions which can be relieved (in captivity) only by a Caesarean operation. Add to this the wholesale decimation of unborn young resulting from the death of pregnant mothers, and the cultivation of the live-bearing method seems to this extent ill advised from the snake's viewpoint. Yet in many cases, the dangers of egg-laying appear to outweigh those of living birth. And particularly in northern, marine or mountainous regions, live-bearing has a definite survival value which may possibly be on the increase

about two and a half feet in height. The individual eggs were at least three times as large as hen eggs. There were more than 75 in the clutch.

Although the mother could not be induced to resume brooding them, they continued to develop under the artificial conditions provided by us. The time for them to hatch had almost arrived when an attack of fungus, possibly due to excessive moisture, killed the nearly mature embryos which we found occupied each egg.

The eggs of pine snakes are fully as large as hens' eggs, and the snakes that hatch from them average more than 14 inches in length. Regal pythons average at least 24 inches at the time they emerge but are not so large in proportion to the parent as the 14-inch pine snake offspring. On the other hand, the pine snake may lay only one-seventh or one-eighth as many eggs as the python. In a particular species, small mothers do not lay small eggs, they merely lay fewer.

The shape also varies with the species. The eggs of the exceedingly slender tree snakes are extremely elongate—sometimes tapering to sharp points at both ends. But for the most part, snake eggs are capsule shaped, that is, cylindrical and round at both ends, or truly egg-shaped—round at one end, pointed at the other.

Different methods of incubation are employed. Mothers' parental care in most species consists only of choosing a nesting site—a sunny sand bank, or a mass of decaying wood pulp in a fallen tree trunk where the heat of decay aids incubation. There is little opportunity for the snake fancier to induce snakes to nest near his home in the way that bird lovers attract birds with houses and other means. Snakes for the most part have little domestic life, that is, in the way birds have. When a mother snake has found a suitable spot, she digs a hole in the sand or soil and afterwards lays her eggs at a depth of several inches. Leaving them here to develop with the heat and moisture received from the sun and rain, she usually never returns to them or displays further interest in them in any way.

Parental attention

However, among our native snakes the black rat snake, *Elaphe obsoleta,* has been observed to take a very decided and prolonged interest in its nest. A pair was once observed to have nested in a sawdust pile where not only the female parent but the male as well brooded the eggs. When one snake was with the eggs the other would sun itself on the surface of the mound and after a time burrow into the nest and relieve the mate. It is probable that they hastened incubation by carrying heat to the eggs with their sun-warmed bodies in this way. Our knowledge of the breeding habits of snakes is sadly incomplete, and it may be that many more species than we suspect share this habit of brooding and aiding the incubation of their eggs.

Parental affection of the kind we know in birds and mammals is very rare in snakes. The male parents particularly are almost unknown to take any sustained interest in either their mates or offspring. It is highly doubtful whether males, except in a few species, ever knowingly encounter any of their progeny. Nevertheless, there are snakes which take their parental responsibilities seriously. Besides the black rat snakes just mentioned, there is the bushmaster, the only viperine snake in the New World that lays eggs, which coils about them throughout the period of incubation instead of burying them. The advantage of having the eggs thus protected against enemies is obvious, although possibly they might suffer more from desiccation than if they were buried.

This habit of the parent coiling about the eggs instead of burying them is by no means confined to the famous bushmaster. All pythons invariably stay with their eggs until their development is completed. Some mothers that have been studied reveal an increase of body heat of several degrees over the normally fluctuating body temperature of reptiles. But this increase in temperature may not be essential to the development of the eggs, since atmospheric temperature is sufficiently high to hatch the eggs of other snakes. Mr. Clifford Pope, while in China, came upon a pit-viper, *Trimeresurus monticola,* tenaciously guarding her eggs. Her devotion to this mass of potential young was so pronounced that it suggested a maternal instinct as fully developed as that of a brooding bird.

Cobras with eggs

Some species of cobras are egg layers and guard their nests, sometimes in pairs. The king cobra, or hamadryad, is notorious for the fearlessness of its attacks on intruders, but its belligerency reaches its height during the mating season and at the time it is incubating its eggs. So dangerous is this behavior that certain roads in India have at times been closed to prevent some unsuspecting traveler from being attacked by a pair of king cobras nesting in the neighborhood.

Not all snakes are egg layers. In about 30 percent of the species the mother retains the eggs within her body until they mature, and gives forth living young. But these snakes are not live-bearing creatures in the strict sense of the term nor have they dispensed with eggs entirely. They merely brood them internally as it were.

The evolutionary tendency among snakes seems to be toward developing the live-bearing, or ovoviviparous, method. From my observations among captive snakes, the mortality among both infants and mothers is higher among the live bearers, yet it is true that they are more prolific and seem more successful as species. We have such classic examples as the garter snake and water snake, to say nothing of the rattlesnakes and copperhead. Yet the observer of living snakes is constantly impressed with the large number of premature births and pathological conditions which cause the death of both mother and young. The writer has frequently seen gravid females of the notorious fer-de-lance which had died in attempting to give birth to their young because the oviducts were so clogged with infertile eggs that neither these nor the normal embryos could be evacuated. Not only the fer-de-lance, but even our common water snakes and garter snakes, as well as other species, often suffer from this same condition. Autopsies of these specimens show the embryos in the ducts interspersed with hard masses of yolk. There seems to be a lack of uniformity in the process of fertilization with the resulting infertile masses imprisoning the normal young with fatal effects on them and the mother. We have made it a practice with valuable specimens of captive snakes to remove the contents of the oviducts by the Caesarean method, before the period of gestation is complete, where we suspect such a condition to exist. Mother snakes undergoing this operation invariably survive, whereas they often die if young are retained.

There is a female bull snake, *Pituophis sayi affinis*, in the School Nature Room of the Museum's Department of Education, which was presented by the writer nine years ago. The specimen was immature at the time it was received. About three years later this snake, having grown to maturity, developed infertile eggs. Never having been mated with a male of the same species no fertilization could possibly have taken place. Six of the hard masses of yolk were thrown but the remaining ones were retained and threatened to cause the snake's death. However, they were easily removed by making a small incision (which was later sutured) and pressing them through the opening. Nine additional masses were removed!

Captive snakes rarely breed

Snakes rarely breed in captivity. Those that lay eggs or have young in confinement usually have mated while in a natural state previous to their capture. The peculiar case of the bull snake described above may be attributed entirely to the fact that it had always lived as a captive, for ordinarily the egg-laying species dispose of the problem of propagation with an ease which is in strong contrast to that of the live bearers. The eggs are laid without difficulty and usually most of the eggs hatch, giving forth healthy and robust young. In a natural state, it is true, the destruction of the eggs by predators is a constant danger. But although some of the eggs might escape such attacks, the young of a live-bearing snake would all succumb with the mother were she to be killed while carrying them; and since the young are retained at least twice as long as with the egg layers the hazard is twice as great. A factor which offsets this is the danger of insufficient moisture, or too much moisture, which would cause the eggs of the latter to dry up or rot during the long incubation period if weather conditions were unfavorable.

Hatching eggs in the laboratory

Hatching snake eggs in the laboratory is a simple matter. Placed in a closed container, buried in moist sand, or just covered with a damp cloth, they will develop successfully at room temperature. The only attention necessary is to be certain that the moisture is not so great as to cause rotting. To give them too little moisture is far less detrimental than too much. Mosses of various kinds, especially sphagnum, and wood pulp have long been favorite hatching media, but destructive fungi are very likely to attack eggs thus treated.

We can only speculate as to what caused certain groups to become live bearers. Undoubtedly various factors in the environment selected the live-bearing or eliminated the egg-laying individuals, or brought about a gradual change from one to the other within a species. The transition from one method to the other is well illustrated by the sea snakes. Having evolved from a group which is principally egg laying, the cobras and related snakes, this method would have obvious mechanical difficulties as the snakes became more and more confined to a marine environment. Possibly only those that were live bearers before, "took to the sea." However, there is living today a genus of sea snakes which is not yet devoid of the power to move on land—a stage between the entirely pelagic sea snakes and the terrestrial cobras. As might be expected, this genus retains the egg-laying habit—evidence arguing the acquisition of the live-bearing habit subsequent to the adoption of the marine life.

The common viper of northern Europe and Asia inhabits such cold climates, for a snake, that if it were an egg layer its eggs probably would never hatch, and the species would never have established itself in the wide area which it is known to cover.

In cold climates or at high altitudes there is insufficient heat to incubate the eggs of an egg-laying form.

Thus we see that the live-bearing habit does have survival value. In fact, it could perhaps be demonstrated that as one goes north from the equator the proportion of egg-laying species decreases and the live-bearing increases. It is difficult to explain the loss of the egg-laying habit in most forms or to correlate it with the habits of certain groups. Most large groups are predominantly one or the other, but there are always exceptions. The viperine snakes for the most part are live bearers, but there are the African night adders, the burrowing vipers, certain Oriental pit-vipers, and in the New World, the bushmaster, all of which lay eggs. The almost cosmopolitan genus *Natrix,* to which our common water snakes belong, consists of live bearers for the most part; but in China, where a number of species occur, there is only one which bears its young alive —all the rest are egg layers!

Period of gestation

The length of time necessary for the development of the young within the eggs varies somewhat, particularly in tropical snakes. The period of gestation in most live-bearing snakes is about four to six months. With the egg layers, gestation is, of course, much shorter, but the total length of time required for the maturing of the young from the time of conception to parturition or hatching, as the case may be, is approximately the same with most of our native snakes. Since the eggs are laid about the second month after mating, the incubation period of the eggs is usually about two to three months.

The young of the egg-laying species are remarkably large and vigorous when the time comes for them to emerge from their leathery encasement. They are always provided with a sharp tooth projecting from the premaxillary bone at the front of the mouth, with which tooth they cut the shell. The tearing of the shell takes place a few days before they leave the egg permanently. Most young snakes remain for a day or so with just the head thrust out of the opening they have made with the egg-tooth and gaze about them before coming out to stay. At this time they are entirely capable of shifting for themselves. One poor youngster, of a brood that once hatched for the writer, was apparently so discouraged by his first glimpse of the world that he drew back into the egg and never came out again! Snakes of all ages display great curiosity—even these babies—but instinctively they draw back out of sight into the shell when they think danger threatens. It is a ludicrous sight to see a clutch of eggs with a head protruding from each and to watch them simultaneously draw back into the shell out of sight, ostrich-like, as a sudden movement frightens them.

Often they deliberately tear the egg shell again and again, sometimes from stem to stern, much more than would seem necessary for their escape. Having served its purpose, the egg-tooth is lost within a week or so after the emergence of the young snake.

Advance of some snakes

Proving the recent acquisition of the live-bearing habit in some species is the presence of this same egg-tooth in newly born specimens for whom it could serve no earthly purpose except as a temporary ornament. There are snakes that have advanced far beyond this stage. They have lost the egg shell and developed placenta-like structures for securing oxygent from the parent's body. Since the yolk of the eggs is not reduced we cannot speak of viviparity here in the sense of mammals. It is nevertheless a step in the direction of mammalian evolution.

MEMBERSHIP CROSS-SECTION

Recently we mailed a questionnaire to a group of our readers. Within two weeks we received a return of 38%. This is unusually high, and we take this opportunity to say "thank you" for your cooperation.

We are proud of the fact that not a few of our readers are third generation members of the Museum, and feel that you should be proud of the high cultural and intellectual level of your fellow members. Seventy-four per cent of them attended college and almost nine-tenths have traveled in the United States or foreign countries. They are from all walks of life, and they continue their membership year after year with extraordinary regularity. This convinces us that the intelligent citizen is eager to keep informed on natural science subjects, which are often available only through NATURAL HISTORY Magazine.

Photography is so popular that there are more cameras among our members than there are members. Hobbies are many and varied. Here are a few picked at random: landscape gardening, geology, woodworking, dogs, big game hunting, flying, farming, fancywork, sculpture, mountain climbing, genealogy "Collecting" includes stamps, coins, books, Chinese prints, old railroad prints and antique furniture.

To readers of the magazine pursuing natural history hobbies, we take this opportunity to offer a service. Pertinent letters of inquiry will be published in the magazine within the limits of space.

Again to you who have answered both the last and previous questionnaires, our sincere appreciation.—ED.

Continued from page 365

even young rats and mice before their eyes are open—this was the first time I had ever seen a rabbit voluntarily take to the water. And there was nothing chasing him either, for I waited to see.

At another time, as I peered cautiously around a brushpile at the bend of a creek, I thought I saw a pair of mallards swimming about a hundred yards down stream. But once at close range, my ducks turned out to be muskrats, and fighting "rats" at that, two old males apparently bent on exterminating each other. They were so busy with their brawl I was able to get what might be called a ring-side seat, and it was well worth the price of the crawl I had made to get there.

"In this corner. . . ."

I arrived at the battleground during a lull in the contest, and at the moment, the two rats were sitting on opposite sides of the creek, only a few feet wide here, with a narrow mud flat in the middle. From the tracked and torn-up appearance of the muddy island between them, I judged this to be the arena, and sure enough it was. I had hardly poked my nose from behind a tree, when they did battle again. With a kind of snarling chuckle both dived in, met on the mud-flat and fought. With arms intertwined like wrestlers they stood on their hind legs and ripped each other with their long incisors. Neither made any attempt to throttle his opponent, and three or four times as if obeying the gong or an unseen referee, each backed off and swam ashore again, only to return quickly for another round. But one finally retreated and the victor sat licking his wounds, keeping up a low whimpering as he worked. I had often trapped muskrats in the spring and I now saw the explanation of the many long cuts I had found in their pelts. Once again nature had been gratuitous.

I have often wondered how many of our wild animals live out their full span of years and die a so-called natural death. Theodore Roosevelt remarks in his African Game Trails that "life is hard and cruel for all the lower animals" and that "death by violence and starvation" is the common fate of most of them. But however, this may be, I believe I saw an animal come to a "natural death" some years ago.

I was sitting quietly on the edge of a woody bluff that morning. Suddenly my gaze fell upon a cottontail hunched against the base of a tree. He was in a normal position, ears laid back and eyes closed as if asleep. As I watched him casually he did a strange thing—leaped straight out from his position for about ten feet, kicked a few times and lay still. When I had sufficiently recovered from my surprise I walked over and picked him up. He was dead enough, but I couldn't see any reason for his sudden demise. I even skinned him and made a sort of post-mortem, but could discover nothing wrong. Yet there he was!

Owing to their many enemies, cottontails probably rarely come to a natural end, but if this one did, then two very uncommon things happened that morning: a wild animal came to his end without violence, and an observer happened to be present to witness his passing.

I know that in all my years of seeing things I have probably not seen any particular creature or happening for the first time. But what of that? Maybe that other fellow who saw it first neglected to write it down. But what if it is in the books, it was new to me when I first saw it; I get just as big a thrill though it has been described a hundred times. And so will you. Did a cowbird lay an egg in that chippie's nest you were watching for the first time? Well, that was your cowbird and your chippie's nest, and all the book descriptions of it can't rob you of that fact. And if your cowbird does as mine did, pitches out the chippie's eggs, and the foolish chippie then incubates that egg and raises it to maturity, that's another thrill for both of us. It is yet another if a bereft robin comes and feeds the cowbird as one did for me.

Nature's secrets

The wise Solomon seems to have been something of a nature lover, though he says that there were only four things that were too wonderful for him. His ancient "poser," "the way of an eagle in the air"—and he probably meant their soaring flight—is still a puzzler to naturalists, but anyone who stops and looks about him can see a thousand unanswerable things in addition to Solomon's four. I need only to look at a nuthatch coming down a tree headforemost to see a bit of mechanics that is too much for me, and when I ask myself how he manages to keep his little body warm and his naked feet from freezing in zero weather, I have found another problem.

"Happy is the man who has learned the meanings of things" wrote Virgil, two thousand years ago. I do not know that we who have learned to stop, look, and listen have found out the meanings of many of the things we have watched, but I do know that in the watching of them and the puzzling over them there is a real happiness.

THE FIRST AMERICANS

Continued from page 356

is shown by thick layers of dust which were deposited above the early artifact horizons. There have been many major droughts of varying duration since that time.

The droughts of the last few years have contributed directly to our knowledge of these people who hunted the mammoth and the camel. In the sand-hill areas, pastures which a few years ago supported large herds of cattle and in some sections were cultivated, have been laid bare. The sand blows easily, once the vegetation has been erased, and large "blow-outs" result. When many feet of sand have blown away, the wind sometimes encounters a very resistant sandy clay layer which is often stained with organic matter. The coloration indicates there has been luxuriant vegetation in this now semi-desert. Folsom and Yuma points, the artifacts of our first Americans, are recovered from this clay layer, and the bones of many extinct animals have also been discovered in it. In some "blow-outs" the fossilized bones of the muskrat, the giant Pleistocene beaver, as well as the smaller beaver, have been found 30 miles from the nearest existing stream, indicating that climatic and physiographic conditions at that time were vastly different from today.

So the story of the struggles of these mysterious people against the hard times which came upon them and which apparently at last proved their nemesis, is being pieced together. The searchlight is being turned into unsuspected corridors in human history. Science has rescued the first American from oblivion.

THE ROMANCE OF MISTLETOE

Continued from page 327

zoumofskya pusilla), grows from Newfoundland to Connecticut, New York, Pennsylvania and Michigan —the host trees being spruces and tamarack. A half-dozen species of this genus grow in western United States, the host trees being conifers.

Except to the naturalist, more interesting than its botanical relationship and geographical distribution is its folk-lore. To revert to this, Brand assigns it a place in the kitchen, where "it was hung up in great state, with its white berries; and whatever female chanced to stand under it, the young man present either had a right, or claimed one, of saluting her, and of plucking off a berry at each kiss." Nares makes it ominous for the maid not so saluted, and says, "The custom longest preserved was the hanging up of a bush of mistletoe in the kitchen, or servants' hall, with the charm attached to it that the maid who was not kissed under it at Christmas would not be married in that year."

Whatever the origin of kissing under the mistletoe, the custom was a deservedly popular one, and still retains its hold. Let us keep up the good old custom at this season of the year, for it is eminently worth preserving, especially when a pretty girl is concerned, and certainly it adds to the gayety of Christmas festivities. An enthusiastic English minstrel sings—

Yet why should this holy and festival mirth
  In the reign of old Christmas only be found?
Hang up Love's mistletoe over the earth,
  And let us kiss under it all the year round.

THE INSECT GLEE CLUB AT THE MICROPHONE

Continued from page 345

song that lasts for six seconds or more. It starts off with a series of sounds much like a rapid winding of a clock, but in less than two seconds it has reached such a speed that it suggests the whirring of a clock-spring that has broken and is unwinding. The air-vibrations are so rapid that even with the magnification shown here many of the lines are so close together that they cannot be seen in the reproduction as separate lines *(page 344)*. They are at the rate of about 10,500 per second—in the second octave above the piano range. However, since human ears are relatively insensitive to such a high pitch we notice—"hear"—only the lower notes of such an insect-musician.

Another of our genera of long-horned grasshoppers, *Scudderia*, has a song-pattern that includes the same sort of bunched sound-waves. This genus was named in honor of Samuel H. Scudder, a master entomologist of former years who wrote extensively on the sounds made by insects. How delighted he would have been with a method of making photographic records of such sounds!

The famous "Katy-did" song of *Pterophylla camellifolia* is shown in full on page 345. Notice how irregular the sound-waves are. In sharp contrast with that of crickets it is far from pure in tone. We must admit that it is noise. Still, with Holmes, "I love to hear thy earnest voice wherever thou art hid, thou testy little dogmatist, thou pretty Katy-did."

Now the editor says that I must close for the present our album of insect songs. We have looked but briefly at some of the sounds that Orthoptera make by rubbing their wings together. Other Orthoptera make sounds in other ways. And there are the cicadas that have a very curious and complicated musical apparatus, to say nothing of the bees that hum, the flies that buzz, the beetles that rasp, and so on.

Why and by what means has Nature developed sound-making by insects? We do not know—yet.

THE INDOOR EXPLORER

Artist and "Animal Trainer"—the Story of a Double Life

AMONG the residents in the town of Valley Stream, Long Island, is Madame Helen Ziska who leads a double life. During working hours she is known to her colleagues in the American Museum as an extremely competent staff artist in the Comparative Anatomy Department—a career offering far less opportunity to display her work in the exhibition halls than that pursued by most Museum artists. Her chores consist of working out infinitely detailed illustrations for the vast if esoteric literature by which Museum scientists communicate to their profession the results of their laboratory and expeditionary findings. And from the very nature of this work it is obvious that Madame Ziska can achieve little recognition outside the limits of professional circles. But once the cares of the day are over she bursts her cocoon. To her neighbors in Valley Stream she is famous for her off-time hobby—the keeping of strange pets.

Not long ago Madame Ziska picked up the telephone in her home and called her grocer much as any of the neighboring housewives were doing that morning. When the connection was completed and the grocer ready to take her order she announced calmly "I want some cockroaches." There was a moment of silence on the other end of the line. Then she was politely asked to repeat her order. She did, quite distinctly. "But nobody *wants* cockroaches," pleaded the tradesman. "But I do," she insisted, "and I must have them as quickly as you can get them. Mike, my scorpion, is very hungry."

Mike had entered the Ziska homestead by a devious route. Some friends who worked in a downtown post office were aware of her insatiable lust for extraordinary pets and one afternoon they called her at the Museum stating that they had something which might interest her. "They simply said they had an animal down there which had arrived in a mail bag," said Madame Ziska in reporting the incident. "Of course, I didn't know whether that meant a rhinocerous or a canary, but I did know that unusual things occasionally came in on mail ships from South American ports, so I went right down. Well, it was a scorpion and I have never seen so many faces turn pale at one time when I told them it could sting. 'Take it away!' they said. And so I did. I took it to my home."

Out at Valley Stream, Mike, half dead from hunger and the not particularly salubrious environment of a mail bag, was presented with a little

box in which some sand and green leaves were placed to make him feel as much at home as possible. But that was not enough. There had to be cockroaches. Thus began Madame Ziska's strange dealings with her grocer. Finally, the latter, fearing possibly that this nefarious traffic might be carried to such lengths that the store's reputation would be ruined, gathered together a large tin can brimful of the ordinarily obnoxious bugs and brought them to Madame Ziska. "Here," he said, "these are all I can find. Please don't ask me for any more."

Madame Ziska cannot remember when she did not have an interest in keeping pets of an unusual nature. But she recalls very vividly the turning point in her artistic career. The daughter of the famous Viennese Wagnerian baritone, Josef Beck, she was constantly being shunted back and forth as a child between New York with its Metropolitan Opera House and the Royal Opera House in Vienna. Having early shown a distinct talent for sketching, her father sent her to an art school in Munich where she went through the usual art school course, distinguishing herself by the winning of several medals.

"Vienna was such a comfortable city in those days," said Madame Ziska with a sigh, "I fear it has changed greatly since then. As for my art I did nothing exceptional at that time, just the ordinary landscapes and figures. And all simply to amuse myself."

When she returned to the U. S. A., however, financial reverses after her father's death forced her to seek out a way of commercializing her talent. It was at this time that a physician friend of the family's suggested medical drawings. Madame Ziska had never heard of them. The physician took down a heavy volume and opened to one of its illustrated pages. It showed a rather terrifying abdominal operation. The outer walls of the stomach were laid back and forceps, surgical knives and similar appurtenances loomed large in the foreground. The young girl was aghast.

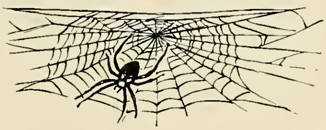
"Oh, I could never, never do anything like that," she said.

But the doctor persisted and presently after training under him for some time, Madame Ziska entered the College of Physicians and Surgeons at Columbia University as a professional medical illustrator. Here she studied anatomy and surgical drawing, doing much of her work right in the operating room under the supervision of Dr. Hermann von W. Schulte. When the latter became Dean of Creighton Medical College in Omaha, Madame Ziska went out there with him to continue her illustrating work on some of his scientific papers. At Creighton she learned to dissect human bodies.

"I shall not forget my first experience," she told the writer. "I had hoped fervently, before I went into the dissection room that I would not have to touch the face of the body because I felt that I could not bear to see the expression of a dead person. But I had no luck. I was told to dissect the tongue of a dead child."

Madame Ziska soon found, however, that just as had happened when the family physician showed her the abdominal operation, the first shock of the experience wore off almost immediately and she became intensely interested in the work. The knowledge and experience acquired in this rather gruesome way led directly to her appointment at the American Museum. "So you see," she said, "after all that, I could not be afraid of a little scorpion."

Madame Ziska stoutly insists that scorpions have very interesting personalities. She taught her pet to regard her as a beneficent provider and to come scuttling over whenever she held out a cockroach and seize the prey gratefully from her finger tips. "Oh, he came to know me very well," she said, "whenever I rapped on his box he would come to me at once, eager for his dinner. I really got much more fun out of him than I ever could have with just an ordinary household pet."



Spiders have very interesting personalities, too, Madame Ziska declares. And she had a pet butterfly once who fed almost exclusively on apple juice. But snails—they are the most wonderful of all. Doctor E. W. Gudger, noted Museum fish specialist, had presented her with a land snail which he brought back from Florida. This was a new and delightful problem for Madame Ziska. The snail was named Rastus and under her ministrations, soon became very tame. The first problem was, of course, finding the proper food for it. Lettuce and spinach were tried without much success. But finally, she hit upon his two favorite delicacies—apples and carrots. By spreading carrot shavings along her finger, Madame Ziska taught Rastus to feed complacently from her hand, and in time, she developed a sort of spiritual communion with him, even closer than that which had existed between her and the scorpion.

"You will laugh at me for telling you this, but I have absolute proof—Rastus would come to me when I called him."

This performance had, in truth, been witnessed by Doctor William K. Gregory, Curator of the Department of Comparative Anatomy, under whom Madame Ziska has done most of her scientific art work. Rastus began to come, of course, in response to his ever-present hunger pangs, but it was not long before the habit was firmly established, and he would come without fail whenever she called. The call—really a smacking of the lips—which Madame Ziska kindly demonstrated for the writer was, curiously enough, remarkably like the one used in calling a horse. But it worked very well for Rastus, too, and at its sound he would make his way toward her from wherever he happened to be, sticking his head out of his shell and with his little "eyes" waving in the air.

Like the more common household pets, Rastus had to be exercised. Madame Ziska took care of this by turning Rastus loose in her garden. While his owner sat watching him on the porch, Rastus would creep delightedly across the lawn at the astonishing rate of about 1.5 feet per minute. This was allowed to go on until Rastus, feeling his oats, would begin to climb trees. At this point, Madame Ziska would give "the horse call" and the land snail with arboreal ambitions would be taken up and told that tomorrow was another day.

When the writer inquired whether Madame Ziska supplemented her pet training activities by any spare time painting or sketching, she shook her head emphatically. "I leave my house at 7 o'clock in the morning and I return at 7 at night. Now, I ask you, when would I find the time to do any painting?"

"But you have done some in your earlier days?"

"Oh, yes," she said, waving her hand airily toward the wall of her office. "There is one of them." It was a very nicely done oil of a winter landscape with excellent perspective and a particularly fine snow texture.

"And you have no longing to do more of that?"

"Oh, no," she said. "This work I do here is much more interesting. Look at these." Madame Ziska showed the writer a collection of unbelievably delicate line drawings spread across her desk. There was a genuine excitement in her voice as she expounded the delights of catching the most minute morphological changes that took place in the musculature of one species, the bone structure of a second, the tail of a third. She loved this work, she said. It presented the artist with many difficult problems and it demanded much special knowledge, but she felt she had a gift for it. "How I got the gift, I do not know," she said, "nobody knows—I just shook it out of my sleeve."

Madame Ziska is convinced, however, that sights to delight the eye of the most sensitive artist are more than abundant in her work. Both in the larger anatomical sections and in those requiring microscopic study, there exist, she declares, some of Nature's most intricately beautiful designs. Many of them, she feels, would make the most lovely textile decorations imaginable, an application someone ought to look into.

Aside from her more routine tasks of providing necessary illustrations for most of the individual technical papers by scientists in the Comparative Anatomy Department, Madame Ziska has undertaken several larger projects. Among the books which she has illustrated are *Garden Cinderellas* by Mrs. Helen Morgenthau Fox and Mr. W. K. Vanderbilt's *Cruises of the Yachts Eagle and Ara* which contains hundreds of detailed drawings mostly of the microscopic marine animals collected for the Vanderbilt Museum. She also did all the illustrations for Dr. W. K. Gregory's work *Our Face from Fish to Man* and in the same connection, executed many of the sculptures of the lower forms for the Museum exhibit which summarizes this same pattern of evolutionary development. One or two other displays in Comparative Anatomy exhibition halls are also embellished by her work.

Perhaps her most important contributions were the enormously detailed skeletal restoration drawings of that famous giant of the past—the Baluchitherium. These took over a year to complete and involved much mathematical juggling of ratios and scales. With only a few bones of the actual animal to work from she was at length able, under Doctor Gregory's direction, to sketch the enormous beast of Baluchistan in his very appreciable entirety. Once finished, her drawings were used as the basis for the life-

Continued on page 394

LETTERS

SIRS:

I want to congratulate you on the October issue of NATURAL HISTORY. It is fine indeed.

I hope some time you will give us an article, similar to the one entitled "The Road to Man", giving the evolutionary history of the plant world. I am sure it would be most interesting.

W. A. MITCHELL.
Savannah, Ga.

* * *

SIRS:

Have heard some mighty favorable comments on NATURAL HISTORY. I would like to say that to me it is astoundingly interesting and beautifully edited. In my opinion it is the top among magazines.

DEVEREUX BUTCHER.
Lumberville, Pa.

* * *

SIRS:

It is no easy job to edit a magazine well, whether popular or special. I have been so pleased with the latest numbers of NATURAL HISTORY that I take the liberty of telling you that it is a good job. Popular writing about science can be so stupid, because the writer's personality is waved before you or just because the writing is stupid. But you manage to keep NATURAL HISTORY interesting as well as instructive. The article on Panda, big and little, in the June number was all right, though I've thought Panda a bit of a bore since first seeing his pictures.

HENRY OSBORN TAYLOR.
Cobalt, Conn.

* * *

SIRS:

Admired the painting by Else Bostelmann on the cover of the October NATURAL HISTORY and would appreciate greatly any information on obtaining same.

ELEANOR WILCOX.
West New York, N. J.

AMPHIBIANS—Young frogs with full complement of legs but not yet rid of their tails of tadpolehood.

Photograph by L. W. Brownell

SIRS:

I should like very much to have a copy of the print used for the cover on the October issue which would be suitable for framing. I have been wondering if you ever have these designs or pictures printed on a matte for just such purpose, and if so, how much are they? Your covers are always a delight to the eye, as the material inside is to the mind. This one of the orchids is especially lovely, I think, and I would like to have it if possible.

DOROTHY M. ANDERSON.
Department of Biology,
Hood College,
Frederick, Md.

* * *

In acknowledging these and other requests for copies of NATURAL HISTORY cover designs, we must regretfully say that it is impossible to print these separately without the three bands which regularly appear at the bottom. Covers of current issues, with the bands, are hereafter offered at 10¢ each.—ED.

* * *

SIRS:

I should like to express again, as I have previously, my appreciation of the new form and contents of NATURAL HISTORY. . . . The comprehensiveness and imaginative scope of the articles are exceptionally commendable, I think.

Might I trouble you to convey to Mrs. Eifert my cordial thanks for her "Story of Orchids" in the current number? I had left a blank page two years or so ago in one of my large scrapbooks, under the theme of Orchids; and I feel that it has been awaiting selections from this article in NATURAL HISTORY. "Enthralling" is a somewhat forceful adjective and may sometimes be heedlessly used, but it certainly applies to this monograph, in my estimation.

(REV.) ELIOT WHITE.
Roselle, N. J.

* * *

SIRS:

It was very pleasant to read Reverend White's letter to you expressing his interest in the Orchids. There have been many good comments among nature people of Springfield, many of whom are just "discovering" NATURAL HISTORY for the first time and are thrilled with its fine form. . . .

VIRGINIA S. EIFERT.
Springfield, Ill.

* * *

SIRS:

In happening to glance over a carbon copy of my review of "The Nation's Forests" by William Atherton De Puy [NATURAL HISTORY, November, 1938], I was shocked to notice an omission. Where it read, ". . . approximately ninety percent of all forest fires being caused by the carelessness of 'nature-lovers' ", I meant to say, "approximately ninety percent of all forest fires being manmade, twenty-nine percent of these caused by the carelessness of 'nature-lovers.' "

. . . In skipping this line, I am indeed sorry to say I was more careless than the "nature-lovers."

R. NEUMANN LEFEBVRE.
Seattle, Wash.

* * *

DEAR MR. BARTON:

Because I once wrote a book about masks called "Masks and Demons" and because I am now collecting specimens of this interesting art, I read your article in the November NATURAL HISTORY. Because it was so well written I enjoyed it and, therefore, want to thank you for it.

I wonder if, by any chance, you are a collector of masks or know of any collectors? I have found three. One is a character actor out here, Christian Rub, one is Emil Meier, a lawyer in Chicago, and the other is Mrs. Madeline Langworthy of Berkeley, California.

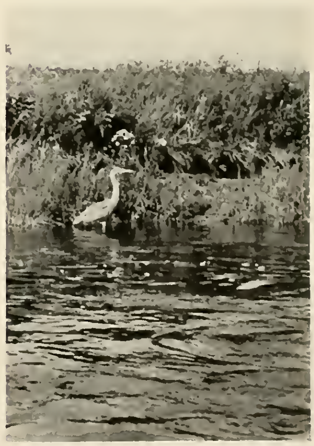
KENNETH MACGOWAN.
Twentieth Century-Fox Film Corporation,
Beverly Hills, California.

* * *

DEAR MR. BARTON:

I have read with much interest in the November issue of NATURAL HISTORY your article ["Of Masks and Man", *The Indoor Explorer*] dealing with the development of drama. One person

Continued on page 390



GREAT BLUE HERON—Taken last summer on the shores of the Allagash River in Maine.

Photograph by Ruth Gray

FILM SPEEDS

By CHARLES H. COLES

Chief Photographer,
American Museum of Natural History

DID you ever try to photograph a black cat at midnight at the bottom of a coal mine? No? Well, even that subject is almost possible with one of the so-called cat's-eye cameras loaded with the latest thing in speed film. Film is many times as sensitive as it was only a few years ago, and manufacturers of exposure meters are calibrating their instruments to take care of expected increases which will be even more sensational.

Even so, the person who only takes occasional snapshots and, hearing about these fast films, rushes out to have his Brownie loaded, will probably expect the impossible. When his films are returned from the finishers and our snapshooter removes one blank film after another from the envelope, he is completely at a loss to explain his failures. Didn't he take the pictures in a well-lighted room? Weren't all of three 60-watt bulbs burning at once? Surely that was enough to work the super-special film he had used, which was especially recommended for indoor pictures. Perhaps he had done something wrong.

Yes, he had done something wrong. He had assumed that his film-camera combination could function with the same amount of light that his eyes required.

The first film speed

Around the turn of the twentieth century, two English research men set out to formulate the laws that govern the reaction of photographic emulsions to light and development. The basic relation that emerged from their mass of experimental data is called the Hurter and Driffield Curve and still forms the basis of all exposure and development analysis. Out of their work grew the now important rating of films according to their speed, or sensitivity.

For a long time the H & D speed rating was the only standard that the photographer had to follow. It was used mainly in England, being ignored by manufacturers here as well as on the continent. Not until the advent and rise to popularity of visual exposure meters did the assignment of film speed become necessary. Inasmuch as the first visual exposure meters were made in Germany, it is natural that a German system was devised to indicate film speeds. Thus the Scheiner system of film rating came into general usage.

The Scheiner Speed

The Scheiner speed of a film is determined in a laboratory by placing the emulsion in question behind a solid wheel that has slots cut into it of various lengths. As the wheel is rotated once at a predetermined speed various parts of the film are exposed through the slots for graduated periods of time to standard illumination. The first slot from the rim gives the film a short exposure to the standard lamp. The fourth slot inward gives the film twice as much exposure. Counting inward three slots doubles the exposure, while the in-between slots give proportional increases. Each step toward the center increases the exposure by the cube root of two, or 1.26.

After the wheel has completed its single rotation the film is developed in a standard manner and examined. The faintest deposit of silver marks the slot which produced the smallest exposure that had a visible effect on the film. The number of the slot is taken as the Scheiner speed number of that film.

Several things should be noted in regard to the Scheiner speed system of film rating. The first is that every third number higher represents a doubling of film speed. The second thing to be recognized is that a speed rating based on the faintest visible deposit merely indicates that at a certain low level of illumination a barely noticeable image will be produced. There is a theoretical objection to this method in that films differ in their contrast characteristics, that is, in the rate at which the image builds up in development, but this usually has little bearing on practical matters. The last thing to be watched is important. There seem to be two Scheiner ratings for each film. One is the Continental and the other the American rating, the first being about four times as high as the latter. It is important, therefore, to know by which system the exposure

Continued on page 394

YOUR NEW BOOKS

CHAPMAN'S TROPICAL NATURE STUDIES • TEN YEARS OF CAVE EXPLORATION • FLAHERTY OF THE NORTH • BIRDS, HERE AND ABROAD • BEHOLD OUR LAND • COLOR PHOTOGRAPHY

LIFE IN AN AIR CASTLE

- - - - - - - - by Frank M. Chapman

D. Appleton-Century Company, $3.00

THIS book may be considered a sequel to Doctor Chapman's *My Tropical Air Castle*. It gives a charming picture of the experiences of a veteran naturalist at the Barro Colorado Island Laboratory in Panama. The style is particularly appropriate to the narrative and leaves nothing to be desired. Doctor Chapman combines a first hand knowledge of the life of tropical forests gathered over a lifetime of travel with an ability to tell his experiences as only few naturalists can. The reader is able to live the events and share the emotions almost as vividly as if actually living in the tropical forest. The fine series of photographs of the birds and mammals, many of them taken at night by flashlight, add reality to the word pictures.

Although the observations of the ever varying life of the forest and shore line of Barro Colorado Island are enchanting and exciting, Doctor Chapman is continually attempting field experiments to enlarge his understanding of the behavior of birds and mammals. His account of the way in which the coati solves the puzzles presented to him, and the way the buzzards find their food under conditions where smell seems to predominate over sight, gives us an indication of the rich addition to knowledge which will come from the field experimenter. The intricate courtship behavior of the Gould's Manakin gives answers to many controversial questions that have been bothering naturalists for years. The precise territorial activities and correlation of structure and color with courtship antics give us a glimpse of the results of evolutionary forces operating on adaptive behavior. Surely the complexity of nervous reactions is comparable to the complexity of structure and is only to be seen by the naturalist with patience and opportunity to study the intimate details of life in the natural environment. Barro Colorado Island obviously offers an opportunity as close to the ideal as has yet been attained, and it is inspiring to see experienced men energetically pointing the way toward a pioneer development on the frontiers of science.

ALFRED E. EMERSON.

THE CAPTAIN'S CHAIR

- - - - - - - - by Robert Flaherty

Charles Scribner's Sons, $2.50

ROBERT FLAHERTY was a prospector in his youth, but the artistic success of his cinematic story of Hudson Bay Eskimo life, *Nanook of the North*, made in 1920-21, turned him from questing out minerals to questing out little-known peoples in far places: he directed superb pictures in the South Seas *(Moana)*, on an island off the west coast of Ireland *(Man of Aran)*, and in Southern India *(Elephant Boy)*. The setting for his new book, however, is the sub-Arctic region in which he did much traveling and exploring prior to filming *Nanook*.

The fly-leaf of *The Captain's Chair* bears the declaration: "The characters in this book are entirely imaginary, and have no relation to any living person." The *leit-motif* is the author's prodigious search for a fabulous Captain Grant, master of a fur trading company's supply ship, who may be able to give him information about an uncharted, mineralized island of the Belcher group and possibly take him to it. The search entails a hazardous inland sled journey from the east coast of Hudson Bay to Ungava Bay, and another journey by canoe from Ungava Bay back through northwestern Quebec to Hudson Bay and thence up to Wolstenholme at the western end of Hudson Strait.

Before, during and after all of this traveling—which is vividly described and based on personal experience—tales of Eskimos' adventures are worked in. Outstanding is the saga of Comock, who loses several members of his party and most of his outfit when the floe-ice on which they are sledging breaks up; and he and his fellow survivors spend ten years on an uninhabited island as a sub-polar Swiss Family Robinson. This is complete in itself, a little book within a book, a poetic gem.

The book is full of close shaves, death and disaster, tense situations; and the final chapters leading to Mr. Flaherty's meeting with Captain Grant grippingly build up an atmosphere of weird, brooding suspense and foreboding.

RICHARD FINNIE.

TEN YEARS UNDER THE EARTH

- - - - - - - - - by Norbert Casteret

The Greystone Press, $3.00

TRANSLATED, edited and supplemented, both as to text and illustrations, by Barrows Mussey, this unusually fascinating volume combines the essential parts of two of the author's books, one of which, bearing the title used above, has been crowned by the French Academy. For all that, we have here not a dry technical description of subterranean wonders but instead a glowing account of Pyrenean cave exploration involving numerous physical hardships and many exciting rewards. As evidence of the latter, the results of the examination of about five hundred caves have shown important bearings on such varied branches of science as geology, hydrography, paleontology, zoology and archaeology.

The book, prefaced by the well-known cave expert, E. A. Martel, opens and closes with two outstanding exploits. One is the story of the exceptionally daring discovery in the Montespan cave, in 1923, of several modeled clay bears, lions and horses of Paleolithic date, as published at the time. The other relates how the long-sought proof was finally obtained that the Garonne River of France has its source on the Spanish side of the Pyrenees, a fact of sufficient economic importance to require diplomatic action. Paleolithic cave art, which M. Casteret's labors have enriched not a little, gets a fair share of attention, but equal or stronger sidelights are thrown on paleontology and zoology. Of the several extinct mammals which frequented the subterranean world the Great Cave Bear is awarded the prize (hitherto held by man) as a cave explorer and it is of interest also to learn that toward the end of his career he often suffered with arthritis. Concerning the bat as a member of the small group of birds and mammals which still frequent caves, we learn the astounding fact that one species migrates between France and Japan! Lastly, we are told that our caves are inhabited by all of a hundred species of organic forms, ranging from protozoans to mammals, besides twenty-three kinds of fishes, all of which have become more or less adapted to permanent underground existence.

The general reader, whether he has ever visited a cave or not, can scarcely fail to find this little book interesting. It is liberally, if not systematically, illustrated, but unfortunately some of the more important pictures are not captioned. The specialist will find in it many valuable facts and suggestions, though perhaps he will be a trifle disturbed by some questionable statements regarding climate, extension of the last glacial advance and Paleolithic chronology. The translation, barring a few errors and inept renderings, seems well done.

N. C. NELSON.

THE WORLD WAS MY GARDEN

- - - - - - - - - by David Fairchild

Charles Scribner's Sons, $3.75

AS the title suggests, this book brings us the story of many adventures, wide explorations, disappointments and worth-while achievements. It is the autobiography of a man who for over twenty years was in charge of the division of Foreign Plant Exploration and Introduction in the United States Department of Agriculture, and who played a very important role in its development.

Doctor Fairchild went to Washington in 1889 at the age of nineteen when the Department of Agriculture boasted of six employees and was housed in one small building. But even in that day momentous things were being discovered. He tells of the thrill on being shown through Theabald Smith's microscope, the first blood parasite known to be carried by an insect —that of the Texas Cattle Fever.

The search for plants that might be successfully grown in America carried the author to Persia, Egypt, Java, Siam, the

Dutch East Indies, the Cannibal Islands, South America, Cuba, Canada, Australia, New Zealand, China, Japan, Corsica, Europe, Africa and other lands. Their soil and climatic conditions in relation to methods of propagation of types of food plants were investigated in the hope that these alien food plants could be transplanted under similar conditions in some part of America.

From Peru he sent seeds of the Omas alfalfa, later renamed Hairy Peruvian, that is an important forage crop in California. From Bohemia came cuttings of "Maliner Kren," a horse-radish at present grown about Camden, N. J. In Alexandria he found "Feterita," sorghums, which are now growing on some 300,000 acres of our irrigated land in the Southwest. Cuttings of Corsican citrus fruits were successfully sent by inserting them in potatoes to give them the required moisture during transport. The, so-called, Chinese cabbage was another of his successful imports. Near Pandua, Italy, he found a seedless raisin grape *Sultania Rosea* from which Doctor A. B. Stout of the New York Botanical Gardens developed a variety that grows well in the Atlantic States.

There were onions from Egypt that thrive in Texas, Egyptian cotton for Arizona, a wild turnip from Finland that finds Alaskan climate similar to its homeland and Tung Oil trees of China now furnish an important industry in Florida. It is estimated that the plant introductions during his time of service amount to something like one hundred million dollars increase a year in economic products.

Over two hundred of his excellent photographs add greatly to the understandability and interest of the book. Among these we find portraits of insects taken through a twenty-five foot long camera, views of the first public flight of Glen Curtis, a number pertaining to the life of Alexander Graham Bell, scenes from the countries he visited, and, of course, great numbers of botanical subjects.

Whether he is describing in his conversational style his experiences with suspicious natives, his prying into the private lives of fungus raising ants of Java, his wooing and winning of Alexander Graham Bell's daughter or any of the events that were part of his arduous and adventurous life, this Agricultural Explorer tells a fascinating story.

FARIDA A. WILEY.

MOUNTAINS OF THE MOON

- - - - - - - - by Patrick M. Synge

E. P. Dutton & Co., $4.00

WERE you suddenly to find yourself on the lower slopes of Mount Ruwenzori in East Africa, you might well think you had wakened in the mountains of the moon. Giant lobelias and groundsels would tower over you, forests of ordinary heather more than fifty feet high would startle you, and you would soon admit that even the mushroom of Alice in Wonderland might be just around the corner.

This is the country that Patrick M. Synge takes us to in his account of the British Museum Expedition of 1934-35. It is the country that H. M. Stanley discovered fifty years ago and the area that the Duke of the Abruzzi visited shortly before the great war. However, this is an entirely new and modern treatment of the "Mountains of the Moon," as Ruwenzori and the surrounding peaks are called. It is the story of botanical exploration and collection in a region where plants attain amazing size; and the tale, fortunately, is told in language never too technical for the average reader.

Mr. Synge tells us of other sections of Africa besides Ruwenzori. We are shown the great tangled papyrus swamps which blocked Roman explorers, and hear of the vegetation on the upper slopes of Mount Kenya. Objects of natural history likewise interest the author. With his camera we find him pursuing the goliath heron and whale-headed stork. He tells also of huge flocks of brilliant flamingoes, of the rock hyrax (a kind of cony) and its unearthly shrieks, and of the tame crocodile of Lake Victoria that was formerly fed on human flesh. There is excitement in the fire which destroyed one camp, and humor in scnes such as the one where little black Toro boys go tobogganing on banana leaves. Here the author missed a good opportunity to parallel the famous ditty.

"Australian boys they have no sleds
They slide down hills on codfish heads."

In *Mountains of the Moon* Synge shows a marked preference for descriptive material. His verbal pictures of individual plants are clear and graphic, and these fortunately more than make up for the structural weakness of the narrative by which he ties together separate episodes of the expedition. Had he treated fewer sections of the country or left out his final chapters on economic life in Uganda of today and tomorrow, his book would hold together better, though it is possible that the very scope of the book will give it greater popular interest. Certainly the photographs and illustrations will everywhere meet with high approval.

If you are interested in unusual plants and people, this book will catch your imagination and make you wish to set out for the "Mountains of the Moon" tomorrow.

R. H. BATES.

BEHOLD OUR LAND

- - - - - - - - - - by Russell Lord

With an introduction by William Allen White

Houghton Mifflin Company, $3.00

UNDER natural conditions, it probably takes from five hundred to a thousand years to develop an inch of rich top-soil. The National Resources Board finds that at least three billion tons of solid soil materials are washed out of the fields and pastures of the United States each year, by water erosion alone. This wholesale loss and destruction of top-soil, "the film of life" is Mr. Lord's subject.

Hugh Bennett, Chief of the U. S. Soil Conservation Service estimates that the United States had 610 million acres either tilled or tillable. Of this area Bennett states "approximately 50 million acres of once fertile land in this country have been essentially ruined for practical cultivation by erosion. Another 50 million acres are in a condition almost as serious. About 100 million acres now in cultivation have been seriously impoverished by loss of soil; and about 100 million acres more of cultivated land are being depleted of productive soil at an alarming rate."

But Mr. Lord writes not only of today. He traces the development of the country —and the destruction of our soil—from the time of the landing of the first settlers. To them, as to the farmer who said: "You can't tell me nothin' about farming; I've wore out two good farms and am working on my third"—land was plentiful and rich soil an asset taken for granted. But even in those early days some there were who saw the dangers of the kind of farming practiced then—as now. In a letter to William Strickland, Esq., in July, 1797, Washington wrote: "Your strictures on the agriculture of this country are but too just. . . . A half, a third, or even a fourth of what we mangle, well wrought and properly dressed, would produce more than the whole under our system of management." Jefferson suggested contour ploughing to prevent soil loss, and Patrick Henry said: "He is the greatest patriot who stops the most gullies."

But it has been during the last decade only that the nation has begun to seriously consider the danger. The land can be, and now is being saved. But it is a long job, patience is needed as well as hard, very hard, work. "Men who have half ruined a stretch of land in twenty years are rarin' now to plunge into reverse and fix up everything in twenty months." The Soil Conservation Service aided by other government agencies and by yeoman-like work by CCC boys—"far too young and ardent to dawdle and lean on shovels"—are beginning to fasten down the top-soil and to educate the agriculturists to the need for conservation. This education has proceeded to the point where the name "non-co-operator" has become an opprobrius term.

But there is so much to be done and so little time. "The work started late. . . . On more permanently established countrysides we have burned out an unbelievable extent of top-soil to the point of immediate ruin. Over most of the country the same process has started, or is well under way. Things are bad, and getting no better fast."

H. E. Vokes.

Color Photography for the Amateur

- - - - - - - - - - by Keith Henney

Whittlesey House
McGraw-Hill Book Co., Inc., $3.50

THIS is the first real book on color photography that has appeared. The author, being an engineer, uses a language that is as concise as it is explicit. He has evidently been through all the processes that he describes and is well aware of the difficulties that await the amateur who is to follow the same methods. The unusual completeness of the instructions is a welcome departure from those in other books that purport to describe color processes but are no more than reprints of the pamphlets distributed by the manufacturers of color printing materials.

The first part of the book is devoted to a discussion of color and light. The theory of the two methods of color reproduction, additive and subtractive, is outlined in a clear and new way aided by novel color sketches. Films and plates are treated with a delightfully scientific approach that is so necessary to the understanding of modern color photography.

The second section of the book deals with transparency-making by all the popular color processes now available. The exposure, development, and finishing of each kind of transparency is described with meticulous detail.

The last part of the book takes up the making of color prints by the four processes now available commercially. Chromatone, Wash-Off Relief, Trichrome Carbro, and Colorstill are taken up step by step. The instructions first include the manufacturer's recommendations which are then followed by the author's observations on how the details work out in actual practice. Practical hints are numerous and effective in clearing up vague points in manipulation. Particularly good are the methods outlined for the conversion of a color transparency into a color print.

Any amateur or, for that matter, any professional photographer who is contemplating making photographic prints with any of the direct color processes could find no better introduction to a fascinating art than that contained in this book.

Charles H. Coles.

Australian Parrots. Their Habits in the Field and Aviary

- - - - - - by Neville W. Cayley

Angus and Robertson Ltd., Sydney and London, 12s. 6d.

THIS book will be popular far beyond Australia, depicting with beautiful colored plates, the charming and exquisitely colored parrots for which that continent is so justly famous. Everyone of the 51 species is described, the range is illustrated on individual maps and a good deal of information is presented on their habits. Particularly attractive to me is the account of the original discovery of each species, incidentally giving some interesting side-lights on the exploration of Australia. Most of the lorilets and parakeets are popular pets and a good portion of the book is devoted to the experiences of the aviculturists, as to how these birds are to be kept and fed. Fortunate Australia to have so many beautiful birds; unfortunate, because some of the finest species are threatened with extinction with the encroachment of civilization. There are a number of slips and inaccuracies throughout the book and the account of the life histories are not as detailed as would be desirable.

E. M.

PATAGONIAN YEAR

- - - - - - - - - by Bruno Nordang

Translated from the Norwegian by Arthur G. Chater

Alfred A. Knopf, $2.75

THIS is an account of the experiences and impressions of an engineer in central Patagonia during the author's second trip there near the close of the World War. At that time high wool prices had so stimulated the sheep raising industry that even the poorest land was being occupied by settlers and the services of a land surveyor were much in demand.

It is entertainingly written, with a frankness and humor one might expect of a Scandanavian; it cannot be recommended for children or even all adults. Other modern books have been criticized by the residents of southern Argentine as over-emphasizing certain phases of the life in the coastal towns and for unnecessary references to some of the people, and this one may be subject to the same comment.

As with all books one likes, there is regret when the end is reached. Personally, we wish that a greater portion of it dealt with the author's experiences afield of which he writes so feelingly. It is too impressionistic to be classed as a reference but it can be recommended on its other merits.

JUNIUS BIRD.

THE BIRD LIFE OF LOUISIANA

- - - - - - by Harry C. Oberholser

State of Louisiana, Department of Conservation

Bulletin No. 28. $1.00

IN a bulky volume of over eight hundred pages, Doctor Oberholser presents us with the most comprehensive work to date on the birds of the state of Louisiana. He recognizes 430 species and subspecies as having occurred in Louisiana, some of them recorded here for the first time, with the total exceeding by 77 forms the number included in the last preceding state list, with an additional 22 forms of doubtful authenticity, here placed in a hypothetical list.

These forms are discussed in varying detail, with occasional brief descriptions, some accounts of habits, and extended treatment of distribution within the state, with the important records or specimens on which such analysis is based.

Although the book obviously will find its largest reading public among the nontechnical bird-lovers and sportsmen of the state of Louisiana, and is in no basic sense a technical treatise on systematic ornithology, Doctor Oberholser has introduced a very large number of taxonomic and nomenclatural problems into his text, which are likely to be very confusing to the general reader. The scientific names of more than a hundred birds as listed in this book differ in some way from the standard usage in the last edition (1930) of the American Ornithologists' Union Check-list of North American Birds which Doctor Oberholser helped to prepare. For most of these changes the author briefly gives his reasons, for others there is mere citation of the check-list name in a footnote, and in a few cases there is no special notice that any alteration has been made.

Quite apart from the validity of these proposals (and the reviewer must confess that he is in full sympathy with Doctor Oberholser on the desirability of a large proportion of them) the present volume seems hardly the place to set them forth. In times past, Doctor Oberholser published in the pages of *The Auk* a series of useful lists of proposed changes in the current A.O.U. Check-list where this technical information was then readily accessible until such time as it was embodied in one or more supplements to the Check-list or in the next edition of the Check-list itself. The present reviewer cannot but wish that Doctor Oberholser had made the present proposals in a similar way and left the pages of his Bird Life of Louisiana free from such controversial matter.

J. T. Z.

BIRDS OF THE PACIFIC STATES

- - - - - - - - - by Ralph Hoffman

Houghton Mifflin Company, $3.50

THIS appears to be an exact reprint of the volume of the same title that appeared in 1927, without the revisions that might properly have been made to bring the nomenclature into accord with the 1930 edition of the A.O.U. Check-list of North American Birds or to add such items of information on the birds of the Pacific states as may have been put on record in the last decade.

Aside from this needed improvement, the book retains its value as an excellent handbook for students of the far western birds. Emphasis is placed on species rather than subspecies and when more than one geographical form of any species is found in the region, the distribution of each form is noted but the descriptive matter is generalized for the species as a whole. The result is a concise delineation that should be appreciated by the field observer for whom the book is intended and should smooth the path of the beginner in western bird study who is trying to familiarize himself with the appearance of the various species in his part of the country.

J. T. Z.

THE LYRE BIRD, AUSTRALIA'S WONDER SONGSTER

- - - - - - - - by R. T. Littlejohns

Angus and Robertson Ltd., Sydney and London, 4s. 6d.

IF the Lyre bird was an inhabitant of the British woods, it might easily occupy the place in literature now being held by the nightingale. As it is, the species is justly famous in Australia, but not as well known generally as it deserves. The Lyre bird has two attributes the nightingale lacks, a remarkable "dance" during which his bizarre tail plumage is displayed (somewhat in the fashion of the peacock), and an uncanny ability to imitate other songsters, in fact, any sound in his haunts. A broadcast of the mimicking song performance of this species directly from its native habitat is one of the most popular features of the Australian Broadcasting Corporation. The descriptive text and the superb plates of the present book will help to spread the popularity of the Lyre bird. The photographs illustrate the forest, in which he lives, its dancing grounds, the dance, the nest, and some of the song birds most frequently imitated. Altogether a very commendable publication. E. M.

Stars to Windward

by Bruce and Sheridan Fahnestock

Harcourt, Brace and Company, $3.00

STARS to Windward! If you have never sailed the briny sea in all its glory and its anguish; if you've never stood before the wheel for hours on end, rain slashing your face in fury, the salt brine whipping into the cuts and stinging like the lash of a thousand whips in your face; if you've never faced the sea in its fury, your clothes frozen stiff, your arms aching as though some insidious devil were prodding you as each sea washed over and turned your bow into a seething cauldron of foaming white which all but carried you whirling into the maelstrom it created; if you have never stood there, stiff, staring, hoping, praying; then stars to windward mean nothing. Only the mariner who has experienced these things knows. Stars to Windward! The storm is ended! With those stars come the dying wind, the rhythmic roll of the ship on a dying sea, peace, a prayer of thankfulness, a rest well earned. Such is the life of a sailor.

Yes, such is the life of a sailor: but what of three kids who started out of New York something over three years ago, on a New Year's Day, their spirits high, their ego untamed by the experiences that must befall all adventurers upon the sea that knows no mercy. They were simple and trusting kids, and I liked them because they were that way. They had begged me to come with them: had offered me every inducement. I had responsibilities that could not be cast aside. I stayed home.

The spirit of youth is insurmountable. The spirit of adventure never dies. If this spirit should die there would never be a cruise to equal that of *Director*. There will be other cruises but I doubt if there will be any in which the young adventurers set forth their experiences in the way that the owners of the *Director* have done. Theirs is a free, racy style that carries the reader along with them, that causes him to experience all the things that they have experienced, to glory with them, and to suffer with them, to starve, and to gorge upon all the good things of the earth, to lie disconsolate and irritable, a thousand miles from land, and to yell oneself hoarse upon sight of a single bit of green. There is something uncanny about their book: something that holds you, and carries you with them, be you sailor or landsman. Let me quote from it.

"I stood in a garden surrounded by ten-foot walls of coral, alive in color with the movement of a thousand living, pulsating sea animals stirring beside me. . . . Into that light came what I have had nightmares about since I first saw the picture of one in my geography book. An octopus.

"My first instinct was to waste no more time in this world in which I was sure now I didn't belong at all. . . . But the octopus was small, just a baby. . . . He walked . . . but he did not walk. He did so many things at once that slow motion would not have been slow enough to catch his multipedal movement. At any rate the bad dream went out of the picture. . . ."

"I stooped and slowly moved ahead. . . . I never took my eyes off that oyster after it closed. That shell, and that shell alone, was the one I wanted. . . . I'd seen a pearl as big as my fist. . . .

"I felt something small and pulled it out. Everyone laughed. For there, in the palm of my hand, winking a tiny ray of gold at me, laughing a little, too, I suppose, was the smallest seed pearl I'd ever seen!"

We can do no better than continue with the tale:

"Mepula told us what to bring when we came again some day. Then he asked us what we wanted from his Island—what he and his people could give us in return for our kindness. We longed to have samples of all their implements, their strange snakelike chief money and their dance decorations. . . . In an hour, while we explained to Mepula that all these things would be put in a big house in our country for all our friends to see, several canoes came back with the things we wanted. (These are now in the American Museum of Natural History.) Mepula said goodbye. He asked us to return—certainly we were the first ship ever asked to come back to Ndeni. Most others have left with a flight of arrows whistling in the air around them."

Schooner Mary is a strange character. She is not a ship. She is the mother of the authors. She joined them in Tahiti and again in China. Her part in the story is rather incidental but everyone who reads the book cannot fail to realize what she means to each and every one of the adventurers. She was a goddess to them, just as she was a goddess to the Oceanians who had never before seen a white woman. You can imagine her out there, sitting on the deck surrounded by cannibals—but then, you don't know Mrs. Fahnestock. She was scared stiff, but she wouldn't show it, and her sons do not know it now. Her only fear was that she might spoil their expedition—their young dreams. Without such a mother the Fahnestock expedition would never have achieved success, and this, I think, is apparent in the record of their travels.

This is a book that you and I can read time after time and each time we read it we shall find something new and invigorating. Perhaps you'll love the soft-voiced maidens of Tahiti, the dusky-skinned savages of Ndeni, the brown-skinned nurses of the Philippines, the slant-eyed girls of Peking, the dour chiefs of the South Seas, or just the tang of the salty breezes on your face. Whatever it is that lends spirit to your slumbering soul you'll find it in *Stars to Windward.*

C. H. CURRAN.

THE MAMMALS OF CHINA AND MONGOLIA

Natural History of Central Asia, Vol. XI, Part I

- - - - - - by G. M. Allen, Ph. D.

American Museum of Natural History, New York, 1938

THIS scholarly and entertaining work, eagerly awaited by those who knew of its preparation, fills a long-felt need among students and laymen who are interested in the biology of China. Its appearance seems particularly apt in these times of strife when the old régime of the "Celestial Empire" is fighting for its life and the activities of a new human administration over vast areas of the country may in the future conceivably bring about local, minor modifications in the fauna.

After offering the reader a historical résumé of the work of collectors of mammals in China, from Marco Polo to the members of the First, Second and Third (The Central Asiatic) expeditions, headed by Dr. Roy Chapman Andrews, Doctor Allen discusses in two succeeding chapters the Faunal Areas of China and the faunistic relationships between China and North America. Thereafter the mammalian orders, Insectivora (tupaias, shrews, moles and hedgehogs), Chiroptera (bats), Pinnipedia (seals), Cetacea (whales and porpoises), Nomarthra (pangolins), and part of the Rodentia (hares and their allies) are successively given detailed consideration.

Seven named faunal areas are shown by the author to enter into the zoogeographical composition of China: The Northern Forest, the Gobi, North China, South China, the Western Highlands, the Subtropical, and the Tibetan Plateau. Under each head Allen sketches the extent and characteristics of the area and comments upon its distinctive mammals. The reader's comprehension of general faunal conditions would have been facilitated if a zoogeographical map had accompanied that chapter.

Intercourse between the faunas of China and America has been moderately free only for Northern Mongolia and the Northern Forest, according to Allen. The more southerly portions of the country present only distant relationship with America or none at all. Even in the northern regions Allen points out a number of anomalous distributional conditions. Passage of mammals to and fro took place by way of land connections across the Bering Sea. The most recent union of Asia and America seems to have occurred in Pleistocene time; an earlier one possibly during the Pliocene. After such connections were established their south shores had a milder climate than today, due to the warming effects of the Japan Current and exclusion of Arctic waters.

The distribution maps by means of which the geographical ranges of twenty-four genera can be studied, though they "indicate the range of each in only the most general way," are valuable in giving the reader a visual conception of the relations of those genera to a little understood region of enormous area—Doctor Allen treats of a portion of the Earth's surface "roughly some 2000 miles square." On those maps the place names might with advantage have been set in larger type.

The quality of the halftones is of a high order. Their selection shows the author's desire both to illustrate typical life-zone conditions in various parts of China and to depict species of mammals either seldom illustrated or in attitudes rarely recorded.

A valuable feature of the book is the complete bibliography carried through to the year 1936. The usefulness of that list of references is enhanced by inclusion of papers pertinent not only to the orders of mammals treated in Volume I but also to the Rodents and Ungulates which will be dealt with in Volume II.

Doctor Allen is to be congratulated upon the successful completion of an exceptionally fine piece of research which involved an enormous amount of preliminary labor. We close with the hope that the second and concluding volume of *The Mammals of China and Mongolia* will appear in the near future.

G. H. H. TATE.

LETTERS

Continued from page 381

that to me is entitled to much greater recognition than is generally given her is Hrotsvitha. You may have omitted mention of her because of the brevity of the article or possibly her existence may have escaped your studies. In any case I am taking the liberty of sending you a copy of POET LORE in which I had an article dealing with her. I trust that it may be of interest to you.

JOHN HEARD.

8 Arlington St.
Boston, Mass.

* * *

Hrotsvitha, a 10th century Saxon nun who wrote plays for monastic production, was the subject of illuminating researches by Mr. Heard, writer of the foregoing letter and at present editor of the 49-year-old publication POET LORE. Two of her plays, translated from the Church Latin by Mr. Heard, together with an explanatory article, appear in POET LORE for the spring of 1935.

In his article Mr. Heard points out the significance of this little-known ecclesiastical playwright of the Dark Ages. Referred to by some as a Christian Sappho, her work, in the opinion of Mr. Heard and others, represents the only cultured dramatic expression of the Western World from the death of Terrence (159 B.C.) to the birth of the modern theater (about 1500). Thus in Mr. Heard's own words: "Hrotsvitha . . . and her work stand out preëminent, if not unique, almost in the middle of a span of ten centuries of literary drought. Who [else] in the world of letters occupies [a comparable] position?"

—ED.

Who · *When* · *Where*

DECEMBER CALENDAR OF ENTERTAINMENT

On these pages will be found a calendar of museum events in metropolitan New York for December. It is hoped that this list will enable those at a distance who contemplate a visit to New York to plan more efficiently, and that those who live in or near the city may be able to choose lectures and other activities that fit their needs or interests.

CHARLES RUSSELL,
Curator of the Department of Education, American Museum of Natural History

General Information

AMERICAN MUSEUM OF NATURAL HISTORY
Central Park West at 79th Street, New York City
Hours: Daily 9:00 a. m. to 5:00 p. m. Sunday 1:00 p. m. to 5:00 p. m. Open holidays 9:00 a. m. to 5:00 p. m. Admission Free.
Exhibitions of gems, human and animal habitat groups, prehistoric creatures, and fossil arrangements showing evolution.

AQUARIUM
Battery Park, New York City
Hours: Daily 9:00 a. m. to 5:00 p. m. Admission Free.
Collections of living aquatic animals; fresh-water and marine, principally fishes but including other groups.

BROOKLYN BOTANIC GARDEN
1000 Washington Avenue, Brooklyn
Hours: Daily from 9:00 a. m. until dark. Sundays from 10:00 a. m. Conservatories open from 10:00 a. m. until 4:00 p. m. Admission Free.
Rose garden; wild flower, Japanese rock, and wall gardens; horticultural displays; conservatories.

BROOKLYN MUSEUM
Eastern Parkway and Washington Avenue, Brooklyn
Hours: Daily 10:00 a. m. to 5:00 p. m. Saturdays and holidays 10:00 a. m. to 6:00 p. m. Sundays 2:00 p. m. to 6:00 p. m.
Admission Free except Mondays and Fridays, when charge is 25¢ for adults and 10¢ for children.
Arts of the world arranged in chronological and geographical order to illustrate the history of cultures.

THE CLOISTERS
Fort Tryon Park (190th Street Subway Station) New York City
Hours: Daily 10:00 a. m. to 5:00 p. m. Saturdays and holidays 10:00 a. m. to 5:00 p. m. Sundays 1:00 p. m. to 5:00 p. m.
Admission Free, except Mondays and Fridays, when charge is 25¢.
Branch of the Metropolitan Museum of Art devoted to European medieval art.

FRICK COLLECTION
1 East 70th Street, New York City
Hours: Weekdays 10:00 a. m. to 5:00 p. m. Sundays 1:00 p. m. to 5:00 p. m. Admission Free.
14th-19th century paintings, Renaissance bronzes, Limoges enamels, Chinese and French porcelains, period furniture.

METROPOLITAN MUSEUM OF ART
Fifth Avenue and 82nd Street
New York City
Hours: Daily 10:00 a. m. to 5:00 p. m. Saturdays and holidays 10:00 a. m. to 5:00 p. m. Sundays 1:00 p. m. to 5:00 p. m.
Admission Free, except Mondays and Fridays, when charge is 25¢.
Collections of Egyptian, Classical, Oriental, European, and American art—paintings, prints, sculpture and decorative arts.

MUSEUM OF THE AMERICAN INDIAN
Broadway and 155th Street
New York City
Hours: Daily 2:00 p. m. to 5:00 p. m. Sunday 1:00 p. m. to 5:00 p. m. Admission Free.
Anthropological collections from the aboriginal inhabitants of North, Central, and South Americas, and West Indies.

MUSEUM OF THE CITY OF NEW YORK
Fifth Avenue and 103rd Street
New York City
Hours: Daily 10:00 a. m. to 5:00 p. m. Saturdays and holidays 10:00 a. m. to 6:00 p. m. Sundays 1:00 p. m. to 6:00 p. m. Closed Tuesdays. Admission Free, except Monday, when charge is 25¢.
Exhibits of the chronological development of New York City life from earliest times to the present.

MUSEUM OF MODERN ART
11 West 53rd Street, New York City
Hours: Daily 10:00 a. m. to 6:00 p. m. Sundays 12:00 m. to 6:00 p. m.
Admission Free on Monday, other days 25¢.
Art of today—showing American and European painting, sculpture, architecture, industrial art, photography, motion pictures.

MUSEUM OF SCIENCE AND INDUSTRY
RCA Building, Radio City, New York City
Hours: Daily 10:00 a. m. to 10:00 p. m. including Sundays and holidays. Admission 25¢. (Free to New York City teachers with classes upon application to the Educational Department of the Museum.)
Exhibits in transportation, communications, power, food, housing, electro-technology and other scientific and industrial fields.

NEW YORK BOTANICAL GARDEN
Bronx Park, Bronx, N. Y.
Hours: Museum and Conservatories open daily 10:00 a. m. to 4:30 p. m. Admission Free.
Extensive greenhouses, outdoor plantings, floral displays and museum collections of economic, drug and fossil plants.

STATEN ISLAND MUSEUM
Stuyvesant Place and Wall Street
St. George, Staten Island
Hours: Daily 10:00 a. m. to 5:00 p. m. Sunday 2:00 p. m. to 5:00 p. m. Admission Free.
Collections in science, art and history, especially relating to Staten Island.

WHITNEY MUSEUM OF AMERICAN ART
8-12 West 8th Street, New York City
Hours: Daily 10:00 a. m. to 6:00 p. m. Sunday 2:00 p. m. to 6:00 p. m. Closed Monday. Admission Free.
Collection of sculpture, painting, watercolors, drawing and prints by American artists.

DECEMBER 1

AMERICAN MUSEUM OF NATURAL HISTORY
8:15 p. m.—Lecture—"Wilderness Wanderers," by Wendell Chapman—Auditorium—Open to members.*

METROPOLITAN MUSEUM OF ART
11:00 a. m.—Lecture—"The Mediaeval Point of View," by Mr. Grier—Classroom D—Open to public.
3:00 p. m.—Lecture—"Design and Color: French Decorative Art," by Miss Cornell—Classroom K—Open to public.

MUSEUM OF THE CITY OF NEW YORK
3:30 p. m.—Lecture—"The English Colony, New York," by Aileen G. Barlow—Auditorium—Open to public.

DECEMBER 2

AMERICAN MUSEUM OF NATURAL HISTORY
10:30 a. m.—Lecture—"Prehistoric Animals," by John R. Saunders—Auditorium—Open to public.

* *(Membership of $10 per annum and over)*

GUIDE SERVICE

The following institutions offer free lecture tours of their collections:

AMERICAN MUSEUM OF NATURAL HISTORY
Wednesdays, Fridays and Saturdays at 11:00 a. m. and 3:00 p. m. Meeting Place: 2nd Floor, Roosevelt Memorial.

METROPOLITAN MUSEUM OF ART
Tuesday at 12:00 m., Wednesday and Thursday at 2:00 p. m. Meeting Place: Main Hall.

MUSEUM OF MODERN ART
Daily at 11:00 a. m., 1:30 p. m., 3:00 p. m., and 4:30 p. m.

DECEMBER 3

AMERICAN MUSEUM OF NATURAL HISTORY
2:00 p. m.—Lecture and motion picture—"Elephants," by William L. Smith—Auditorium—Open to public.

BROOKLYN MUSEUM
11:00 a. m.—Concert—Gramercy Chamber Trio—Sculpture Court—Open to public.
2:00 p. m.—Lecture—"History of Music and Its Parallels in Visual Art," by David LeVita—Classroom A—Open to public.
3:00 p. m.—Syrian and Mexican Folk Festival—Sculpture Court—Open to public.

METROPOLITAN MUSEUM OF ART
11:00 a. m.—Lecture—"Sluter and Burgundian Realism," by Mr. Grier—Main Hall—Open to public.
11:00 a. m.—Lecture—"Flemish Print Makers," by Miss Abbot—Lecture Hall—Open to public.
2:00 p. m.—Lecture—"France and England: an XVIII Century Contrast," by Mrs. Fansler—Main Hall—Open to public.
2:30 p. m.—Motion Picture—"Digging into the Past: The Daily Life of the Egyptians—Ancient and Modern"—Lecture Hall—Open to public.

3:00 p. m.—Lecture for the Deafened Who Read the Lips—"Jean Baptiste Simeon Chardin," by Jane B. Walker—Classroom B—Open to public.

4:00 p. m.—Lecture—"Chinese Landscape Painting," by George Rowley, Princeton University—Lecture Hall—Open to public.

MUSEUM OF THE CITY OF NEW YORK

1:15 p. m.—Motion picture—"The Life of George Washington"—Auditorium—Open to public.

3:00 p. m.—Lecture—"Fires and Fire Fighting," by Estelle Donin—Meet at Information Desk—Open to public.

NEW YORK BOTANICAL GARDEN

3:00 p. m.—Lecture—"From the Andes Down the Amazon," by Dr. A. C. Smith—Open to public.

DECEMBER 4

BROOKLYN MUSEUM

2:30 p. m.—Organ Recital by Robert Bedell—Sculpture Court—Open to public.

3:00 p. m.—Motion picture—"Winter Sports in Finland"—Classroom A—Open to public.

4:00 p. m.—Concert—New York State Symphonic Band—Sculpture Court—Open to public.

FRICK COLLECTION

3:00 p. m.—Concert—Friends of Ancient Instruments—Lecture Room—Admission by free ticket secured on request.

METROPOLITAN MUSEUM OF ART

2:00 p. m.—Lecture—"France and England: an XVIII Century Contrast," by Mrs. Fansler—Main Hall—Open to public.

2:30 p. m.—Motion picture—"Behind the Scenes in the Metropolitan Museum; The Making of a Bronze Statue"—Lecture Hall—Open to public.

2:30 p. m.—Lecture—"The Cesnola Collection of Cypriote Art," by Mr. Shaw—Main Hall—Open to public.

3:00 p. m.—Lecture—"Interior Design: Apartments," by Miss Cornell—Classroom K—Open to public.

4:30 p. m.—Lecture—"Ingres and the Classical Tradition," by Walter Pach—Lecture Hall—Open to public.

MUSEUM OF THE CITY OF NEW YORK

3:30 p. m.—Lecture—"Trees of New York City," by Dr. Harold M. Moldenke—Auditorium—Open to public.

DECEMBER 6

AMERICAN MUSEUM OF NATURAL HISTORY

3:00 p. m.—Lecture—"Digging for Dinosaurs," by Dr. Barnum Brown—Auditorium—Open to public.

8:15 p. m.—Forum—"The Origin and Biology of Man," by Dr. Harry L. Shapiro—Roosevelt Memorial Lecture Hall—Open to members.*

METROPOLITAN MUSEUM OF ART

11:00 a. m.—Lecture—"The Painter's Use of Color: Color in Composition, I," by Miss Cornell—Classroom K—Open to public.

2:30 p. m.—Motion Picture—"Tapestries and How They Are Made; The Making of a Stained Glass Window"—Lecture Hall—Open to public.

3:00 p.m.—Lecture—"Interior Design: Textiles," by Miss Cornell—Classroom K—Open to public.

DECEMBER 7

FRICK COLLECTION

3:00 p. m.—Lecture—"English Painting in the Collection," by Dr. Ritchie—Lecture Room—Open to public.

METROPOLITAN MUSEUM OF ART

11:00 a. m.—Lecture—"Rugs of Nomadic Origin," by Miss Duncan—Main Hall—Open to public.

4:00 p. m.—Lecture—"Cabinetmakers: The Period of Louis XVI," by Miss Bradish—Main Hall—Open to public.

MUSEUM OF THE CITY OF NEW YORK

3:30 p. m.—Motion picture—"Queen of the Waves"—Auditorium—Open to public.

DECEMBER 8

FRICK COLLECTION

3:00 p. m.—Lecture—"Dutch Painting in the Collection," by Mr. Arnason—Lecture Room—Open to public.

METROPOLITAN MUSEUM OF ART

11:00 a. m.—Lecture—"The Tale of Troy in the Middle Ages," by Mr. Grier—Classroom D—Open to public.

3:00 p. m.—Lecture—"Design and Color: French Decorative Art," by Miss Cornell—Classroom K—Open to public.

MUSEUM OF THE CITY OF NEW YORK

3:30 p.m.—Lecture—"Revolutionary New York," by Harriett Freedman—Auditorium—Open to public.

DECEMBER 9

AMERICAN MUSEUM OF NATURAL HISTORY

10:30 a. m.—Lecture—"Modern Explorers," by Georgine Mastin—Auditorium—Open to public.

FRICK COLLECTION

3:00 p. m.—Lecture—"French Painting, 19th Century, in the Collection," by Dr. Ritchie—Lecture Room—Open to public.

PLANETARIUM

Schedule for December

★

"Stars Over Bethlehem"

Weekdays—2:00, 3:30, and 8:30 P. M.

Saturdays—11:00 A. M., 1:00, 2:00, 3:00, 4:00, 5:00 and 8:30 P. M.

Sundays and Holidays—2:00, 3:00, 4:00, 5:00 and 8:30 P. M.

General Admission Afternoons	25¢
Reserved Seat "	50¢
General Admission Evenings	35¢
Reserved Seat "	60¢

General Admission for Children under 17, accompanied by adults, 15¢ at all times. (No reduced price for reserved seats occupied by children). Children under 5 not admitted. Doors close on the hour. Special facilities for the hard of hearing.

DECEMBER 10

AMERICAN MUSEUM OF NATURAL HISTORY

10:30 a. m.—Nature Talk—"Native Alaska," by Nutchuk—Auditorium—Open to children of members.*

2:00 p. m.—Motion picture and lecture—"The Silent Enemy," by Georgine Mastin—Auditorium—Open to public.

BROOKLYN MUSEUM

11:00 a. m.—Concert—Gramercy Chamber Trio—Sculpture Court—Open to public.

2:00 p. m.—Lecture—"History of Music and Its Parallels in Visual Art," by David LeVita—Classroom A—Open to public.

3:00 p. m.—Ukrainian Folk Festival—Sculpture Court—Open to public.

FRICK COLLECTION

3:00 p. m.—Lecture—"The Art of the Late Renaissance," by Mr. Arnason—Lecture Room—Open to public.

METROPOLITAN MUSEUM OF ART

11:00 a. m.—Lecture—"The Gothic Style in England and Germany," by Mr. Grier—Main Hall—Open to public.

11:00 a. m.—Lecture—"The Etchings of Rembrandt," by Miss Abbot—Lecture Hall—Open to public.

2:00 p. m.—Lecture—"American Painting of the XIX Century," by Mr. Busselle—Main Hall—Open to public.

2:30 p. m.—Motion Picture—"The Pottery Maker; The American Wing"—Lecture Hall—Open to public.

4:00 p. m.—Lecture—"The Sculpture from the Athenian Agora," by T. Leslie Shear, Princeton University—Lecture Hall—Open to public.

MUSEUM OF THE CITY OF NEW YORK

1:15 p. m.—Motion Picture "Columbus"—Auditorium—Open to public.

3:00 p. m.—Lecture—"Costumes of Old New York," by Mary Leola Gaffney—Meet at Information Desk—Open to public.

NEW YORK BOTANICAL GARDEN

3:00 p. m.—Lecture—"The Plants Used by American Indians," by Mr. G. L. Wittrock—Open to public.

DECEMBER 11

BROOKLYN MUSEUM

2:30 p. m.—Organ recital by Robert Bedell—Sculpture Court—Open to public.

3:00 p. m.—Motion Picture—"Making of an Etching"—Classroom A—Open to public.

4:00 p. m.—Concert—New York State Symphonic Band—Sculpture Court—Open to public.

FRICK COLLECTION

3:00 p. m.—Lecture—"Chinese Landscape Painting," by George Rowley, Princeton University—Lecture Room—Admission by ticket which may be secured free upon application.

METROPOLITAN MUSEUM OF ART

2:00 p. m.—Lecture—"American Painting of the XIX Century," by Mr. Busselle—Main Hall—Open to public.

2:30 p. m.—Motion Picture—"The Etcher's Art; Drypoint—a Demonstration"—Lecture Hall—Open to public.

2:30 p. m.—Lecture—"Chinese Jade, Early and Late," by Miss Duncan—Main Hall—Open to public.

3:00 p. m.—Lecture—"Architectural Backgrounds," by Francis H. Lenygon—Classroom K—Open to public.

4:30 p. m.—Lecture—"The Stamp Tax and Boston Port Bill in English Cartoons," by R. T. H. Halsey—Lecture Hall—Open to public.

MUSEUM OF THE CITY OF NEW YORK

3:30 p. m.—Lecture—"The Cloisters and the New York Public," by James J. Rorimer—Auditorium—Open to public.

DECEMBER 13

AMERICAN MUSEUM OF NATURAL HISTORY

3:00 p. m.—Lecture—"Prehistoric Man," by Dr. Nels C. Nelson—Auditorium—Open to public.

METROPOLITAN MUSEUM OF ART

11:00 a. m.—Lecture—"The Painter's Use of Color: Color in Composition, II," by Miss Cornell—Classroom K—Open to public.

2:30 p. m.—Motion picture—"The Making of Wrought Iron; The Pilgrims (Yale Chronicles of America Photoplay)"—Lecture Hall—Open to public.

3:00 p. m.—Lecture—"Interior Design: Ceramics," by Miss Cornell—Classroom K—Open to public.

DECEMBER 14

FRICK COLLECTION

3:00 p. m.—Lecture—"Piero della Francesca, Type of the Renaissance Man," by Mr. Arnason—Open to public.

METROPOLITAN MUSEUM OF ART

11:00 a. m.—Lecture—"Rugs of Imperial Origin," by Miss Duncan—Main Hall—Open to public.

4:00 p. m.—Lecture—"Cabinetmakers: The Period of Adam, Hepplewhite, and Sheraton," by Miss Bradish—Main Hall—Open to public.

MUSEUM OF THE CITY OF NEW YORK

3:30 p. m.—Motion picture—"New York, a City of Waterways"—Auditorium—Open to public.

DECEMBER 15

AMERICAN MUSEUM OF NATURAL HISTORY

8:15 p. m.—Lecture—"The American Museum in Action," by Roy Chapman Andrews—Auditorium—Open to members.*

FRICK COLLECTION

3:00 p. m.—Lecture—"French Painting, 18th Century in the Collection," by Dr. Ritchie—Lecture Room—Open to public.

METROPOLITAN MUSEUM OF ART

11:00 a. m.—Lecture—"Classic Myths in Mediaeval Story," by Mr. Grier—Classroom D—Open to public.

3:00 p. m.—Lecture—"Design and Color: French Decorative Art," by Miss Cornell—Classroom K—Open to public.

MUSEUM OF THE CITY OF NEW YORK

3:30 p. m.—Lecture—"New York in the Federal Period," by Aileen G. Barlow—Auditorium—Open to public.

DECEMBER 16

AMERICAN MUSEUM OF NATURAL HISTORY

10:30 a. m.—Lecture—"Animals that have Changed Maps," by Irene Cypher—Auditorium—Open to public.

* *(Membership of $10 per annum and over)*

* *(Membership of $10 per annum and over)*

* *(Membership of $10 per annum and over)*

Frick Collection

3:00 p. m.—Lecture—"Italian Painting in the Collection," by Mr. Arnason—Lecture Room—Open to public.

DECEMBER 17

American Museum of Natural History

2:00 p. m.—Lecture and motion picture—"Beavers," by Grace F. Ramsey—Auditorium—Open to public.

Brooklyn Museum

11:00 a. m.—Concert—Gramercy Chamber Trio—Sculpture Court—Open to public.

2:00 p. m.—Lecture—"History of Music and Its Parallels in Visual Art," by David LeVita—Classroom A—Open to public.

3:00 p. m.—Christmas Carol Program—Sculpture Court—Open to public.

Frick Collection

3:00 p. m.—Lecture—"French Painting, 19th Century, in the Collection," by Dr. Ritchie—Lecture Room—Open to public.

Metropolitan Museum of Art

11:00 a. m.—Lecture—"The Pisani and the Beginnings of the Renaissance," by Mr. Grier—Main Hall—Open to public.

11:00 a. m.—Lecture—"Other XVII Century Developments," by Miss Abbot—Lecture Hall—Open to public.

2:00 p. m.—Lecture—"French Painting of the XIX Century," by Mrs. Fansler—Main Hall—Open to public.

2:30 p. m.—Motion picture—"The Temples and Tombs of Ancient Egypt; A Visit to the Armor Galleries"—Lecture Hall—Open to public.

4:00 p. m.—Lecture—"Sparta," by A. J. B. Wace, Cambridge University—Lecture Hall—Open to public.

Museum of the City of New York

1:15 p. m.—Motion picture—"Yorktown"—Auditorium—Open to public.

3:00 p. m.—Lecture—"The Indian and Dutch Period," by Robert Russell—Meet at Information Desk—Open to public.

New York Botanical Garden

3:00 p. m.—Lecture—"Garden Books for Gifts," by Miss Elizabeth Hall—Open to public.

Staten Island Museum

8:30 p. m.—Lecture—"Scanning Venezuela by Sea, Land and Air," by Ralph W. Nauss, M.D.—Open to public.

DECEMBER 18

Brooklyn Museum

2:30 p. m.—Organ Recital by Robert Bedell—Sculpture Court—Open to public.

3:00 p. m.—Motion picture—"China's Home Life"—Classroom A—Open to public.

4:00 p. m.—Concert—New York State Symphonic Band—Sculpture Court—Open to public.

Frick Collection

3:00 p. m.—Concert—Coolidge Quartet—Lecture Hall—Admission by free ticket secured on request.

Metropolitan Museum of Art

2:00 p. m.—Lecture—"French Painting of the XIX Century," by Mrs. Fansler—Main Hall—Open to public.

2:30 p. m.—Motion picture—"Digging into the Past; The Daily Life of the Egyptians—Ancient and Modern"—Lecture Hall—Open to public.

2:30 p. m.—Lecture—"The Message of the Angel," by Miss Abbot—Main Hall—Open to public.

3:00 p. m.—Lecture—"Furniture Design," by Edward Warwick—Classroom K—Open to public.

4:30 p. m.—Lecture—"The Relations of Ancient Egypt with Syria and Palestine," by Ludlow Bull—Lecture Hall—Open to public.

Museum of the City of New York

3:30 p. m.—Lecture—"Holidays of Old New York," by Aileen G. Barlow—Auditorium—Open to public.

* *(Membership of $10 per annum and over)*

DECEMBER 20

American Museum of Natural History

3:00 p. m.—Lecture—"Reactions in Plants and Animals," by John R. Saunders—Auditorium—Open to public.

8:15 p. m.—Forum—"The Origin and Biology of Man," by Dr. Harry L. Shapiro—Roosevelt Memorial Lecture Hall—Open to members.*

Metropolitan Museum of Art

11:00 a. m.—Lecture—"The Painter's Use of Color: Method and Material, I," by Miss Cornell—Classroom K—Open to public.

2:30 p. m.—Motion picture—"Behind the Scenes in the Metropolitan Museum; Drypoint—a Demonstration"—Lecture Hall—Open to public.

3:00 p. m.—Lecture—"Interior Design: Wood," by Miss Cornell—Classroom K—Open to public.

SPECIAL EXHIBITS

OLD NEW YORK as captured by the celebrated engravers—Currier & Ives—is the subject of an exhibit of these pictures opening December 14th at the Museum of the City of New York.

•

CHRISTMAS SEASON is heralded by two current exhibits. The Christmas Story in Art is on view in Gallery E 15 of the Metropolitan Museum from December 17th through January 1st. Christmas Toys from Many Lands can be seen on the Balcony of the Brooklyn Museum from December 3rd to January 1st.

•

THE HISTORY of the New York Stock Exchange will be depicted by a new permanent exhibit at the Museum of the City of New York. Created shortly after the American Revolution, the history of the stock exchange is the history of the United States itself. Especially interesting to New Yorkers are the changes in the City depicted from the days when a buttonwood tree grew in front of numbers 68 and 70 Wall Street to the present day.

DECEMBER 21

Frick Collection

3:00 p. m.—Lecture—"Holbein, Humanist and Realist," by Dr. Ritchie—Open to public.

Museum of the City of New York

3:30 p. m.—Motion picture—"A Highway to the Sea"—Auditorium—Open to public.

DECEMBER 22

Frick Collection

3:00 p. m.—Lecture—"Dutch Painting in the Collection," by Mr. Arnason—Open to public.

Museum of the City of New York

3:30 p. m.—Lecture—"New York in the Gay Nineties," by Martha A. Dodd—Auditorium—Open to public.

DECEMBER 23

Frick Collection

3:00 p. m.—Lecture—"Spanish Painting in the Collection," by Dr. Ritchie—Lecture Room—Open to public.

DECEMBER 24

Brooklyn Museum

11:00 a. m.—Concert—Gramercy Chamber Trio—Sculpture Court—Open to public.

2:00 p. m.—Lecture—"History of Music and Its Parallels in Visual Art," by David LeVita—Classroom A—Open to public.

3:00 p. m.—Christmas Music—Sculpture Court—Open to public.

Frick Collection

3:00 p. m.—Lecture—"Piero della Francesca, Type of the Renaissance Man," by Mr. Arnason—Open to public.

Metropolitan Museum of Art

2:30 p. m.—Motion picture—"The Pottery Maker; The American Wing"—Lecture Hall—Open to public.

DECEMBER 25

Metropolitan Museum of Art

2:30 p. m.—Motion picture—"Tapestries and How They Are Made; The Making of a Stained-Glass Window"—Lecture Hall—Open to public.

DECEMBER 27

American Museum of Natural History

2:00 p. m.—Motion picture and lecture—"The Life of Louis Pasteur," by Grace F. Ramsey—Auditorium—Open to public.

Metropolitan Museum of Art

2:30 p. m.—Motion picture—"A Visit to the Armor Galleries; The Etcher's Art"—Lecture Hall—Open to public.

DECEMBER 28

American Museum of Natural History

2:00 p. m.—Motion picture and lecture—"Trailmates," by John R. Saunders—Auditorium—Open to public.

Frick Collection

3:00 p. m.—Lecture—"Gentile Bellini and the Narrative Tradition," by Mr. Arnason—Open to public.

DECEMBER 29

American Museum of Natural History

2:00 p. m.—Motion picture and lecture—"Simba," by William L. Smith—Auditorium—Open to public.

Frick Collection

3:00 p. m.—Lecture—"Limoges Enamels in the Collection," by Dr. Ritchie—Lecture Room—Open to public.

DECEMBER 30

American Museum of Natural History

2:00 p. m.—Motion picture and lecture—"Sequoia," by John R. Saunders—Auditorium—Open to public.

Frick Collection

3:00 p. m.—Lecture—"Italian Sculpture in the Collection," by Mr. Arnason—Open to public.

DECEMBER 31

Brooklyn Museum

11:00 a. m.—Concert—Gramercy Chamber Trio—Sculpture Court—Open to public.

2:00 p. m.—Lecture—"History of Music and Its Parallels in Visual Art," by David LeVita—Classroom A—Open to public.

Frick Collection

3:00 p. m.—Lecture—"Holbein, Humanist and Realist," by Dr. Ritchie—Open to public.

Metropolitan Museum of Art

2:30 p. m.—Motion picture—"The Making of Wrought Iron; The Making of a Bronze Statue; The Pottery Maker"—Lecture Hall—Open to public.

DECEMBER RADIO PROGRAM

DECEMBER 1

1:05 p. m.—Organ Recital—Station WNYC—Brooklyn Museum.

2:30 p. m.—"The Insect World," by Dr. Roy Chapman Andrews—Station WABC—American Museum of Natural History.

4:15 p. m.—"House Plants Easy to Grow," by Miss Ellen Eddy Shaw—Station WNYC—Brooklyn Botanic Garden.

DECEMBER 2

1:05 p. m.—Organ Recital—Station WNYC—Brooklyn Museum.

5:15 p. m.—"Men Behind the Stars"—Station WABC—Hayden Planetarium.

DECEMBER 3

10:00 a. m.—Organ Recital—Station WNYC—Brooklyn Museum.

12:00 noon—"This Wonderful World," (Question and Answer Program)—Station WOR—Hayden Planetarium.

DECEMBER 5

1:05 p. m.—Organ Recital—Station WNYC—Brooklyn Museum.

DECEMBER 8

1:05 p. m.—Organ Recital—Station WNYC—Brooklyn Museum.

2:30 p. m.—"Davy Jones' Locker," by Dr. Roy Chapman Andrews—Station WABC—AMERICAN MUSEUM OF NATURAL HISTORY.

4:15 p. m.—"Manners and Customs of New Amsterdam." by Aileen G. Barlow—Station WNYC—MUSEUM OF THE CITY OF NEW YORK.

DECEMBER 9

1:05 p. m.—Organ Recital—Station WNYC—BROOKLYN MUSEUM.

1:15 p. m.—"Adventuring with Plant Hunters," by Mr. Charles F. Doney—Station WOR—BROOKLYN BOTANIC GARDEN.

5:15 p. m.—"Men Behind the Stars"—Station WABC—HAYDEN PLANETARIUM.

DECEMBER 10

10:00 a. m.—Organ Recital—Station WNYC—BROOKLYN MUSEUM.

12:00 noon—"This Wonderful World." Question and Answer Program)—Station WOR—HAYDEN PLANETARIUM.

DECEMBER 12

1:05 p. m.—Organ Recital—Station WNYC—BROOKLYN MUSEUM.

DECEMBER 15

1:05 p. m.—Organ Recital—Station WNYC—BROOKLYN MUSEUM.

2:30 p. m.—"Fish Facts and Fables," by Dr. Roy Chapman Andrews—Station WABC—AMERICAN MUSEUM OF NATURAL HISTORY.

4:15 p. m.—"Evergreen Shrubs for City Gardens," by Charles F. Doney—Station WNYC—BROOKLYN BOTANIC GARDEN.

DECEMBER 16

1:05 p. m.—Organ Recital—Station WNYC—BROOKLYN MUSEUM.

5:15 p. m.—"Men Behind the Stars"—Station WABC—HAYDEN PLANETARIUM.

DECEMBER 17

10:00 a. m.—Organ Recital—Station WNYC—BROOKLYN MUSEUM.

12:00 noon—"This Wonderful World" (Question and Answer Program)—Station WOR—HAYDEN PLANETARIUM.

DECEMBER 19

1:05 p. m.—Organ Recital—Station WNYC—BROOKLYN MUSEUM.

DECEMBER 22

1:05 p. m.—Organ Recital—Station WNYC—BROOKLYN MUSEUM.

4:15 p. m.—"Holidays in Old New York," by Aileen G. Barlow—Station WNYC—MUSEUM OF THE CITY OF NEW YORK.

DECEMBER 23

1:05 p. m.—Organ Recital—Station WNYC—BROOKLYN MUSEUM.

5:15 p. m.—"Men Behind the Stars"—Station WABC—HAYDEN PLANETARIUM.

DECEMBER 24

10:00 a. m.—Organ Recital—Station WNYC—BROOKLYN MUSEUM.

12:00 noon—"This Wonderful World" (Question and Answer Program)—Station WOR—HAYDEN PLANETARIUM.

DECEMBER 26

1:05 p. m.—Organ Recital—Station WNYC—BROOKLYN MUSEUM.

DECEMBER 29

1:05 p. m.—Organ Recital—Station WNYC—BROOKLYN MUSEUM.

4:15 p. m.—"New Developments in Plant Science during 1938," by Dr. Arthur H. Graves—Station WNYC—BROOKLYN BOTANIC GARDEN.

DECEMBER 30

1:05 p. m.—Organ Recital—Station WNYC—BROOKLYN MUSEUM.

5:15 p. m.—"Men Behind the Stars"—Station WABC—HAYDEN PLANETARIUM.

DECEMBER 31

10:00 a. m.—Organ Recital—Station WNYC—BROOKLYN MUSEUM.

12:00 noon—"This Wonderful World" (Question and Answer Program)—Station WOR—HAYDEN PLANETARIUM.

THE INDOOR EXPLORER

Continued from page 380

sized plaster bas relief of Baluchitherium now on view in the Hall of Asiatic Mammals.

Beyond reach of her professional duties, Madame Ziska conducts private naturalist expeditions in her Valley Stream garden which contains 275 varieties of growing plants and flowers. But she is not concerned merely with having a nicely landscaped garden to show off to her friends. She likes to poke about at night with a flashlight, surprising nocturnal insects and spiders at their work and play. Whenever one of them takes her fancy, she will immediately make a pet of it, often attempting to train it, always discovering what it eats, so that she can try feeding it by hand. Butterflies, moths, caterpillars, and birds take up her daytime investigations. And she insists that she has taught at least one member of all these species to recognize her.

At this writing Madame Ziska has no strange personality to cultivate, but she is on the lookout for one.

"If only," she said wistfully, "I could get that little boa constrictor that they have in the exhibition case downstairs. That is what I want now—a boa constrictor."

—D. R. BARTON

FILM SPEED

Continued from page 383

meter which you are using has been calibrated, as well as the corresponding speed number of the film that you have in your camera.

The Weston speed

The second system of speed rating in common use today is that which the manufacturers of the Weston exposure meter have devised for use with that instrument. Originally it was an adaptation of a speed table worked out some time ago by Burroughs Wellcome & Company, of England, for use with their famous exposure calculator. In the Weston system the numbers are directly proportional to the film speed. A number twice as large as another denotes a film twice as fast. This simple relation permits films to be readily compared with one another without mathematics.

As originally assigned, the Weston film speeds produced negatives that were amply exposed for contact print purposes, but many amateurs found that negatives more suited to enlarging could be produced by giving about half the exposure that the Weston ratings indicated. This practice became so general that at last a new table of speed ratings was issued, recognizing the trend toward thinner negatives. Realizing their usefulness, the General Electric Company has adopted the Weston speed figures for use with their exposure meter. Even the Eastman Kodak Company, who for so long has fought shy of making any commitments about the speed of their films, has at last published Weston speed ratings for their newest miniature camera films.

Correct Answers to Questions on page 357

1. (b) Spear-points exhibiting some of the finest workmanship in stone. See page 346
2. (c) Live under markedly little nervous strain. See page 330
3. (c) Shows practically no variation. See page 371
4. (c) Have multiple stomachs. See page 369
5. (b) Bats. See top part of first column on page 385
6. (d) Paralyzed grasshoppers. See page 364
7. (b) A parasite. See page 327
8. (c) Dust storms. See page 378
9. (b) A disease. See page 328
10. (a) When the baby snake "pecks," through its shell with its "egg tooth." See page 376
11. (c) Sprinkling salt on its back. See page 370
12. (c) Do not sing at all. See caption on page 339
13. (c) Insects. See page 338
14. (c) They keep down harmful rodents. See page 365
15. (b) By the bills of birds. See page 327
16. (a) Had its ancestral home in America. See page 356
17. (b) Occurs in a few species who guard their eggs tenaciously. See page 374
18. (a) Rubbing their wings together. See page 340
19. (a) The Druids. See page 323
20. (c) Their legs. See caption on page 339

GARDELL DANO CHRISTENSEN

Story of Panda (Page 33)

June **NATURAL HISTORY** *1938*

Eve and Her Jewel Case · Black Widows & Scorpions

Swazi Queen · Sargasso Sea & Donald Culross Peattie

FIFTY CENTS

Poisonous and Non-Poisonous
See page 155

September NATURAL HISTORY 1938

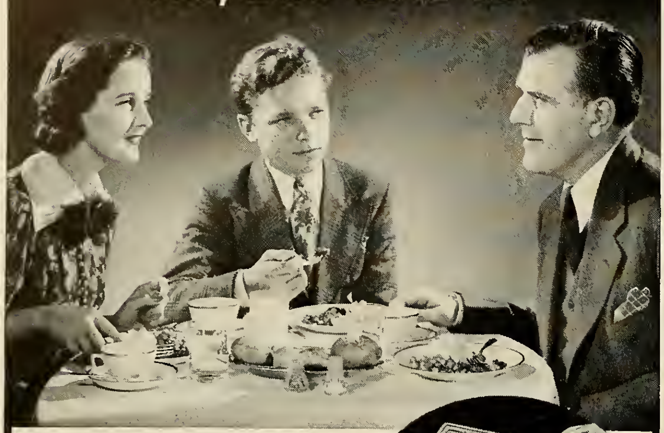
Divers Are Guinea Pigs · Indian & the Supernatural

New "Lost World" · Beaver, Master Conservationist

FIFTY CENTS

"Are all the Vitamins lost by cooking?"

"NO, BUT ONE IS!"



WHICH *vitamin* is lost, and which are retained in cooked foods? You will find the essential facts about the *vitamins* in the Merriam-Webster Dictionary article. This is only one of the many vital topics which are explained in this greatest of all reference volumes.

When the children want to know about animals, birds, fish, flowers, coins, flags and so on—or when they ask questions about their school work in history, chemistry, electricity, geology, music, and other subjects—you can send them for complete reliable answers to WEBSTER'S NEW INTERNATIONAL DICTIONARY, Second Edition. It is the parent's most useful question-answerer; it gives boys and girls the invaluable habit of seeking their own mind-broadening information.

Make the "Supreme Authority" Your Home's Supreme Court

It will broaden your own knowledge on practically every subject you read about or hear mentioned in conversation. In the New Merriam-Webster's 3,350 pages you will find authoritative information on every subject—with clear pictures when needed. And in addition to its thousands of encyclopedic articles, this great question-answerer finds room for more regular "dictionary information"—spellings, pronunciations, definitions, etymologies—than any other reference book.

Mail Coupon for FREE BOOKLET

Sample for yourself this wealth of information on all branches of today's knowledge. Mail the coupon for the illustrated booklet, "The New Merriam-Webster: What It Will Do For You"—and ask any bookdealer to show you the volume so rightly called "The Supreme Authority."

WEBSTER'S NEW INTERNATIONAL DICTIONARY *Second Edition* UNABRIDGED

LOOK FOR THE CIRCULAR TRADE-MARK AND THE "NW" MONOGRAM ON THE COVER

THE NEW MERRIAM-WEBSTER
WEBSTER'S NEW INTERNATIONAL DICTIONARY · Second Edition

G. & C. MERRIAM CO., Dept. 115
Springfield, Mass.
Please send me free illustrated booklet describing Webster's New International Dictionary, Second Edition—"The New Merriam-Webster: What It Will Do For You."

Name ....
Address ....
City State

No other cruise like it!

The Raymond-Whitcomb

South Sea Islands Cruise

(Membership Limited)

To sail Jan. 21, 1939 on the M. S. "Stella Polaris"

The eighth annual Raymond-Whitcomb cruise of its kind—to the South Seas, East Indies and round the world to Europe • Visiting delightful places on the frontiers of civilization where no other cruises go • Sailing on an unusual yacht-like motor ship used only for cruises of small membership.

THE ROUTE

New York . . Jan. 21, 1939
Panama Canal
Cocos Isl. Galapagos Isl.
The South Seas (15 calls)
Dutch East Indies (11 calls)
Singapore Ceylon
Seychelles Madagascar
Mozambique Durban
Port Elizabeth Cape Town
St. Helena Senegal
Canary Isl. Casablanca
Gibraltar Southampton

RATES, $1250 UP
(Shore Excursions Included)

•

Round South America Cruise
Sailing February 11 on the "BREMEN"
Round Africa Cruise
February 4 on the "COLUMBUS"
"Normandie" to Rio Cruise
February 4 to 28
Mediterranean Cruise
On the M. V. "SATURNIA."
February 15 (In cooperation with Italian Line)
West Indies Cruise
On the S. S. "CHAMPLAIN." February 17
Spring Mediterranean Cruise
On the S. S. "CHAMPLAIN". March 4

See Your Own Travel Agent . . . or

RAYMOND-WHITCOMB
New York: 670 Fifth Ave. (at 53rd St.)
Boston: 145 Tremont St. & 122 Newbury St.
Philadelphia: 1517 Walnut St.
Cleveland: 841 Union Commerce Building
Chicago: 320 North Michigan Ave.

October **NATURAL HISTORY** 1938

The Lure & Raising of Orchids · Story of Lodestone

Careers in Nature · Ancient Seas · The Road to Man

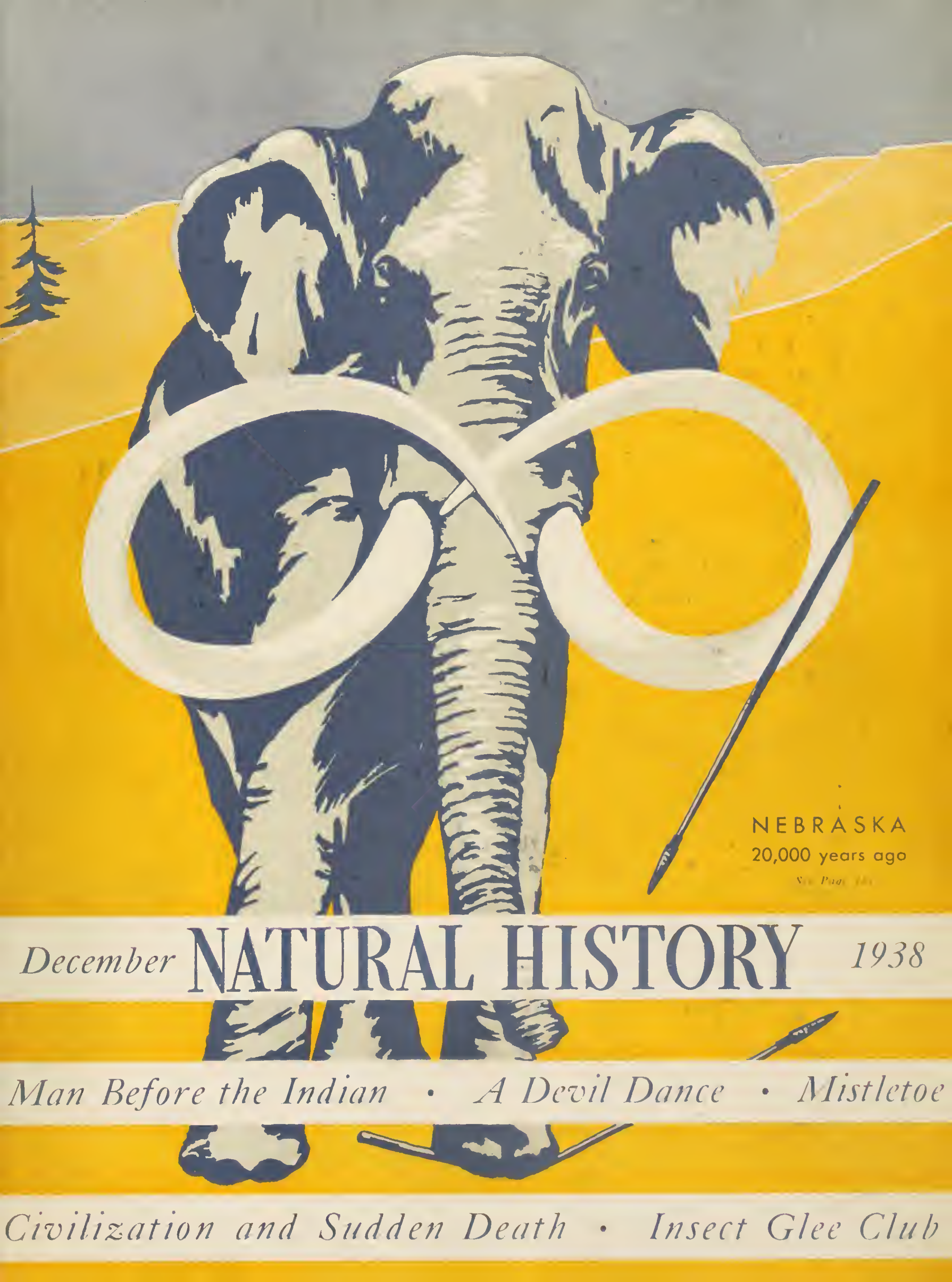
FIFTY CENTS

November **NATURAL HISTORY** 1938

Black Knights · *Medicine Bones* · *Elephant Hunt*

Fragile Creatures of the Deep · *Fight for Sunlight*

FIFTY CENTS


NEBRASKA
20,000 years ago
December NATURAL HISTORY 1938
Man Before the Indian · A Devil Dance · Mistletoe
Civilization and Sudden Death · Insect Glee Club