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OLUME XLVIII. No. 1

FIFTY CENTS

LETTERS

THE COVER THIS MONTH

The cover of this issue of NATURAL HISTORY bears a color photograph of the largest fine star ruby in the world. It is the 100-carat Edith Haggin de Long Star Ruby, one of the finest specimens in the gem collection of the American Museum.

The beautiful six-rayed star that glows within the gem is the result of a hexagonal pattern of fine tubular cavities within the ruby. These myriad tubules reflect the light from within when the stone is cut in the form of a dome.

This striking color photograph is probably the finest reproduction of a star ruby that has ever been achieved. The gem is on display in the Gem Hall of the American Museum, where it resides in the dramatic setting designed by William Bayard Okie, Jr.

* * *

SIRS:

The NATURAL HISTORY Magazine covers are most attractive. Is it possible to obtain cardboard replicas such as are displayed on newsstands to advertise the magazines?

I am a Life Member and a teacher in the elementary schools of New York. Many of your covers can be used in Nature lessons. But I do not like to deface the magazine by removing the cover. I shall be glad to come for the pictures if any are available.

May's cedar waxwings are delightful, and April's blossoms were beautiful. I should like those very much for the schoolroom.

(MRS. MYRWIN L.) MILDRED EATON.
New York, N. Y.

NATURAL HISTORY Magazine's full color covers are available not on cardboard but on the same heavy paper that is used on the Magazine at a cost of 5¢ each, plus a charge of 5¢ for postage on any order up to ten copies.

—ED.

* * *

SIRS:

I am very sorry to have to inform you that when my current subscription runs out for your most enjoyable and informative magazine, I shall not be able to renew it.

Owing to exchange difficulties, it is now illegal for money to be sent out of Australia except for sustenance, and although I tried to plead that my "mental sustenance" was helped by your publication, I was not permitted to apply for a money order for this purpose. . . .

I have always enjoyed reading NATURAL HISTORY, and when I have finished each number I send it over to friends in Taupo, New Zealand, where it is passed round the district and brings much pleasure. . . .

ESTHER BUCK.
Newcastle Girls' High School,
Hamilton, Australia

* * *

SIRS:

As a source of supplementary material for informal talks and class discussions, NATURAL HISTORY's educational value is inestimable. Its wide range of subjects in its own field appeals greatly to the boys here, who find it not only informative but extremely interesting. I sometimes wonder what we would do without it.

Your pictures are splendid, if not the best, but for readers who may be interested in photography may I suggest that more photographic data be given whenever such is available.

RODERICK HAGENBUCKLE.
The Fessenden School,
West Newton, Mass.

* * *

SIRS:

In a recent discussion of the homing instinct of various animals, mention was made of experiments with a toad. The experiments were made somewhere in the vicinity of Boston.

I wonder if you could give me some further information concerning these experiments or suggest some publication containing the information?

FRED S. JOHNSON.
The Bowery Savings Bank,
New York, N. Y.

Mr. C. M. Bogert, of the Department of Herpetology in the American Museum, gives the following brief summary of what is known:

Most of the information regarding am-

IMPORTANT NOTICE TO MEMBERS

NATURAL HISTORY is not published during July and August. Those members, however, who wish to have their September issue sent to a temporary summer address are requested to notify the Membership Secretary, giving the date at which they will return to their permanent address.

phibians has been summarized by the late Dr. G. K. Noble in his *Biology of the Amphibia* (McGraw-Hill, 1931), but one or two papers dealing with the subject have appeared since. The note to which you refer was apparently an account of questionable reliability published originally in the *Overland Monthly* and quoted recently in a popular digest of "tales of the homing instinct."

The author of this note stated that a toad taken from his garden in Wakefield, Massachusetts, was liberated at a spot ten miles from there after being carried on a train through Boston late one evening. The following afternoon, and hardly 20 hours later, the same toad was reputedly back in his home garden. Unfortunately the scientific work done in recent years does not corroborate this story. In his study of the movements of toads, Ray J. Nichols in 1937 reported that of 570 toads tagged and liberated, the maximum distance traveled by any toad in returning to the exact point of capture was 725 yards. Another toad recovered "toward the point of capture" had traveled 1150 yards. The maximum speed Nichols recorded in toads returning to the point of capture was less than one-tenth of a mile an hour, hardly comparable to the alleged speed of half a mile an hour purportedly averaged by the single toad liberated near Boston. Of 141 toads that Nichols removed one mile or less from the point of capture, he was able by intensive work, to recover only 63, and of this number only 30 were at the point of capture in from two and one-quarter hours to 24 days after their release.

The toads which Mr. Nichols was dealing with were mostly Fowler's toad, *Bufo fowleri,* the species most likely to be found in gardens of the Boston suburbs. The logical assumption is that the scientific work is the more reliable, and that the popular account is open to considerable doubt so far as the accuracy of the toad's traveling ten miles in less than 20 hours is concerned.

However, there is every reason to believe that the homing ability in certain amphibians is fairly well developed, particularly in the tailless forms. Under normal conditions many toads regularly return to the same shelter night after night, after spending the evening foraging for insects. During the breeding season many species of frogs will come forth from their retreats at night and return to exactly the same calling station. I found this to be true of a dozen American bullfrogs that I had introduced one spring at a small lake on the edge of the Mojave Desert, far from their normal habitat. This lake had previously been inhabited only by toads and tree frogs, but within a week after I had introduced the bullfrogs, each of about 10 large males had taken up positions at definite localities along the edge of the lake. On subsequent week ends when I visited the place, I invariably found frogs calling at precisely the same places.

In Panama, Dr. C. M. Breder, Jr. discovered that male tree frogs (*Hyla rosenbergi*), which construct mud basins for the rearing of tadpoles, returned on successive evenings to the same basins. Doctor Breder, with Mrs. Breder and Redmond, also published reports on experiments that were conducted in Palisades Interstate Park and near Haskell, New Jersey. Here he found that specimens of Fowler's toad (males) "would sometimes travel at least one-quarter of a mile in less than 24 hours over very difficult paths and surmount numerous obstacles to return to their 'home' territory." Two out of three green frogs released several hundred feet away from their home springs returned even though they had to cross bodies of water where equally suitable habitats existed and where other green frogs were dwelling. It is possible in this instance that other male frogs had already assumed "control" of the suitable stations and did not permit intruders to remain in their territory.

Just how these animals manage to return to their home stations is not known. Some investigators have concluded that amphibians rely upon a number of visual impressions and that new scenes are avoided because they "arouse discordant feelings." Work done by Doctor Yerkes nearly 40 years ago suggests that vision plays some important role in the homing ability of frogs, even though much remains to be explained. Yerkes found that green frogs learned their way through mazes without much difficulty. In an effort to find out what cues were being used he arranged a maze with the walls of one alley red and the other white. After the maze had been learned by frogs, he reversed the colors, and found that frogs were obviously confused. They selected the blind alley instead of the outlet although on previous trials they had learned the maze so well that no mistakes had been made.

Salamanders, oddly enough, seem to show little homing behavior and usually do not return to the same retreats. But they are, nevertheless, able to learn their way through mazes.

Considerable interest has lately been centered on homing behavior, and I imagine some interesting facts will be brought to light. The fact that rattlers as well as some other snakes congregate in winter "dens" in the colder portions of the United States suggests that they possess some ability to find their way to their home dens. The researches of Dr. A. M. Woodbury of the University of Utah have lately shown that desert tortoises also congregate in winter dens but disperse during the summer to establish individual burrows that serve as bases for their activities. The movements of birds have long been studied by attaching identifying tags to individuals, and now similar methods are being used in studying the movements of many other vertebrates, from fish to mammals. Doctor Woodbury has found it possible to tattoo identifying marks on the bellies of snakes; but in most of the frog experiments cited above tags of various sorts were attached to the animals so that there was never any question concerning the movements of individuals. Usually nearly half of the individuals tagged were recovered in the case of amphibians, but with other groups of vertebrates, recaptures have not been so successful.

This will give you some notion of what is known concerning the homing ability of toads, and certainly some of the evidence is very convincing. However, we still doubt that the toad traveled ten miles in less than 20 hours through the streets of Boston. We do not like to spoil a good story, but the substantiated facts are interesting enough, and I look forward to seeing more experimental work done with the homing of amphibians.

* * *

SIRS:

. . . I seldom write letters of comment but I do wish at this time to express my great enjoyment of your magazine. In these times of strain and worry many of us are all too apt to forget to take comfort and refuge in more lasting and dependable interests. Also, city dwellers . . . cannot always get away, physically or mentally, as often as they wish.

We have to plan our vacations very carefully and we have followed up very happily several ideas suggested by NATURAL HISTORY. The most interesting experience was one of our most exciting adventures. Several years ago, following an article on the ice caves in Grant, New Mexico, we set out on a side trip to see the one described. We found it after a good deal of difficulty, and . . . wound up on the Cibola National Forest lookout, and were charmingly entertained . . . by the Ranger, his wife, and three sons. Our objective that night had been the Continental Divide, and it happened that our tent had been pitched squarely across it. . . .

We were so glad the article made the side trip sound more practical than it really was. We didn't really have time to do it but wouldn't have missed it for anything.

(MRS. C. W.) HELEN TALBOT CORELL.
New York, N. Y.

* * *

SIRS:

I have duly received the last number . . . and I am glad to congratulate you on this publication, very fine and useful to me and to the world of naturalists . . .

A. L. HERRERA.
Sociedad internacional de Plasmogenia, Mexico City, Mexico

* * *

SIRS:

. . . You may be interested to know that for years our copies of NATURAL HISTORY have been traveling to the ends of the earth, and in instances they have gone to places where they and other items in the bundle were the only reading matter in English. For some time the Magazine has been forwarded to a friend in Australia who gives two afternoons a week to read to the men blinded in the first world war. And since the present war started, her son-in-law has been with the troops, so that NATURAL HISTORY goes to Australia, is quickly read there, and then is sent (by Air Mail) on to Dick—who was for months in Palestine, and later in Egypt with Wavell. I wish one copy could write back and report on its travels.

So I send my deep appreciation of a fine task done so well that it inspires those who see and hear and read.

MRS. RAY CLARKE TILLINGHAST.
New York, N. Y.

* * *

SIRS:

. . . complimenting you for the fine magazine you publish . . .

MORTON KLEIN.
Brownsville, Pa.

Continued on page 62

NATURAL SCIENCE SPEAKS TO MAN

LINNAEUS, in his *Systema Naturae* (1759), classified all the then known species of animals, plants, and minerals. Just below the angels and at the head of terrestrial creatures Linnaeus placed the Primates (Latin, *chiefs*), beginning with *Homo sapiens* (man) and passing downward through the various species of Simia (apes and monkeys) to the lemurs and the bats.

Eighteenth century man could not accept this ruling without protest. Gratified at being placed next to the angels, he could not endure the idea of being bracketed with monkeys. Writes Thomas Pennant (1781), "I reject his division—because my vanity will not suffer me to rank mankind with Apes, Monkeys and Bats."

Charles Darwin (1871) suggests that, "as man from a genealogical point of view belongs to the Catarrhine or Old World stock [of monkeys and apes], we must conclude, however much the conclusion may revolt our pride, that our progenitors would have been properly thus designated."

Man's origin, going back millions of years to the earliest backboned animals, is today accepted by all natural scientists, yet great numbers of people still refuse to accept such lowly relationship, and even scientists like Pennant and the great Darwin at one time were gravely disturbed.

As the Natural Scientist sees it, man lives in two worlds, the natural world and his own man-made world. In the latter, man is confused by a babel of different languages, mutually conflicting tribal traditions, superstitions, codes and cults; and long records of history, knowledge, and thought only seem to add to his confusion. But although man is apt to think he lives exclusively in his man-made world, the urges or instincts which drive him to action come from his natural world. And it is the service of Natural Science to bid man remember that he is but mortal and that it behooves him to walk humbly, not with vanity or pride.

Natural Science says to man, "Before considering action in your man-made world, know yourself and your place in the world of nature. Since you have been endowed with the priceless freedom of choice, you, alone of the animal world, may deal with your age-old natural urges or instincts. Choose between two instincts if you will—either co-operation with your fellow creatures or force urged by self-aggrandizement and fostered by pride and vanity. Both instincts are of ancient origin in your animal make-up but lead to basically different results. Co-operation, the instinct of the family, herd, and flock, you have never chosen and adhered to on the grand scale. It might bring your man-made world to an enduring brotherhood—enduring, biologically, because co-operation should encourage self-development. Force, self-aggrandizement and individual advantage you have often tried and so set up your many man-made worlds headed by the Caesars of history. These worlds have always perished and, although climate and disease have played a part, the destruction of such worlds is in the main caused by the decadence of inhabitants who have lost their freedom and consequently their initiative and virility. Why not try co-operation?"

A Perry Osborn

First Vice-president of the Board of Trustees,
The American Museum of Natural History

For further reading along these lines, see W. K. Gregory's "The Orders of Mammals," *Bulletin of the American Museum of Natural History*, XXVII (February, 1910); and "Nature's Upstart: *Homo Sapiens*," *The Teaching Biologist*, V, No. 2 (November, 1935); also M. D. Stevers' *Mind through the Ages* (Doubleday Doran, 1940)

NATURAL HISTORY

The Magazine of the American Museum of Natural History

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

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I'LL TAKE

Photo by Courtesy of Canadian Pacific Railway

THE HIGH ROAD

Here are two roads to nature. One of them lets the wilderness alone, enables the nature lover to smell it, feel it at leisure, soak it in through all his senses. The other?—Well, take your pick

By David Lavender

Probably no one is recipient of more unwanted favors than is the poor nature lover. Every Chamber of Commerce that dreams of increasing automobile traffic in its area takes him to its ample bosom. Contractors who can't tell a goldfinch from a trailing arbutus; bond salesmen and purveyors of road machinery; manufacturers of cement and drain pipes; labor leaders and advertising writers—all these and others are his most solicitous friends. He likes nature, doesn't he? Then build him new roads so he can see new sights. What could be more generous?

It is, of course, impolite to bite the hand that feeds one. Besides, the amateur naturalist is an inarticulate sort of fellow whose main desire is the undramatic one of being left alone. Rather than kick up a fuss by appearing ungrateful, he quietly moves out of each new region his friends open up for him and goes on to the next hill or valley.

But more and more he is wondering how long his few remaining hills and valleys can hold out. The wilderness—the inexhaustible American wilderness—is dying before his eyes.

This has been said many times,—so many that it has brought forth rebuttal. I read not long ago statistics that showed conclusively that half of the United States is uninhabited and almost certain to remain so. The author pointed to the Florida Everglades, the great deserts of the Southwest, and the rearing Sierras of California; to the vast gorges of northern Idaho, the trackless bayous of Louisiana, and the spreading pine forests of eastern Texas; to the state of Nevada with a population less than that of Trenton, New Jersey; even to the rocky, grudging hills of New England. He proved, in short, that nearly every state embraces certain profitless localities which can never be settled by more than a few strange outlanders,—and these outlanders add to the region's picturesqueness.

He is doubtless right,—so far as *settling* goes. But he forgets the automobile. Drag a scar of asphalt along the lovely flank of any wilderness, and instantly it ceases to be a wilderness, though not a single "permanent" settler is added to the census taker's list.

Even this is pooh-poohed as an alarmist's point of view. I was grumbling recently to a representative of an automobile club about an improved highway that is slowly being pushed into the Navaho country of northern Arizona. It seemed a wanton thing to me. In the colored desert surrounding Kayenta and in the shadows of the stark red buttes of Monument Valley is one of the last places where the Navaho can live as he used to live, speaking little or no English, content with his hogan of brush or mud, unashamed of his straight, uncut hair done up in a gaudy calico band. Around Shiprock and Gallup, or wherever the main highways run, the Navaho has cut off his hair and aped other "civilized" ways, not always to his benefit. It struck me as a pity, I ventured, that these people could not be allowed one spot where they might cling to the heritages of a past far older than our own.

"Pooh," the auto man said. "One road isn't going to change this whole reservation. The country's so big, and it would cost so much to reach all the back regions that some of your wild men probably never will see an automobile unless they come in to the central trading posts."

Photo by E. W. Van Wagenen from Black Star

In natural wonders easily accessible to the summer tourist, North America has a heritage of unrivaled diversity and beauty.

In California alone one could spend two weeks every summer touring only on National Forest and National Park highways and never see them all in 28 years

Yet with all this natural beauty for the asking, private interests increase the pressure for roads where none are needed and lace up our scenic outdoors with a network that brings destruction to almost every form of natural beauty. It is time to stop the billboard panorama

So big. So many back regions. It makes us—always has made us—criminally careless of our riches.

I spent my boyhood on a ranch in the San Miguel Mountains of western Colorado. I remember my stepfather's telling me that when he and other ranchers first came into the section, they looked at the endless sea of grass and told each other it could never be grazed out. Today the vast herds of cattle they brought in are gone. Arroyos yawn where storm waters roar off the denuded hills. Ranches have dwindled to small units carrying on business behind barbwire fences. Those men have learned that nothing is so big as to be unlimited.

I went back not long ago, thinking to hunt some of the sage chickens which used to swarm in every draw, on every brushy mesa. They, too, are gone. But there is a road. I remember when it was built and the first gunners it brought. And when I think of that I can't help recalling the cold mountain dawns when my brother and I would pile shivering out of bed to meet each new morning with a boy's unquestioning delight.

It was our job to bring in the horse herd. Off we went riding double on a barebacked old "night" horse we had kept tied in the barn. I can still smell the hay on his frosty breath, still feel his warm hide between my dangling legs. The long grass glittered with dew. The rising sun washed the peaks with a golden light that threw each timbered fold into sharp relief.

Suddenly a soft, muttered clucking off in the sagebrush would bring us out of our dreams. We would slide off the horse and creep forward, taut with excitement. When the old cock guarding the covey craned his mottled neck over the scrub, we were ready. *Whir-r!*—we could really peg rocks in those days! Then, after we'd brought the horses thundering into the corral, we would clean our prize and race into the cabin to watch mother fry him in a pan of hot bacon grease. The smell of him was even better than the eating.

Sometimes—high moment!—my stepfather would take down his beloved shotgun and whistle for his two black-eared setters. The dogs were a luxury there where you could flush a multitude of birds in any half-hour walk. But he liked to see them coursing the fields or freezing to stiff, eager point.

Like our neighbors he never killed more than we could use and only when fancy dictated. Consequently we couldn't understand it when, shortly after the new road between Norwood and Dolores was opened, two gunners stopped by and in a single afternoon killed 175 prairie chickens. I am sure of the figure. I saw the back of the car piled high with their slaughter. And I read the account of the trip they wrote up for their home town paper. One hundred and seventy-five in one afternoon. They mentioned the number several times, as though they were proud of it.

Until that day I had thought that gunners were sportsmen. Certainly the ones were who took the trouble to get into our back country before the advent of the road. They liked the beauty of the land as much as its hunting. They respected our grain fields and grazing stock. Above all, they respected the game.

Spoliation

The new road brought in an entirely different kind of being: a man who, if he saw the dawn or violet dusk at all, saw it through a windshield at 50 miles an hour; who kicked down fences, trampled grain and was in such a hurry to kill that he left the trouble of finding his crippled birds to the coyotes. He was the game hog and, game laws notwithstanding, he appears on each new wilderness road as surely as does the billboard.*

A wilderness area in the United States long ago ceased to mean a region awaiting exploration or development. Its connotation now is of a spot noteworthy either for scenery or game and sufficiently remote from roads to require the average camper's staying at least overnight in a bivouac of his own making.

In a country half uninhabited such areas are surprisingly few and far between.

For example, in all California, second largest state of the Union, there are only seven wilderness sections a man can't hike across in a short day. Of these seven, only two are more than ten miles from the end of some existing automobile road. One of them is, of course, truly vast: the famous High Sierra region, some 2,300,000 acres in extent.

Two other sections, surpassing even the Sierras in size, stand out in the wilderness lover's mind. One is the grotesquely carved, highly colored land that lies along both rims of the Colorado River from eastern Utah south into Arizona, a territory of 10,000 square miles more or less (depending on how far up the many tributary canyons its boundaries are conceived to extend). The other is the thundering gorge of the Salmon River in north central Idaho, the largest tract of untrammeled game country left in the United States.

Formidable lands, these three, offering almost nothing in the way of economic exploitation. Yet look what is happening to them.

*The automobile itself has become the unnatural enemy of myriad mammals, birds, reptiles, and amphibians. Hit-and-run motorists who never pulled a trigger may unintentionally wreak even greater havoc among wildlife than the willful depredations of the game hog. Some estimates place the automobile's toll of small mammals alone at a million a week during early summer.—Ed.

It is now officially proposed that a National Monument be created in Utah, starting near the Arizona boundary and embracing both banks of the Colorado as far as Arches Monument, near Moab, and including also the Colorado's main tributary, the Green, as far north as the town of Green River.

Today a single highway barely nicks the eastern edge of this enormous territory. It is a one-way dirt road, passable only in summer, and leads to Edwin, or Owochomo, Natural Bridge at the head of White Canyon. This road, it is argued, should be made into an all-weather highway and extended on down White Canyon to the Colorado, across the river and out the other side, thus splitting the region in half. Eventually, if the proponents of the Monument have their way, other roads will scar both rims of the Colorado, but as a starter they are willing to settle for the first one mentioned.

Not even the most rabid booster of the project pretends that this costly highway will benefit the region itself. The entire population of 200 or 300 miles of the canyon bottom could be taken out in a single car. One lone cattle company grazes stock along the rugged east breaks, and its owners have declared themselves unalterably opposed to the road. But the boosters are not dismayed. They still have, as an argument in favor, their old standby, the nature lover. Just think of the scenery it would open up for him!

"What scenery?" one timidly asks. The deep, colorful gorge of the Colorado? It is deeper and more colorful where roads already exist: in Grand Canyon National Park. The breathless precipices and templed rocks of its great buttes? There are greater buttes in Zion Park. The fantastic erosions of wind and water? Bryce Canyon is more fantastic.

The same threat is even more real for the Salmon River in north central Idaho, Paradise of hunter and fisherman. Already a road has reached down the mainstream from the town of Salmon to the Middle Fork. The CCC, those unflagging zealots of the road-building fraternity, are blasting upstream from the town of Riggins. Now only a hundred miles separate the converging road ends, and two local Chambers of Commerce are whooping it up for quick completion. And what is to pay the enormous cost of constructing and maintaining this highway? Why, a tiny one-family mine here and there, a couple of hat-sized patches of arable land,—and the grateful nature lovers who will flock in with open purses.

One wonders how grateful the nature lovers will really be. In the minds of hunters, campers and fishermen everywhere the Salmon is, above all else, "The River Of No Return." It is so called because, though it is possible for the venturesome to go downstream by boat—"the wildest boat ride in America,"—no one has yet been able to return upstream. The road will end all that. And more. It will end fishing and hunting—steelhead, salmon, trout; deer, wildcats, bear, mountain sheep and goats,—unrivaled anywhere else in the United States.

If you doubt the desecration of roads, look what has happened to some of the tributaries of the Salmon. At Bear Creek, for example, you once could tumble out of your sleeping bag and in half an hour catch all the fish you wanted for breakfast. Now you'll cast all day for a measly mess of six-inch trout. The man who lands one of the salmon for which the watershed was named makes news.

After all this it would be repetitious to tell about the road which the State of California has gouged into Kings River Canyon, the very heart of the High Sierra wilderness; of another that is in the planning stage and will cut the body of this wilderness in two, crossing the entire range from Porterville to Lone Pine and "opening up" the Kern River region.

The motorist already has available to him the lion's share of the finest mountain scenery in the United States: in Glacier, Ranier, Rocky Mountain, Yellowstone, Yosemite, and Sequoia National Parks, —to say nothing of tens of thousands of highway miles which, though not built primarily for scenic attractions, nonetheless afford plenty of them. In California alone, he can drive more than 100,000 miles. The average man, on an average two weeks' vacation trip, could not see all California's roads in a hundred years. He would use up 28 years of vacations just touring that state's National Forest and National Park highways alone.

Meanwhile, bottlenecks and bad crossings

Highway engineers say that before a modern road can pay for itself it must carry 400 cars a day every day of the year. The average purely "recreational" road draws less than 100 a day. And still the pressure is on for more, although California's highway department repeatedly points out that all available funds are necessary to maintain and improve existing roads. Meanwhile traffic arteries, which serve a definite economic function, remain full of bottlenecks, dangerous curves, and railroad crossings.

It is impossible for the true wilderness lover to see the country from a speeding automobile. He has got to absorb it leisurely, sleep right down on the ground, smell it, feel it, soak it in through all his senses. "Improvement" on nature is, to him, incredible,—yet hand in hand with road building has gone improvement. Underbrush has been cleared out and burned, killing nesting birds and making room for the noxious plants of ragweed, burdock, and thistle. Trees have been thinned out, logs removed, whole forests combed and manicured. Famous wilderness trails have been slicked up, notably the Appalachian Trail in the Great Smokies. It would be interesting to know, now that the publicity attendant on that work no longer acts as a magnet, how many more people use the trail than before. Isn't it possible that its main devotees were those to whom it appealed because it was a natural, "unimproved" pathway?

It is said that this clean-up campaign is a fire preventive. But it won't check half as many fires as would the weeding out (if he could be weeded out) of the thoughtless camper brought in by the roads. Meanwhile what of the birds and small game that need the cover and food provided by an abundance of undergrowth and down timber? What of the violets that bloomed by that mossy log? The azaleas that rioted in the thicket?

This is not just the protest of an occasional recluse. Last summer nearly 140,000 people went into California's wilderness areas alone. They did it in what the motorist would call "the hard way." They walked or rode horseback. They carried their supplies on their own backs or packed them on mules. They cooked their own food, made their own beds, cleaned up their own mess. And they did it because they liked it. Because there seems to be in some men and women an inherent craving for pioneering, for outdoor "adventure." Because they can find in the solitude of the soaring buttes or beside the untracked streams a few simple values for living that are overlooked in the rush of the cities.

More roads will bring the motorist nothing that is not already available to him over and over again. But to the wilderness lover they will bring more fires, more erosion, fewer trees, smaller streams, less fish and game.

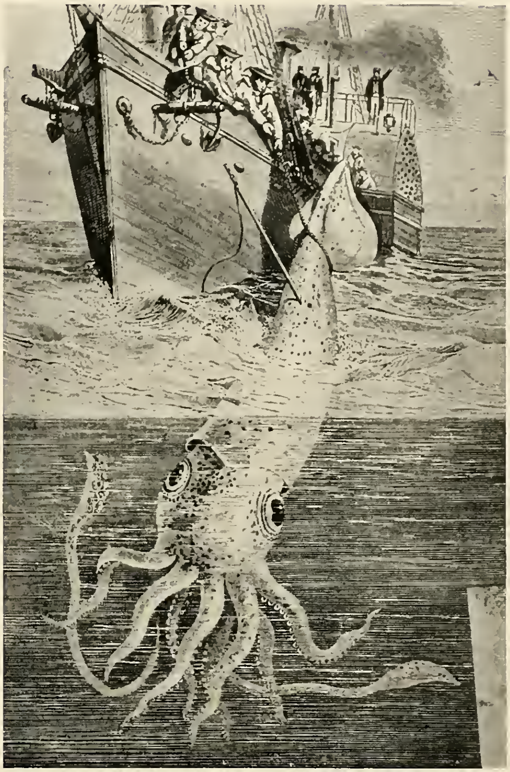
Isn't it time we stopped giving the poor fellow so much?

Philip D. Gendreau photo

SCYLLA WAS A SQUID

By W. LEY

NEARLY all mythical monsters have a basis in fact. The creature at right is the artist's conception, but the inspiration is obviously the giant squid. This drawing depicts the encounter of the *Alecton* with a giant squid, in 1861



Illustrations from Monsters of the Sea, *by John Gibson, 1887*

Charybdis may have been a whirlpool, but modern science now recognizes the other half of Homer's legendary partnership in maritime disaster as possibly the first mention in literature of the giant squid

IT WAS on the last day of November, 1861, that the lookout man on duty on the French corvette *Alecton* announced: "a large body, partly submerged, on the surface." The vessel's position was about 120 miles northeast of Tenerife, the largest of the Canary Islands; the sea was calm in the oppressive heat of a clear sky, and the commander of the corvette decided that the object should be approached and investigated. It turned out to be a gigantic squid of a bright brick-red color, with immense black eyes that were not easy to look at. The body of the monster was about eighteen feet long, the tentacles at least another eighteen feet and the weight was estimated to be about two tons. The squid was drifting lazily at the surface but was unmistakably alive.

The commander of the *Alecton* knew that the existence of such gigantic squids was still disputed, although only recently a few dead and mutilated monsters of that or a very similar type had been washed ashore, one off Zeeland, Denmark, in 1847 and another at the Skaw in the same region in 1854. This encounter with a live animal afforded an excellent opportunity to settle that disputed question once and for all and to furnish a belated vindication for the commander's compatriot, Denys-Monfort, who had published a complete collection of all reports referring to such animals in his *Histoire naturelle . . . des Mollusques* in 1802 without earning anything but ridicule for all his work.

Since the *Alecton* was a war vessel, there was no lack of armament. Cannon balls were shot at and through the lazy kraken (to use the old Scandinavian word for the fabulous sea monster); and harpoons were thrown at it. But it seemed as if no projectile could seriously or even perceptibly damage the flabby flesh of the squid. Nor did the creature seem much disturbed by the belligerent attention paid to it. It disappeared under the surface three or four times, only to come up again each time after intervals of a few minutes at most.

After three hours of intensive naval warfare, the squid suddenly vomited (one of the cannon balls must have hit a vital spot). And soon after, one of the sailors succeeded in throwing a noosed rope around the body. The rope slid along the slippery sides and finally caught at the large rear fins. The men tried to haul the gigantic cuttlefish aboard, but its weight was so great that the rope cut through the body, severing the hind part. This part was salvaged but had to be thrown away soon after. Thus the *Alecton* reached port with empty holds, but captain and crew brought an exciting tale to tell.

As has been said, the existence of giant squids was not generally recognized at that time. (They came to be recognized between 1870 and 1877, when not less than a dozen of the monstrous creatures were washed ashore at Newfoundland, some of them still living.) Therefore some armchair explorers quickly and gravely informed the captain and ship's company that they must have been the victims of a mass hallucination.

To those who put that interpretation on the adventure it sounded perfect. But to the men who had worked for hours under a tropical sun to secure a heavy and repulsive specimen, being in various kinds of danger all the time, that explanation did not seem so correct. It is regrettable that history has the habit of recording only the sayings of politicians and diplomats,—the remarks the French sailors made when suspected of mass hallucination were never printed.

Before those gigantic squids were seen and examined by zoologists,—the one that was battled by the *Alecton* is by no means the largest on record—, knowledge about the existence of such animals rested mainly with the writings of two Scandinavian authors, both of them famous, both immensely learned, but both also given to exaggeration and a peculiar credulity. The older of them is Olaus Magnus, "Archbishop of Upsal and Primate of Sweden," who delivered a vivid description of the kraken (the common use of this Norse term goes directly back to these two authors) in his *Compendious History of the Goths, Swedes, Vandals and Other Northern Nations.* He said that the kraken had "long horns round about like a Tree rooted up by the Roots." And he did not forget to mention the large eyes, telling that they "are red and fiery colored and in the dark night appear to Fisher-men afar off under Water as a burning fire."

The other, Bishop Erik Pontoppidan, wrote about the kraken in the second volume of his weighty *Natural History of Norway.* The book was written in 1753, and an English edition appeared in London in 1755. Since "none of the authors, both classic and modern," consulted by Pontoppidan, "seemed to have much knowledge of this animal," he had to rely on tales of Norse fishermen and on their folklore. The tales were sensible, as we now know. One of them relates that a kraken, "perhaps a young and careless one," was caught between cliffs and trees near Alstahong in 1680 and died when the tide receded. The folklore part was less sensible, speaking of a kraken a mile in circumference, appearing above the waters like a group of small islands.

It was because of this story that the existence of giant squids was doubted and ridiculed for more than a century after the first printing of Bishop Pontoppidan's book.

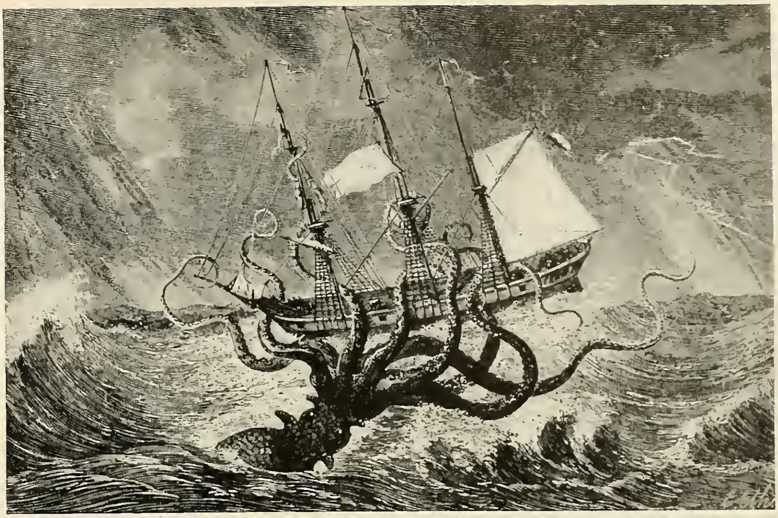
In ancient lore

It is, incidentally, not true that the works of the classic authors do not contain references to the existence of gigantic squids. The best known reference in classical times (and probably the most reliable one) is that in the *Historia Naturalis* of Gaius Plinius Secundus, better known as Pliny the Elder. He reported that "more than a century ago" (which would be around, say, 100 B.C.) a gigantic cuttlefish was caught in the strait between the Pillars of Hercules (Gibraltar). Its head was "as large as a keg holding fifteen amphorae of wine, and the arms were 30 feet long and so thick that a man had difficulties to reach around them."

But even that is not the oldest literary mention of a giant squid. There exists one of much greater age, and it can be found in one of the most famous books of the world's literature, in Homer's *Odyssey*. It is certain that this poem did not undergo even small changes from the time of Peisistratus (530 B.C.), though Homer is usually thought to be an approximate contemporary of Hesiod, which means that he probably lived around 750 B.C. Now it is rather unimportant whether Homer is to be regarded as an historic person or not, or whether he is thought to be the author of the *Odyssey* or only the compiler of older material. The wording of the poem is at least 2500 years old, the material two or three centuries older; and no matter who wrote certain passages, they convey to us what was known or at least believed 2500 years ago.

The mention of a giant squid occurs in the Twelfth Song, where Circe describes to her hero the dangers of Scylla and Charybdis. Again, it is of little importance in this connection whether Scylla and Charybdis

ANOTHER example of reasonable accuracy in fanciful art. The giant squid became generally recognized as a real animal in the 1870's



are thought to refer to the Strait of Messina beween Sicily and Italy or to the Strait of Gibraltar. The older school of thought asserted that the Greeks of that period did not sail the Mediterranean farther west than to Sicily, while more recent commentators point out that more extensive geographical knowledge may be embodied in the poem.

But there can be no mistaking the identity of the creature called Scylla. Circe's careful description of it could only be misinterpreted at a time when the existence of giant squids was denied. In speaking of Scylla, Circe says:

... but her form is a sight portentous that no one
E'er would gladly behold, not even a god if he met her
Round her a dozen of feet she is always waving suspended
Six long sinuous necks outstretching before her and each one
Beareth a head terrific with teeth in a threefold order
Many and thickly arrayed, where gapes death's cavernous blackness.
Up to the midmost part she is hid in the depth of the cavern
Whilst from her lair in the fearful abyss six heads she extendeth
Hunting for fish at the foot of the rock and peering around it,
Dolphins to catch or dogfish, or haply another and greater
Beast . . . (*Odyssey* XII, 96)

It is to be assumed that the Phoenicians experienced an adventure with a gigantic squid about which they told widely and often, possibly with the added purpose to frighten sailors of other nations away from that dangerous spot,—which happened to be on a very lucrative trade route. Needless to say, the description does not satisfy our present-day ideas of zoological accuracy,—an octopus, as the name implies, has eight arms, and a squid ten. But a couple of tentacles more or less would not be a matter of crucial importance in Homer's day, especially to a dismayed sailor. And terrible Scylla, with her dozen feet always waving suspended, could scarcely be other than one of these gigantic invertebrates. The "mythical" animal that has become immortal in literature had "teeth in threefold order," which are surely the lines of sucking disks; and if the locality in question is actually the Strait of Gibraltar it is a section where giant octopuses were encountered again and again from the times of Pliny until recently.

IN EARLY times the huge, tentacle-wielding cuttlefish, or calamary, was often confused with the octopus *(below)*

By Luis A. Sarmiento

National Inspector of Secondory Education, Colombia, S. A.

Photos by L. R. Romos, Courtesy of the Ministry of Education, Colombia

(Above) An ancient statue called "The Sun," which ornaments the square of San Agustín at the headwaters of the mighty Magdalena

Though the ruins of San Agustín lie far in the interior of Colombia, swift modern means of travel enable one to enjoy their peaceful atmosphere of antiquity within four days after leaving New York

(Right) Whatever wars may have troubled the ancient people, this warrior now looks out on the placid plaza of San Agustín, in quiet farmland

THE UNKNOWN AGE IN COLOMBIA

One of the most impressive prehistoric sites in the Western Hemisphere holds the mystery of a vanished people, which will be solved when archaeologists fully explore it

It is from the capital city, Bogotá, that we make our excursion to the ancient ruins of San Agustín. At Bogotá we are near the very center of Colombia, the first of the South American countries one reaches coming from the north, just south of the Panama Canal. We are among clouds which bring thunder and hail, 8660 feet above sea level on Colombia's eastern plateau. But the climate is perpetual spring, similar to that of New York in April. It is a static climate. The government is static too, neither revolutions nor unrest.

Round about spreads the country of Colombia, a country that is built up and down, with abundant high mountains and endless lovely plains and woods, the Amazonian forest.

Our trip through this diversified land to the ruins of San Agustín takes two days. Traveling either by automobile or by train toward Girardot on the Magdalena River, we traverse a magnificent landscape, with the vegetation changing every hour as we descend the mountain. First pastures lie on either side, with crops of wheat, potatoes, and maize. Then coffee appears, and finally more plantations but of different kinds, larger and larger ones, with palm trees, cotton, tobacco, and sugar cane.

Traveling westward on this leg of the journey, the

(Below) A MASSIVE NINE-FOOT HEAD, situated at the foot of a mound near San Agustín where it may have adorned the principal approach to a temple

FIERCE-LOOKING PAIRS of catlike teeth are characteristic of many of the stone gods of the San Agustín people. The statue above, found at Isnos several miles down the river, has been taken to the city hall; and the head below resides in the plaza

tourist or explorer has faced the snow peaks of Tolima, Santa Isabel, and Ruiz, proud, high peaks of the central range of mountains, where condors dwell. At Girardot on the banks of the Magdalena, he turns sharply southward and ascends the valley of the Magdalena, an amazing river, which is navigable even to this point almost 1000 miles from the Caribbean Sea.

The ancient ruins which are our goal now lie directly ahead of us but far to the south, near the very headwaters of this mighty river. We travel through a charming valley between the eastern and central ranges of mountains, toward the snow shrine of Huila, el Nevado del Huila, from which the state takes its name.

At six in the evening the traveler comes into Neiva and finds the Continental Hotel. (What a big name for a hotel that is—so-so. There are no snakes, no flies nor lizards, but plenty of bad meals.) Happily enough, one can proceed immediately by automobile to the southward. In the gathering dusk we ride through lovely though scarcely visible landscapes, past villages and cottages, up toward the very source of the Magdalena River, toward the Valley of San Agustín and its multifarious stone giants.

I think I am correct in saying that despite the unrest that disturbs many other parts of the world today, you will find the country in which you are

THE CARVED GOD below is apparently in the act of extracting an animal from his mouth: an imposing relic left by the ancient people for future archaeologists, a short distance from San Agustín

traveling most pleasantly friendly to the United States. Colombia has ten million inhabitants and an area equal to that of California, Oregon, Washington, and Montana. Last year in November the National Congress voted a bill authorizing the government of Dr. Eduardo Santos to lend 50 million dollars to build air and maritime bases. By so doing, the Government of Colombia hopes to be able to do its duty in the event that it should be necessary to defend the Panama Canal, vital to all of us. And the North American people can be quite sure of that.

When you realize, as you approach the sleepy town of San Agustín, that it has been possible to reach this remote center of ancient culture in four days from New York City, you will no doubt feel that you have been taken on a magic flight back through time, to be set down in another world. Indeed, the transition is so rapid by clipper plane that many prefer to take the two-week journey by ship, boat, and train which gives opportunity to see a great deal more.

Presently we reach San Agustín, in all its tranquillity. The first person who paid attention to the ruins of San Agustín was Francisco José de Caldas, a man of letters and great knowledge, nicknamed *El Sabio Caldas* ("The Wise Caldas"), a close friend of the celebrated naturalist, Alexander von Humboldt. He was killed by the Spaniards a century and a half ago. He was a patriot and also a scholar; but, as so often happens in many countries to wise men, who love so much to look at the stars without seeing the danger behind them, he allowed the Spaniards to catch him and was shot.

No one, however, paid attention to him in connection with the ruins. Not till more than a century later, only 25 years ago, another man of great intellect, Doctor Preuss, formerly Director of the Ethnological Museum of Berlin, paid a visit of six years to the ruins and wrote a handsome book on them.

Which brings us to the interesting fact that, unlike most of the other great ruins of the past, those of San Agustín have yet to give up most of their secrets. Preuss himself acknowledged that he could not discover where these sculptures came from nor what other culture may have influenced the artists.

Not being the director of any museum, there is small hope that I may tell more than he did. But this I can say: that you of North America are heartily invited to visit our country and its ruins, you who love our Indian art, our common cultural heritage. The Government of Colombia is now ready to make arrangements for a joint archaeological expedition to San Agustín and the big archaeological sites surrounding the town. There perhaps lies the key to the full knowledge of our prehistoric past.

And now, look, please, at the statues, for in matters of art an impression cannot be conveyed by word alone.

(Below) GODDESS with child in arms: a four-foot statue introducing the feminine element in the art of early Colombia. This was discovered in 1937 by José Pérez de Barradas, Director of the Archaeological Commission

(Below) A STONE EAGLE carrying scepters in its claws, also found in 1937. Further work is expected to reveal much new material shedding light on the position of this culture in the archaeology of South America

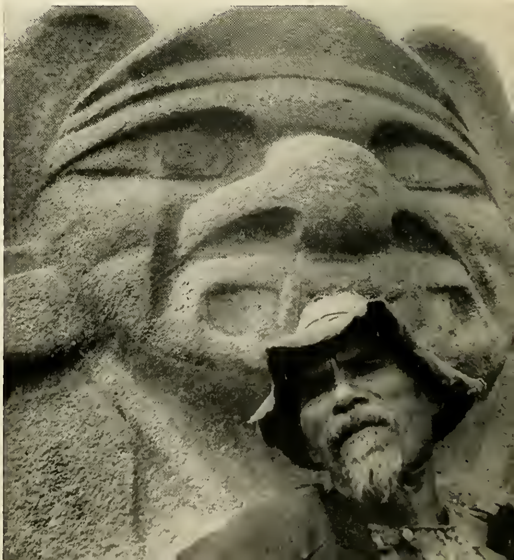
(Above) One of the pools of a ceremonial fountain, possibly used for rituals of sexual significance

(Left) A modern native of the region stands beside a statue of a male figure apparently surmounted by the stylistic representation of an animal. With the conspicuous eyeteeth typical of this ancient art, this figure looks out from the eastern bank of the Lavapatas River a few miles back of San Agustín

(Left center) Figures decorating the pool of the "Fountain of Lavapatas" shown above

(Left, below) A huge circular stone bearing the snake-like figure of a sacred animal, or zoomorph

With bold and imaginative features, the gigantic deity below surveys a tranquil land whose present inhabitants can give the archaeologist no knowledge of the ancient race that left these imposing monuments



A NAVAHO MAKES SOAP *(99 44/100% Yucca)*

By Alexander and Dorothea Leighton

Photos taken while under grant of the Social Science Research Council

1 Raw material: the broad-leaved yucca plant

2 *(Below)* Soap comes from the root

3 *(Below)* . . . which is peeled

4 . . . and sliced

5 The slices are pounded, then dropped

6 . . . into cold or lukewarm water

7 . . . and churned into suds

8 . . . for a foamy shampoo.

9 But hair must be thoroughly rinsed

10 . . . to avoid scalp irritation.

11 She brushes her hair with dried grass

12 . . . and begins her coiffure like this,

13 . . . folding the hair into a club

14 . . . and tightly knotting it

15 . . . so it is all fixed for 2 or 3 days

1 He starts with three forked sticks

2 . . . then adds some straight ones.

3 A little boy brings cedar bark

4 . . . which fills the cracks.

A NAVAHO TAKES A "TURKISH BATH"

By Alexander and Dorothea Leighton

5 The whole house is covered with dirt

6 The Navaho digs out the inside

7 . . . and builds a fire

8 . . . in which stones are made very hot.

9 The hot stones are put in the hut,

10 . . . and a tarpaulin covers the doorway.

11 Clothes are hung "on a hickory limb."

12 And so to bathe—in his own juice.

13 Emerging, he rubs himself with dirt, peels it off, and so is cleaned

GEM FOR JUNE

Two lustrous jewels, the pearl and the moonstone, vie for the delicate honor of symbolizing the month of brides

By FREDERICK H. POUGH

THE official birthstones for June lack the tradition accompanying many of the gems of the month. Neither pearl, nor the alternative stone, moonstone, was used in the Hebrew high priest's breastplate. Pearls are obviously too small and too soft for use in this way; moonstones, which, in a way resemble them in their soft luster, were not known to the peoples of the Mediterranean at that time. We can probably trace the adoption of the pearl as the stone for June to the much more modern tradition which recognizes June as the month for moonlight and brides. The appearance of a pearl makes inevitable an association with the moon—both are round, silvery and softly luminous. Moonstones naturally inspire a similar comparison; their very name arises from the resemblance. But apart from the realm of romantic ideas, the two have little in common.

Pearls are not minerals, for they have an organic origin. They are composed of the same materials as the shell of the oyster which forms them, principally calcium carbonate. Their iridescent luster is the result of the breaking up of light rays by the infinitely thin layers of which the pearl is composed. Starting from a minute irritating granule, the animal deposits layer after layer of pearl substance over the central nucleus, gradually building up the size of the pearl. The process does not stop with the formation of a small pearl, but is continued throughout the life of the oyster, clam, mussel, or snail making the pearl, and the pearl grows ever bigger. Pearls are made by many animals—probably any that can secrete a shell can also make a pearl—but few pearls are valuable. The luster of a pearl is the same as that of the inner shell of the animal responsible. If it is the common edible oyster, the pearl will have the negligible luster and beauty of the inside of an oyster shell, and its value will be correspondingly low. Newspaper stories to the contrary, notwithstanding, the pearls of our edible clams and oysters are practically worthless.

Engraved moonstone from Ceylon

In many parts of the world, however, there is a variety of oyster which is said not to be very good eating but which produces a beautiful lustrous shell, and this is the oyster in which our precious pearls are found. Their slight variations, according to where they are found, enable the expert to tell the origin of any pearl by the nuances of color and luster. Pearls of the Persian Gulf and of the South Sea Islands are the most valuable today. The Japanese natural pearl industry has been wiped out by the much securer system of the artificial cultivation of pearls; man's introduction of a good-sized irritating nucleus has supplanted the natural introduction of small ones. From such large beginnings the oyster is spared many years of work. Often today a few thin layers suffice for the cheaper culture pearl necklaces, but these layers will wear away almost as quickly as they were applied.

Pearls have been highly valued for many years, and a favorite myth tells of dissolving pearls in wine or vinegar to make a precious drink. Cleopatra is supposed to have drunk such a draught, made during a banquet for Mark Antony. But if the pearl were really dissolved before the meal grew very cold, the fluid must have been a potent drink which, we fear, no lady could down. Pearls can be dissolved however, even in weak acid; they are soft and are easily worn away. Few pearls from graves have any luster remaining, because the minute crystals of the thin layers have re-formed in larger sizes, and the delicate sheen is thus lost.

The Romans believed that pearls were solidified drops of dew which fell into the oysters, presumably at low tide. Hindus thought that pearls came from many animals, the most and best from oysters, of course. The Chinese still believe in the medicinal properties of the pearl, and many small and badly formed pearls are used in this way. The Arabians and Persians use pearls as cures for insanity and for various diseases.

All other gems are sold by carat weights —one carat is 200 milligrams, five carats equal one gram. Pearls alone are sold on another system, by grains. Four grains weigh the equivalent of one carat. Values vary according to color, shape, and perfection, and with the larger pearls, as with other unusual gems, it is a matter of an individual price for something unique.

Moonstone, the alternative stone for June, is a variety of feldspar, one of the common rock-making minerals, but in an unusual form. This gem is colorless to slightly milky, and it possesses a remarkable bluish sheen, which is enhanced in a convexly cut stone. Most moonstones come from Ceylon. They are regarded as sacred in India and are always displayed upon a yellow cloth, a sacred color. They are highly prized as a gift for lovers and are thought to arouse love and give lovers the power to foresee their future fortune. Perhaps the moonstone is appropriate as the birthstone for June after all, even without the rhyme the English language supplies.

Exquisitely carved pearl shell from Japan

AMNH photos by Coles

GEM FOR JULY

Assistant Curator, Geology and Mineralogy, The American Museum of Natural History

The blood-red ruby, costliest jewel of all, has derived its virile attributes from the symbolical color of Mars

UNBELIEVABLE though it may sound at first, the rich deep red of July's stone is caused by the same impurity that gives the emerald its brilliant green. Although this impurity, chromium oxide, is unessential to the basic mineral composing either the emerald or the ruby, it is what gives both gems their color and value. In a sense, therefore, chromium oxide, though common enough itself, is the most valuable commodity in the world when purchased in the form of a ruby. When one considers what a slight amount—little more than a trace—transforms a common mineral, corundum, into one of the rarest of gems (provided, of course, it has the clarity and purity essential to any gem), it would be difficult to put any price on it. Even radium could not approach it in cost.

Ruby is one of several corundum gems and is the most valuable and the rarest of all. Fine quality large stones are far rarer than diamonds of equivalent size and quality. Corundum is a common mineral of very simple composition, consisting of aluminum and oxygen,—nothing more. But this compound is the second hardest mineral, exceeded in nature only by the diamond. Corundum is usually gray or brown or greenish or black, and is usually as translucent as a brick. Only rarely do we find it in transparent pieces, and flawless gemmy specimens are even less common. Ruby corundum is the rarest shade, and a large piece of this gorgeous color without a host of imperfections is indeed unusual.

Ruby is found in but few places. The best gems come from Burma, and only these have the bluish-red, "pigeon blood" color. Ceylon rubies tend to be lighter and are less highly valued. The ancients confused various red stones, so that garnets, spinels, and rubies were often thought of interchangeably as rubies. Some of this tendency, if not the ignorance, continues to this day, and we frequently find names like alabandine ruby, Cape ruby, and Arizona ruby applied to garnets. However, the carbuncles of the ancients were often rubies, and many of the legends of carbuncles should probably more properly be applied to rubies than to garnets. Because of their glowing color the myth arose that they contained an internal fire, a fire which could not be quenched nor concealed no matter what cover were placed over it or what cloth wrapped around it. A ruby in water was thought to warm it, eventually bringing it to a boil. Sometimes sex was attributed to gem stones, including rubies, and the darker stones were thought of as being male, the paler ones as female.

In recounting these ancient myths, one would naturally think that so many of the beliefs would be subject to test that they could easily be disproved if anyone took the trouble to try out, for instance, the boiling of water by a ruby. The explanation of their perpetuation lies in several factors, chiefly, the lack of scientific curiosity among the people. If Pliny wrote that something was so, a failure to make it work in a subsequent test was attributed, not to an error on Pliny's part, but to some fault or mistake of the tester. Furthermore, superstitious fear prevented many from trying to summon up the devil, even though they may have thought they had the means to do so within their grasp. Self-styled seers and prophets were willing then, as now, to exploit the gullible, and superstitious peasants were often deceived by tricks. A general lack of knowledge led also to an uncertainty about the nature of materials. If some test failed to work, it might be concluded that the carbuncle in question was not genuine or had perhaps lost its power in some way. All of these factors led to the perpetuation of many ideas which to us seem absurd and obviously fallacious.

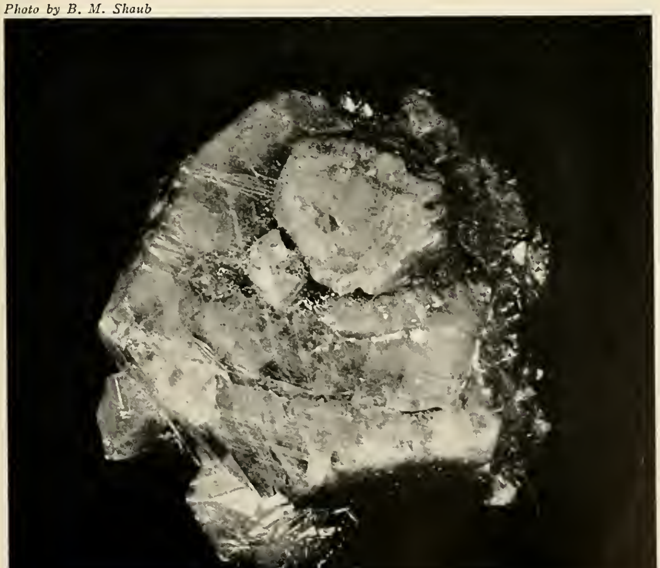
AMNH photo by Coles

Carved ruby rooster (three times actual size), from Burma

Like many stones, rubies were thought to have the power of foreseeing unhappy events. There are many stories of stones that turned dark upon the approach of ill fortune and became brilliant again when the future promised better things. As with other red stones, an association of ideas made the ruby a stone of curative value for any sort of bleeding. Red was the strongest color, and as such was the color of Mars; on a man it signified command, nobility, lordship, and vengeance. Consequently, it was appropriate as a man's gem. Rubies were thought to have caste: the deeper colors were of the highest caste, but stones, too, could lose both caste and supernatural power by coming in contact with the paler stones of a lower caste. In the older breastplate, ruby was the stone for December, but in modern times it was thought more appropriate for a warmer month; hence, we have ruby as the jeweler's birthstone for July.

A Burmese ruby crystal (in the Harvard Gem Collection)

Photo by B. M. Shaub



AMNH photo by Coles

"... HE will remind you of summer lightning."—A small scale model of the Jaguar Group, designed by Mr. C. V. Whitney and Dr. James L. Clark for the new North American Hall

A JAGUAR FOR THE MUSEUM

By C. V. WHITNEY

Like a mirage in the desert, the elusive "tigre" escaped five expeditions bent on his capture

FOUR years ago I attended a meeting in the American Museum of Natural History in which President Davison outlined the plans for the new North American Hall, a hall in which the most important and interesting animals of the land would be displayed in their natural settings. It was a magnificent conception, to create within four walls in the heart of New York City an exhibit that would have scenic beauty, as well as educational and scientific interest for thousands of people who would never otherwise see the wonders of our native wildlife.

Since the age of fifteen I had made hunting, camping, and fishing trips over many parts of North America. I have a deep feeling for the marvelous wildernesses of the North American continent, for the variety and grandeur of its scenery, for its different peoples, and for its beautiful wildlife.

President Davison's plans appealed to me immensely, and I undertook the responsibility of providing and donating one exhibit for the new hall, a group portraying the southwestern desert country, with the mountain jaguar, or *tigre,* as its principal subject.

I visited the Southwest first in 1923, going to Arizona and Sonora, Mexico. Every winter since then I have lived in this area, on and around my farm in Sonora, about 300 miles south of the United States border. During this time I made many trips over the surrounding country, and I was completely under the spell of the desert. Why, I shall never know,—for it is a hard and pitiless land,—hot and dry during winter and impassable and unendurable during the summer rains. But its sublime moments are its sunsets and cool nights and the utter lack of a sense of time, the philosophy of mañana.

The people in this land still depend upon wild game and birds and fish to supplement their food supplies. Cattle and farming are their chief industries, so that the wild animals that affect these are important daily topics. Foremost among them is the jaguar *(tigre grande)* who kills their stock. There are other animals in this great southwest desert, deer, peccaries, bear, mountain sheep, antelope, mountain lions, and wildcats. There are many varieties of birds; I have seen the skies black with geese, and long lines of sand hill cranes winging their way to the shores of the Gulf. I have shot seven varieties of duck on a small watering pond for cattle. There are bobwhites, parrots, scorpions, and snakes; butterflies, hummingbirds, and eagles; yet when you are there you are more conscious of dust, flies, and heat than of all the rest.

If you travel to any extent in this country you will hear much about our friend the "tigre." You may see at firsthand the evidences of his depredation. I have seen two full-grown Hereford bulls killed within 100 feet of each other and left lying there with their throats severed, but nothing eaten. If you camp in the country, ranchers may travel as far as 50 miles, having heard by the grapevine that you are there with hunting dogs, to implore you to come and kill the "tigre" who is destroying their live stock.

Occasionally the natives kill a jaguar. They lie in wait near some mountain spring night after night until by luck the beast should come there to drink or kill a deer; or, one of their mongrel dogs will locate a "tigre" too stuffed with food to run or too lazy to be annoyed. But not many are killed in this way.

I made five expeditions to secure a male jaguar for the Museum, but failed. The animal was finally secured three months after my last attempt and at the exact location where I myself had been hunting! On all my hunts, dating from 1929, I was accompanied by Les Wooddell of Nogales, Arizona, a cowboy by profession but a good hand at any outdoor job. You could not wish for a better companion. He will drive you hard but do it with a laugh, and he has a sense of humor, which saves many a situation.

It remained for Les and Miss Mary Ogden Abbott to secure the jaguar three months after my last attempt, and her story follows. He is a fine specimen, and we are not ashamed of him. He lived in the Bacatete mountains, the last stronghold of the Yaqui Indians, and was a legend in the small villages within a radius of 100 miles.

In the exhibit being prepared for him in the North American Hall, you will see him as he was in real life, the monarch of all he surveyed, in the setting of that wild and awe-inspiring country in which he lives. You will admire his muscular display and perfect symmetry; he will remind you of summer lightning.

The Pursuit of OLD JUAN

By Mary Ogden Abbott — *With sketches by the author*

The hardest kind of riding over cactus and boulders was necessary for a glimpse of this magnificent creature—who soon will be viewed by countless thousands in the full beauty of his natural surroundings in the American Museum

EARLY last January, I received a wire which read, "HAPPY NEW YEAR, EXPECT YOU FEBRUARY FIRST," signed Les Wooddell.

The telegram called my bluff on a series of one-sided jests connected with assisting Les to collect what he calls "a big stud tiger," otherwise known as a jaguar or *Felis onca,* for the American Museum of Natural History.

I replied immediately, asking if he would be seriously inconvenienced if I did not arrive until February 4th. The whole idea continued to retain its charming suggestion of total improbability even after I had engaged a passage on the "sky sleeper."

On Tuesday the 4th of February, half an hour before dawn, I arrived at the airport of Tucson, was met by Les, and proceeded across the Mexican border to his new ranch in the Yaqui reservation, 300 miles south of Nogales.

Ever since a year before, Les had been hunting the *tigre* who, from then on, we knew as "Old Juan." The Museum people were getting impatient, writing that everything was ready to finish the jaguar group, except the most important jaguar. Mr. Whitney, who was presenting the group, had suggested offering a reward for a suitable animal.

It is not easy to catch such an animal in the State of Sonora, or anywhere else if you need one badly. They are not plentiful, and the range of the individual animal is wide. He may leave the country entirely; and, like all game, the big ones grow wary and drift farther than the less desirable specimens. In Sonora they are hunted with dogs, chiefly bloodhounds or a cross between a bloodhound and a fox or a coon hound. Not only are the scenting conditions extremely difficult on account of the dry ground and the heat, but water is scarce in that country, and the cactus is everywhere. The brush is thick, and where other things are not so bad there is likely to be a feather grass that gets into the dogs' noses. The dogs must be trained to ignore the numerous deer. Finally, a jaguar is a large and powerful animal and he is more than likely to turn to bay and kill or cripple a whole pack of hounds. This happened to Mr. Whitney's packs on two occasions.

We traveled from Nogales to the ranch in a Chevrolet truck, accumulating supplies, Ramus, the Mexican hunter, Analito, the camp tender, and vari-

"Time and again the dogs tried to straighten out the trail . . ."

"We followed . . . where a mistake meant a caught foot or a broken leg . . ."

ous odds and ends as we went. On arriving in the valley we were treated to a sunset of unparalleled drama, which culminated in a blast furnace effect as the last rays shot skyward against the clouds through a notch in the western Sierra.

On the ranch there were no tracks of Old Juan, so we moved camp and hunted the south end of the valley for five days. Nothing was found but old tracks and disappointment. Strange and picturesque Mexicans and Indians showed up at intervals, camped with us the night, and departed. Captain De Broussio, who lived at Agua Caliente, a small, desolate and dusty military post in the valley, provided us with mounts, hunted with us briefly, and left. He was very amiable, very silent, and a competent horseman.

The nights were brilliant with the great full Mexican moon. The dawns (we always rode at dawn) were beautiful and cold as death. One longed for the sun, knowing that toward noon one would grow to hate it. The grass stood dry to a horse's belly, the cactus stuck in the dogs' feet and hide, the saguaros pointed to the sky, and the thorns, which protect almost every brush, tore at the rider.

All the tracks of "big ones" were old and they all tended toward the mountains on the west. But at last came a report that fresh tracks had been seen near the Agua Verde, over against the Sierra del Gallo to the west.

We moved camp that night to a tree in the center of the dusty expanse that lies inside the fence at Agua Caliente, and at four o'clock the next morning we broke camp. The horses were sent on eight miles west. We followed in the truck escorted by two Yaquis armed to the teeth and shod in sandals.

Shortly after sunrise we started on the serious business of trying to outguess Old Juan—Les, Ramus, and I mounted, and the two Yaquis afoot. We rode through dense, stiff, leafless brush which grew among large loose black stones. A mounted man could disappear in 20 yards. It was bad going and got worse.

We finally emerged in a boulder-filled arroyo, difficult for ponies, but easier for the Yaquis. On the sandy places Les and Ramus pointed to signs indicating that Old Juan was in the habit of going up and down here, but he had not passed recently.

The morning wore on, the dogs found no scent, and the ponies picked their way over and among the boulders. There is a special name for that black boulder country, but it was easy to make up other ones.

At last we came to some pools of water in the arroyo; the water looked like pea soup. The dogs swam about in it with relish, and the horses drank. Les discussed the situation in his expressive Spanish, which is nothing but an agreeable sound to me.

At noon we stopped by a charming pool of clear water with a grassy place near by. A duck flew up from it. I produced the lunch, which consisted of a handful of raisins all around and a small piece of cheese.

No sooner had I dismounted than the dogs began to "bawl" on a track of something in the brush. We mounted and followed them as they made a loop up the hillside. Time and again the dogs tried to straighten out the trail, but could not. Finally Les called them off, saying he would rest them and let them try again.

We dismounted and sat about, ate our raisins, and

"The rocks slid under Les' pony, he threw up his arm to keep his balance, caught my eye and grinned . . ."

waited. After about an hour the dogs tried again, but they could not take the trail out of the arroyo. After this was certain, we proceeded along the arroyo and stopped again. "No use to trail the dogs back to camp in the heat," said Les. This time when we dismounted I went to sleep with my head on a stone, which made me realize I was tired.

After five o'clock we prepared to start for "home" —the truck. I staggered to my feet and reset my saddle. No one but me likes that saddle. It was acquired in the bazaar at Athens, and my mother rode it from Hermes, via the Temple of Basse, to Sparta. I believe it was a Russian army saddle. It was embellished with a pair of Army stirrups, from which the brush of Sonora effaced the "U. S." in ten days! I seemed to be the only person below the border who knew how to put it on a horse.

We went out of the arroyo and climbed up a narrow trail onto a "bench," interlaced with more cactus than any stretch I'd seen. Suddenly, on the trail behind us, the dogs picked up a scent. They carried it under the horses, ran it up the trail, checked and turned back, and then turned off into the brush and cactus toward a side hill and the setting sun. They worked it over the bench and through the cactus with only two errors.

Following Les and Ramus, I thought, "If the dogs get the line into the shade it will be all right." Ramus found a track and said something to Les, just what, I was afraid to ask, having decided for myself that this was Old Juan. At the foot of the slope the scent freshened and the cactus was thinner, but the footing worse. The dogs went over the top, and we followed as fast as we could, over boulders where a mistake meant a caught foot and possibly a broken leg for our horses.

The brush grew higher and snatched at our bridle reins. We had to fend our faces, dodge, and try to give the ponies as little trouble as possible. My pony was nothing short of miraculous. He was old at the game and never hesitated for his footing or made a mistake. With a mouth ordinarily extremely sensitive. he never threw up his head or faltered when the brush dragged at his rein. He never stepped on a loose stone and would jump a bad place onto a pile of boulders that did not slide.

When we reached the top, the dogs were on the side of another ridge ahead, still going strong. Going down was worse than going up, but I knew that where the other ponies could go mine could go better. The rocks slid under Les' pony, he threw up his arm to keep his balance, caught my eye and grinned. My pony followed him, and no rocks rolled,—on down a place where only goats should go, and up a steeper one. When we reached the rim the dogs had the cat at bay in the flat below. The sun was nearer the horizon, and time pressed. Ramus looked for a way down, said something to Les and, rather to my astonishment, turned back from the cliff. Finally he found a way that could not have been steeper and still passable, with loose black stones. I held back for Les to follow him because the dogs and cat had moved again. To my surprise, Les seemed to expect me to go ahead and said as I passed, "Hold on to the trees as you go down, so that if your horse falls you will slide clear." Even Les thought it rough country; he'd asked me twice if I was all right!

When we reached the arroyo at the bottom, the dogs had moved again but were still in hearing. We kicked our ponies into a gallop, and Les started taking down his .30-30.

The awful thought crossed my mind, "Suppose it is only a *little* cat!"

As we approached the sound of the dogs, Ramus pointed to a big tree, and there in the branches against the setting sun was Old Juan. Les dismounted and I after him, determined to see this fabulous animal. Les had vanished in the brush, and of course I got almost in front of him! I heard an angry voice and then a shot; Old Juan lost his footing and fell to a lower crotch. Les fired again and the animal came down. Ramus appeared, and we all embraced one another. The dogs worried the carcass for a little out of politeness, but for them the show was over. Les started to protest that the animal was not very big and only had big feet, but I thought him a perfectly magnificent specimen.

Les and Ramus cleaned the animal, lashed him across Ramus' saddle, and we pulled out for "home." We watered the horses at the Agua Verde, which was luckily near by, and continued.

There was no trail, the brush was thick and the going rough. Ramus' horse carried more than double, for Old Juan weighed over 180 pounds. It was impossible to ride a straight line, for the cactus was thick in patches or the rocks impassable for tired horses. The light was almost gone when we came to a place where the land broke off in rock slides. Ramus said his horse could not manage them. The ground was hardly visible to us. Les kept turning left, trying to get down. He said, "There is a trail somewhere, if I could find it." At last he discovered a passable descent, and within 50 yards we struck the trail!

We had ridden hard about four miles while the dogs were running, and it must have been ten miles more to the truck. The light was gone and the stars were out. I felt that the way would never end, and my horse went sore on the hard road. I let him trail along behind; and when we got in, I was "out" on my feet.

We packed the truck and pulled out for the ranch arriving at one o'clock or later. The hunt was done. The jaguar for the Museum and I were headed for "civilization."

Each year many New Yorkers, as well as multitudes of people from other parts of this country, journey long distances at considerable expense to view the wonders of the Grand Canyon of the Colorado River, never knowing that within 130 miles of Manhattan there is a canyon about 50 miles long that is comparable to the Grand Canyon in depth, and probably more spectacular in appearance in that it is less than half as wide at the rim. We cannot compare the two in scenic effect. We do not know whether the marvelous coloring of the rocks of the Grand Canyon region is duplicated here or not, for no one has ever seen the canyon! It is a submarine canyon whose rim is 500 feet below the surface of the Atlantic, and whose mouth lies at least 8400 feet deep.

Although the Hudson Submarine Canyon has never been seen, it has been quite accurately mapped during the past decade by the United States Coast and Geodetic Survey. The scale model of it, shown in the accompanying illustrations, has recently been completed in the American Museum of Natural History and is now on exhibition in the Hall of Ocean Life.

The existence of the canyon has been known for only a little more than half a century. It was in 1885 that Captain Lindenkohl of the United States Coast

CANYONS UNDER THE SEA

By H. E. Vokes

Assistant Curator of Invertebrate Paleontology, The American Museum of Natural History

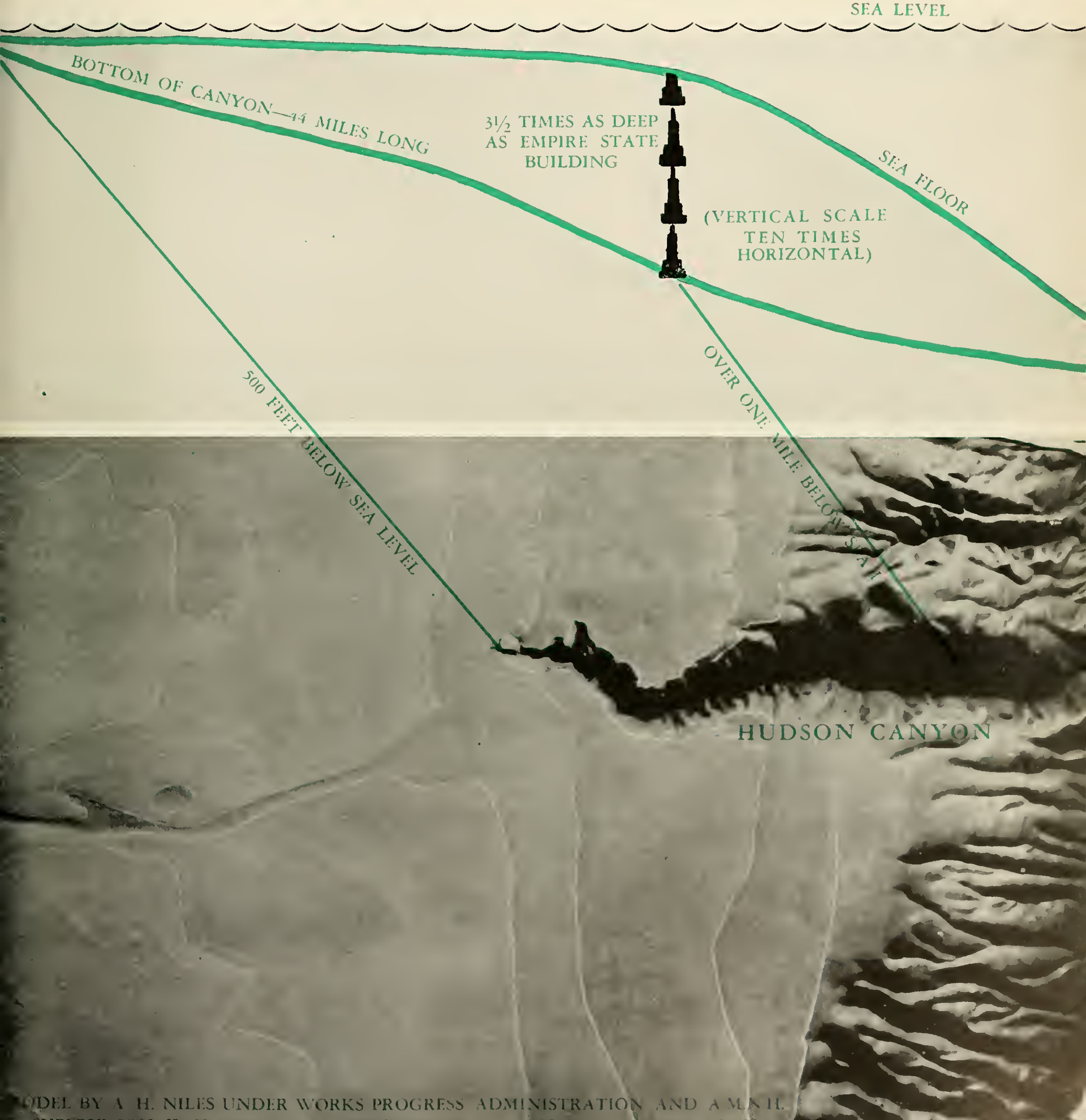
Equal to the Grand Canyon in depth and having more precipitous sides, Hudson Canyon remains one of the great mysteries of the deep, for it represents a strange family of submarine features which no scientific facts can explain

and Geodetic Survey first announced that a *ravine* had been found at the edge of the continental shelf, near the end of the known submarine channel of the Hudson River. Only recently have deep-sea sounding methods demonstrated that such depressions are common features along the margin of the continental shelf and that they possess a depth and length such as to make the term "ravine" hardly appropriate.

HUDSON CANYON BEGINS 130 MILES FROM NEW YORK CITY

On land, canyons are found cut into highland areas, either in mountains or plateaus. Their mouths are always at the lowest part of their course, generally where the highland slopes to join the lowland. They are almost invariably formed by moving water, either that of flowing streams, or by water frozen to form the ice of glaciers.

In the sea, the canyons are found in somewhat similar "terrain," being cut into the margins of the continents where these drop off into the true ocean basins. One is likely to consider that the edge of the continent is where the land dips beneath the sea. Scientists have long recognized, however, that the continents are great uplifted blocks, whose real margins lie some distance out from shore, at a point where the bottom drops off rather abruptly to the true ocean basin. In other words, the surface of the continent passes gradually beneath the surface of the sea



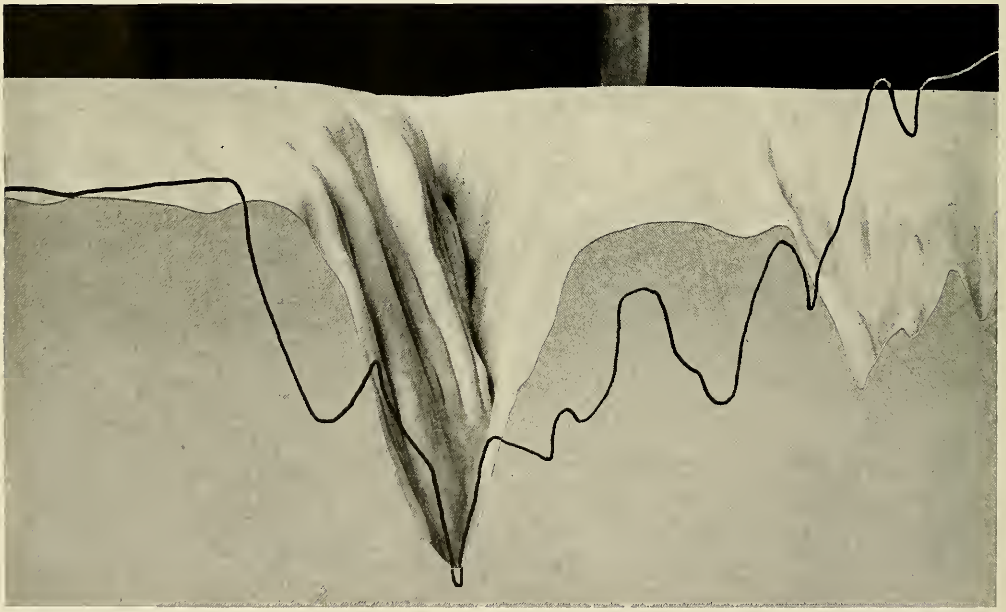
MODEL BY A. H. NILES UNDER WORKS PROGRESS ADMINISTRATION AND A.M.N.H. SUPERVISION. DATA FROM GEOL. SOC. OF AM.—A.M.N.H. PHOTO BY COLES to a depth of approximately 600 feet in most places, at which point a sharper slope occurs. The submerged edges of the continents are referred to as the "continental shelves," and the submarine canyons are all cut into the shelves along their outer edges. The new model, which shows the shape of the margin of the continent in a very graphic manner, is eleven feet long and three and a half feet wide. It represents an area 164 miles long and 53 miles wide and was constructed in the Department of Paleontology with the assistance of the Works Progress Administration, the work being done under the supervision of the writer.

Submarine surveys made during the past few years have indicated the presence of a great many canyons similar to the one shown in the model. At the present time canyons are known to occur off all the edges of the continents save on the Arctic and Antarctic slopes. Their apparent absence is probably due to a lack of adequate surveys in those regions rather than to any considerations having to do with their method of formation.

Many of the canyons occur off the mouths of rivers, those off the Hudson River in North America and the Congo River in Africa being among the most spectacular. Others occur off the Ganges, Indus, Niger, and Columbia Rivers, as well as a multitude of smaller streams. This general alignment led to an early suggestion that the canyons had been cut by these rivers at some time when the continental margins were much higher in relation to the ocean level than they are today. But the recent investigations have shown that there are many gorges that cannot be related to any modern river. One of the more interesting canyons of this type begins almost at the head of the pier at Redondo Beach, California.

When canyons of this sort first became known it was suggested that they might possibly be very old features, perhaps dating even from 200 or 300 million years ago, in the Paleozoic era, and that all evidence of the eroding rivers had been destroyed in the subsequent eras. But within the past five years we have learned that the canyons are cut into rock containing more recent fossils (Cretaceous and Tertiary), and it is now realized that the canyons are young structures, geologically speaking, probably not older than the Pleistocene or glacial period of approximately a million years ago.

The suggestion was then offered that the amount of water frozen to form the glacial icecaps of that period might have lowered the sea sufficiently to permit the rivers to cut the gorges, and that the tilting of the continents under the weight of the glacial ice had so deflected the courses of the rivers across the continental shelf as to permit their cutting the canyons which today cannot be related to any present river course. For example, a large canyon, the Wil-



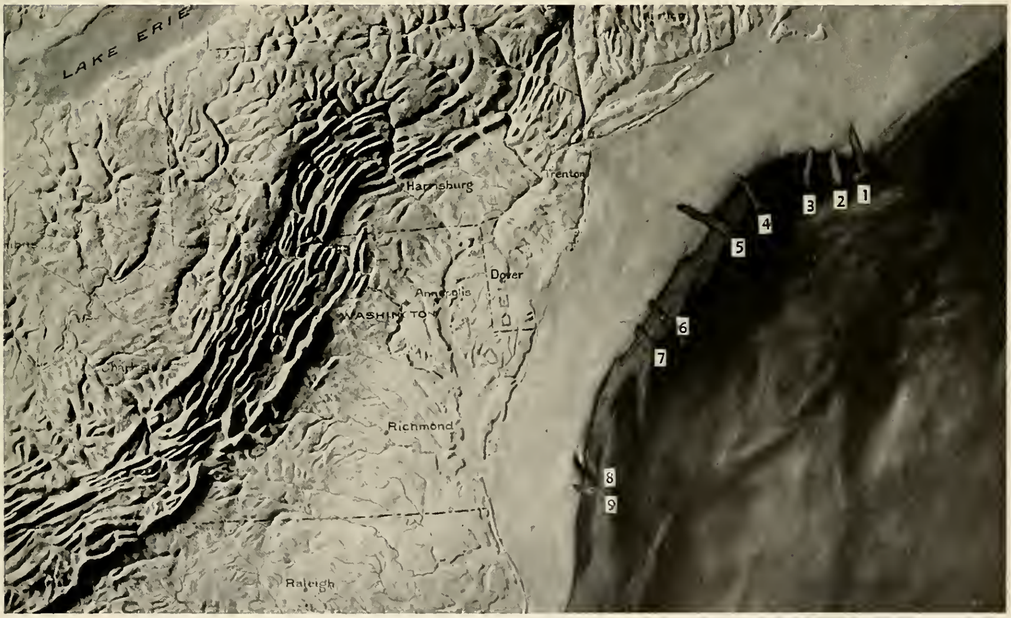
AMNH photos by Coles

HERE a line representing the cross section of Grand Canyon is placed against the cross section of the model of Hudson Canyon. Note that the canyon 130 miles offshore from New York City has almost the same depth but much steeper sides. (Both profiles show the vertical distances ten times the horizontal) mington Canyon situated slightly northeast of Cape May, has been attributed to the eroding power of the Hudson River during one of the earlier glacial advances, while the present Hudson Canyon has been attributed to the erosion of this river during the last glacial advance. Numerous careful studies have indicated that the level of the ocean surface was indeed lowered by the water frozen into glacial ice, but all the evidence suggests that such a lowering cannot have been more than 300 feet. This is still some 200 or more feet above the level of the heads of most of the canyons, and no known river today has sufficient current to erode any such structures off its mouth at these depths.

It has been argued that we are misinterpreting the evidence and that the surface of the sea may have been lowered much farther than has been supposed. In answer to this, Professor Shepard of the University of Illinois has pointed out that the valleys extend to a depth of one or more miles and that the removal of enough water from the oceans to permit land at those depths to be cut by rivers would require the storage of about one-half of all the water in all the oceans and the piling up of an icecap at least fifteen miles thick on the continents. This seems impossible and is incompatible with all the evidence.

If the level of the sea was not lowered, perhaps the land itself rose, allowing the canyons to be cut, and then sank back beneath the sea. The amount of up and down movement necessitated by this suggestion is rather staggering to the imagination of the geologist. It would have had to occur along the margins of all the continents, and the amount of uplift would have to have been approximately equal everywhere, and the depression the same. One cannot conceive of such uniformity, geologically; furthermore, it is impossible to believe that such disturbances of the earth's crust could have occurred without leaving their mark on the adjoining lands, and there is no evidence suggesting such gigantic disturbances.

Despite the number of objections which have been raised against the possibility that the gorges were formed by river erosion, a number of students still believe that the true explanation of their origin will be found in this hypothesis. A multitude of other suggestions have been offered to explain the canyons. The recent great increase in our knowledge of their distribution and physical characteristics has shown that many of the earlier suggestions are wholly untenable. There are, however, still some five or six hypotheses which are receiving serious consideration by scientists engaged in the study of them. But there remain so many pertinent and significant objections against the acceptance of any of these that it seems probable that the correct explanation of how these gorges were formed (or are now being formed) has not yet been proposed.



Based on Plate I, Geol. Soc. America, Special Public. No. 7; Veach and Smith: Atlantic Submarine Valleys . . .

As elsewhere along continental shelves, a number of canyons are known to exist off our eastern coast. The canyons shown above are: (1) Hydrographic Canyon, (2) Veach Canyon, (3) Atlantis Canyon, (4) Block Canyon, (5) Hudson Canyon, (6) Wilmington Canyon, (7) Baltimore Canyon, (8) Washington Canyon, (9) Norfolk Canyon

THE RETURN OF A NATIVE

By Paul Knight
Assistant Professor of Entomology, College of Agriculture, University of Maryland

Regarded by the superstitious as a harbinger of war, the periodical cicada, miscalled seventeen-year locust, is an astonishing, if somewhat destructive, "regular" on Nature's timetable

All photographs taken by the author, near College Park, Maryland

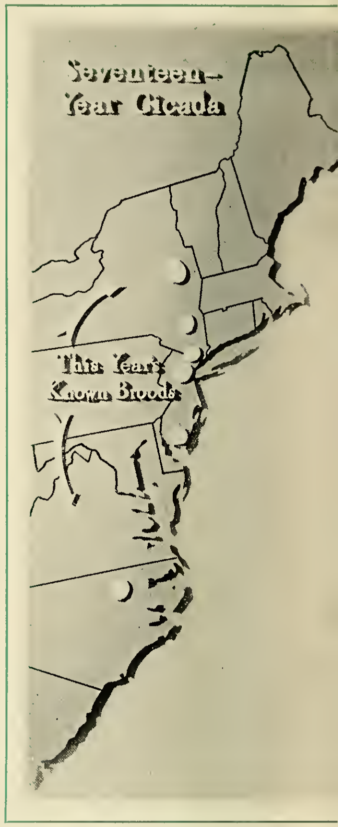
Every year during late spring some areas in the eastern half of the United States play host to one of the strangest insects recorded anywhere in the annals of natural history, the ephemeral but noisy periodical cicada. From subterranean caverns where a generation has lived for just a few weeks short of seventeen years it emerges to disturb the quiet of woodlands and towns for a brief interval, then to drop from sight and sound by midsummer. Seventeen seasons later the progeny of this brood will come out of the soil to repeat the behavior processes in the same way as their parents and all the preceding generations.

The periodical cicada, often incorrectly dubbed "seventeen-year locust," was first recorded by white man on this continent in the Massachusetts Bay Colony in the year 1634; and the cicadas that appeared in 1940 in this region were lineal descendants of this historic brood. The cicada was noted in the earliest known work on the natural history of the original colonies, a book written by a clergyman who resided in Tidewater, Virginia, before the American Revolution. It was not until the latter part of the nineteenth century, however, that the true nature and longevity, the long periods of quiet between sporadic outbursts, were understood. And today there still remain many unsolved problems regarding the peculiar behavior patterns. Many superstitions have developed out of man's observations on the cicada; and not all of these were originated by primitive tribes. One is especially appropriate this year because it deals with war. Often those who incline to believe in the improbable, point to a distinct letter *W* in the wings as a portent of armed conflict,—in spite of the fact that the insect is always marked thus. War, however, in the light of the past record of human achievement seems a fairly safe prediction, because it seems to occur about as often as "cicada years."

There occurs a brood of the periodical cicada somewhere in eastern United States almost every year, perhaps every year. But in certain seasons the populations of the insect are so small that they may escape notice. Some broods are confined to narrow geographic limits, as is the case for 1941. The impending June invasion, as well as can be told from past records in Government files, will occur in southern and northern New Jersey, in the vicinity of New York City, in the lower and upper Hudson River Valley, and in one location in eastern North Carolina. Readers may be able to add many records to the list already compiled by entomologists interested in this species.

Some broods are very destructive in restricted areas, as for example the one which appeared in northern Illinois and southern Wisconsin in 1939. Several broods cover vast sections of the eastern half of the continent. The largest invasions during recent years occurred in 1936 and 1940. When prevalent, the cicada may cause serious damage to many shade, forest, and fruit trees as well as ornamental shrubs. Some of the oaks are especially susceptible. The writer recently witnessed areas where, after two successive severe swarms, many trees were dying and nearly all those remaining had many dead branches.

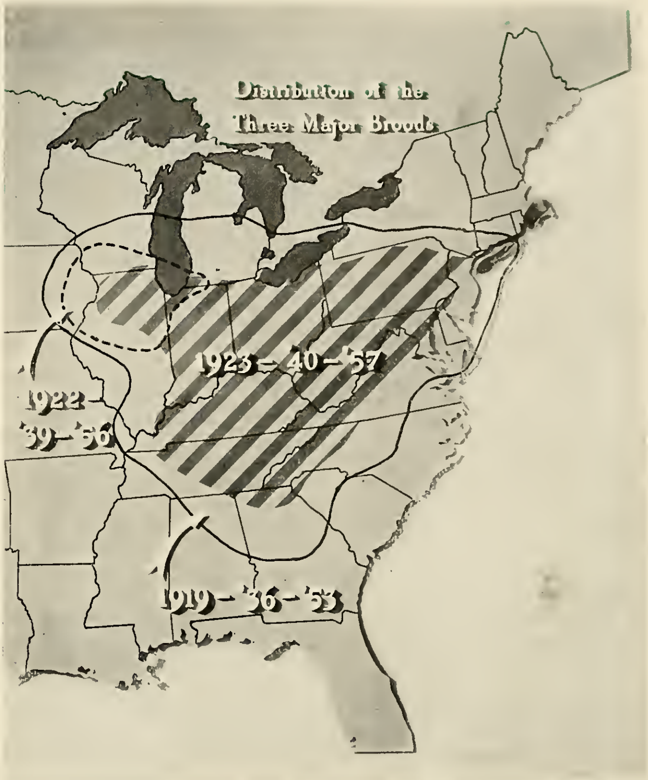
Each brood has been given a number



Seventeen and ready to mate and die within the next few weeks. The cicada has emerged from the ground and anchored its claws in the bark of a tree for the transformation

THE MAP at left shows the known areas where this amazing insect is preparing this month, after seventeen years of life underground, to make its appearance for the few short weeks of sunshine that Nature allows it. Many other regions will probably also see the cicada this year, and readers can help scientists plot the distribution seventeen years hence

THE DISTRIBUTIONS of the three major broods according to the years in which they appear is shown at right. The largest and most injurious of all of them is represented by the outside line and is known as Brood X. Similar in distribution but more circumscribed is Brood XIV, indicated by stripes. The dash line indicates the restricted but severe Brood XIII



SHEDDING ITS ARMOR. The split along the back, which began in the preceding picture, has widened in the first stages of the disrobement that will result in a winged insect

A SNOW-WHITE ANIMAL is revealed within the dark brown casing as the split widens. The transformation requires one or two hours, but cold will retard or stop the process

ONCE shedding begins, the skin is not part of the living animal and must be discarded quickly. If the insect has not anchored itself well, it will be deformed or remain imprisoned

These views from the side show how the cicada begins to free itself by drawing upward and outward and humping its back. Head, wings, and legs have here made their appearance. The insect is preparing for the final struggle for freedom

corresponding to a definite year, a Roman numeral which has definite meaning in the literature of entomology. Largest of all cicada broods is the one which last occurred in 1936, brood X, due again in 1953. Younger readers will live to see this prediction (if prediction it can be called) come true. The 1941 cicadas belong to brood XV. Many broods overlap in distribution, and so in a given region the insects may appear several times during a seventeen-year interval, but the elapsed time from egg to adult and egg again is always, as far as we know, the same. Of this time the cicada spends about sixteen years and ten months in the ground as an embryonic animal and enjoys adult existence for about one month.

During late winter or early spring the cicadas that will mature in the approaching season start burrowing upward through the earth and come to rest just beneath the surface a few days or sometimes a few weeks before they are to emerge. They may open their tunnel to the air some time before they come out. Often they construct mud turrets similar to those of the crayfish, though this is a variable phenomenon. The almost rhythmic appearance of these insects, starting just after dark and continuing until about midnight, is like something out of Jules Verne or H. G. Wells. Each night for about three weeks the emergence continues in the same manner. The almost mature nymphs emerge awkardly from their caverns and proceed slowly across the ground to a near-by tree, shrub, post, or whatever they can find to climb. Where cicada populations are heavy the movement of the insects across the surface vegetation can be heard distinctly for a considerable distance, and it is impossible to walk across such lawns or woodlands without stepping on them. Long undisturbed places such as shrubbery borders and orchards may have more than 100 cicada nymphs per square foot of soil.

When the nymph leaves its burrow and climbs a tree or shrub, it is still an immature individual, a subterranean animal that must soon discard the structures that have served it so long. Its new equipment must fit it for life in the air and sunlight. This transformation the cicada accomplishes in one or two hours, depending largely upon the warmth of the night. If it is cold, the metamorphic processes are retarded or altogether stopped. The insect climbs up a plant about one or two feet or, if its host is crowded, perhaps as much as ten or fifteen feet, until it finds a suitable resting place for its last coat of mail. It often shifts back and forth and rolls its body around for from ten to 20 minutes in an endeavor to anchor its claws deep into the bark. It must attach itself securely for this final process, for if its hold is broken after the skin begins to open it will end its life a deformed individual or may be completely imprisoned and killed by the drying shell it is trying to cast off. This does happen

Just after emerging from its armor, the creature often moves about erratically for a short while

Then it anchors itself firmly again and seems literally to pump fluid and air into its stubby wing pads

The wing pads expand as the onlooker watches them. Gradually the creature that has passed almost seven-

Suddenly the cicada becomes furiously active. Clawing the air, it grasps the sides of the shell and pulls free

Its breathing tube linings (visible above as threadlike objects) are pulled out of the holes along the abdomen

to many cicadas, especially if the atmosphere is dry and hot.

So abruptly that its beginning may be missed, the outer skin suddenly parts in a line down the back, first in the thoracic region, then proceeding forward to the head and backward part way down the mid-line of the abdomen, revealing a snow-white animal within a dark brown casing. The moment the skin starts to shed it is no longer part of the living animal and must be discarded quickly. When the fissure has opened wide enough, as the "profile" photographs show, the cicada begins to free itself by humping its back and drawing upward and outward. First the back of the thoracic region comes out, then in rapid succession the head, wings, and legs. The lining of its tracheae or breathing tubes are also cast off.

When the inner animal seems about ready to leave its shell, it suddenly bends back at a sharp angle, almost as if it were going to fall over backward, and often remains in this position for as much as 20 minutes. Sometimes it is very still and at other times its body pulsates and rotates. After remaining in this apparently awkward position for some time, the insect suddenly becomes furiously active. Its legs seem to claw the air, and it bends forward and backward several times; finally, as if by a supreme effort, it pulls itself upward far enough for the legs to clasp the sides of the nymphal shell and pull itself free. After this it often moves around in an erratic manner for a short while, and then it anchors itself again and seems literally to pump fluid and air into its stubby wing pads until at last they become fully expanded organs of flight. The cicada is still snow white, save for its pigmented eyes and two large dark spots in the thoracic region, and it does not take on its characteristic reddish-brown color until the coming of the warmth and sunlight of the following morning.

A few days after the appearance of the first adult cicadas, mating takes place, and woodlands and parks vibrate with the high-pitched din of the males. Strangely enough the females are mute. The sound of the male cicada is a high-pitched whirring sound halfway between a whistle and a siren and quite distinct from the more rasping call of the harvest fly or dog-day cicada which occurs later in the season. It has been aptly described as saying "pha-a-a-a-roh," and those who have heard it are not likely to confuse it with any other woodland sound. Shortly after the orchestral din is in full sway, the females commence to lay eggs. This is accomplished by cutting deep gashes in woody tissues with the ovipositor, the egg-laying equipment of the female, and it is from this that the damage occurs. The eggs hatch in late July and August, and tiny white nymphs wiggle out of the bark and drop to earth, often from great heights, to burrow deep into the soil that will hold them until some warm spring night seventeen years in the future.

teen years underground becomes equipped with flying apparatus for its brief aerial existence

The cicada is still snow white, except for its pigmented eyes and two large dark spots back of them

For a generation 17 years hence: a female depositing her eggs during her short life in the world we know

BIG FOR HIS DAY

Bone No. 4666 turned out to be the shank of a brand new dinosaur, greatest predator of his time and equal in ferocity to *Tyrannosaurus rex* though he preceded this famous monster by 65 million years

By GRACE ERNESTINE RAY

Two Oklahoma cattlemen went out eight years ago to wrangle some horses that had strayed, and they found something which eventually resulted in the rounding up of a petrified flesh-eating monster that was new to science. Here is the story of that extraordinary roundup which took place under the guidance of Dr. J. W. Stovall, paleontologist.

While squatting by the roadside on their high-heeled cowboy boots and watching the road-working crew on Highway 64, Pard Collins and Truman Tucker suddenly saw things which surpassed their wildest imaginings of what lies below the surface of the ground. A huge curved bone resembling a giant rib about seven feet long and one foot in circumference was turned up by the wide blade of the grader. Mr. Collins shouted, and the driver stopped the machine. The workmen and cattlemen inspected the grim apparition, with the comforting thought that they could not all be experiencing the same hallucination at the same time. They hastily scratched around for more bones and were rewarded with eye-filling discoveries, including fossilized toes about nine inches long. They concluded that they had found the "grave" of some prehistoric animal. They knew it was a *big* discovery from the standpoint of physical size, if nothing else.

Now at that time these ranchmen had not had the advantage of the popular motion picture, *Fantasia*, with its mixture of classical music, art, science, and humor, in which the horrible flesh-eating monster in Stravinski's *Spring* slays and eats a peaceful monster much larger than itself. But these cattlemen read the newspapers regularly so they had at least heard about the prehistoric animals that roamed this region millions of years before the time of the thundering herds of buffalo and the Indian tribes. In fact, Mr. Collins had a habit of wandering through the hills looking for fossils and had previously found several locations, although nothing strikingly important. A typical old-timer of the West, he lifted his ten-gallon hat and scratched his head thoughtfully as the spring breezes played against his brown, wind-bitten face.

"Let's write Stovall—that bone-digger in the University at Norman," he suggested.

"Okay," Mr. Tucker agreed.

In traditional cowboy dialect, these cattlemen did not "savvy" what the bones were, but they were shrewd enough to know they might be rare, and they

(Left) EXCAVATING a new dinosaur, *Saurophagus maximus,* who once roamed the region of Oklahoma's Panhandle and who upsets previous scientific ideas about the antiquity of huge carnivores

(Above) DOCTOR STOVALL, putting the finishing touches on a *Saurophagus* foreclaw. This lethal weapon is even larger than that of *Tyrannosaurus rex,* who came 65 million years later

were public-spirited enough to call in a museum expert instead of taking possession of their discoveries and trying to sell them as mere curios.

Doctor Stovall, with a scientist's curiosity and elation, could not wait for a week end, but placed an assistant in charge of his classes, jumped into his professorial flivver, and chugged out to the Panhandle the very next day. He took with him Mr. L. I. Price, then a student, who is now associated with the Harvard Museum of Zoology. The site of the discovery was near Kenton in Cimarron County, in that narrow strip of Oklahoma which was known as "No-Man's Land" in the Territorial days and was nicknamed the Panhandle because of its shape.

Doctor Stovall arrived quickly enough, and the hastiest inspection indicated presence of dinosaur specimens packed away in the Morrison shale, a rock formation dating from 150 to 120 million years ago and identified with the Jurassic period.

No wonder Doctor Stovall was all keyed up when he hurried back to his classrooms, even though he knew that the removal of the huge remains intact would not be as simple a job as spring plowing or branding a crop of calves. He immediately applied for federal funds from the Works Progress Administration to excavate the site, and his request was granted. A crew was put to work under his supervision. This was in 1934, and the work proceeded through the months.

Never absent from the site for any great length of time, Doctor Stovall was properly thrilled one day when he checked up and found that his colossal bone yard had yielded specimens of four known kinds of dinosaurs, including the gigantic "Thunder Lizard," *Brontosaurus,* of whom readers of NATURAL HISTORY have already read.* Like a massive petrified tree trunk, the femur or "thigh" of the giant lizard was as tall as the tallest six-foot Westerner when they stood it on end beside the Cimarron pit, and the animal was estimated to be 65 feet long. The other three known kinds of dinosaurs found in this pit were the *Ceratosaurus, Camptosaurus,* and *Stegosaurus.*

These WPA employees, contrary to the proverbial saying, wasted no time leaning on their shovels, but

**See also* R. T. Bird, "Thunder in His Footsteps," NATURAL HISTORY, May, 1939, p. 254; "A Dinosaur Walks into the Museum," *ibid.*, February, 1941, p. 74.

their assignment was long and laborious, and they had to be very careful not to chip off any pieces from the fossils found in this mysterious skeleton closet of prehistoric times. Much skill is required to excavate all around and beneath a huge block of rock containing the bones of a monster, make plaster of Paris protections for it, and remove the entire block. Week after week and month after month the project continued. Once it was discontinued for a year, but was begun again. All the bones and bone fragments were numbered, and it later proved that more than 3500 of the bones were identifiable. Apparently all the animals had lived in the region of a swampy lagoon, in a warm, moist climate, and when old age or disease crept upon them, they sought the company of their fellows on the shores of marshy lakes at their favorite feeding grounds. There they died in great numbers, and petrification took place where they lay.

One morning while visiting the site and poking among the excavated specimens, Doctor Stovall found some bones that were not familiar to him. Of course, to a layman it would be hard to find any prehistoric bone that *was* familiar, but the paleontologist seldom sees a vertebrate bone that he does not recognize as an old friend.

"What's this thing?" he asked that morning as he picked up a hefty long shank numbered 4666. He suspected that it did not fit into the skeleton of any known dinosaur. It was heavier and stockier in proportion to its length than any of the familiar brands of old-style dinosaurs already removed from the pit.

"I had no hope at first that this would prove to be a new kind of dinosaur," Doctor Stovall modestly relates. However, a greater surprise was in store for him. As he personally dug around in the pit where the strange bones had been found, he unearthed a wicked-looking claw. He saw that it was the claw of a forefoot or hand about a foot long, much bigger than those of the known flesh-eaters of the Jurassic period. Of course, he knew that the herb-eaters did not have such claws.

He collected all he could find of the unfamiliar bones, but his diligent searches revealed mainly dissociated bones, scattered about among the familiar bones of the known dinosaurs. Fortunately very few of the bones were broken. Still doubtful about the identity of his strange bones, Doctor Stovall shipped them all to Norman, went home, and then began the detailed process of measurement and comparison of the unidentified bones with the bones of dinosaurs already known. The strange bones proved to be the wrong shape and too small for the herb-eating varieties of Jurassic dinosaurs. And they were too large for the hitherto known small carnivores of that period, yet they had the characteristics of the flesh-eater. In size they reminded him of the horrible-looking *Tyrannosaurus rex* of the later Cretaceous period, yet there were very important differences.

More study and research followed, and finally Doctor Stovall knew without doubt that he had discovered a new kind of dinosaur—a genus that no scientist had ever found before! In instances such as this, no christening ceremony is held, but a new creature, even though it is only an inanimate dinosaur, must have a name—one can't simply go on indefinitely calling it "It." So the new dinosaur was named *Saurophagus maximus.*

The significance of this new discovery is that prior to this time it had been supposed that the *big,* tough and ugly flesh-eating dinosaurs appeared on earth much later—about 65 million years after Doctor Stovall's geologic debutante made its appearance in the Jurassic period. Some *smaller* tough and ugly beasts such as *Allosaurus* had already been found in the Jurassic period, but the largest of these was 29 feet long—small when compared with Doctor Stovall's big-clawed dinosaur, which measures 42 feet.

In other words, it is the first dinosaur of its kind found anywhere on earth. Doctor Stovall found the bones of two fairly complete specimens, and they are now being prepared for exhibit in the University of Oklahoma Paleontology Museum at Norman. This is easier said than done, for many weary months are required to clean all extraneous rock from the specimens, without chipping the fossils themselves. Camel's hair brushes are used, although it seems incongruous that such a delicate tool is needed to work on such colossal skeletons.

In what respects does the *Saurophagus* differ from the smaller carnivores of the Jurassic period? In total size, principally, of course, but the hands and arms are much larger, and the arrangement of the metatarsals is less specialized in that they are well separated and have no overlap. In what ways does this large-clawed dinosaur differ from *Tyrannosaurus rex,* the terrible flesh-eater that stalked about as the king animal of prey about 65 million years later in the Cretaceous period? The *Saurophagus* was much more massive in proportion to its height, and it had arms more than twice as long as the *rex,* because it had not evolved as far away from the dinosaurs that walked on four legs. Which one was more terrible, more destructive to contemporaneous animals in his prehistoric wilderness? That question is difficult to answer. Perhaps it is a toss-up. Both dined regularly off the neighbors.

To make more realistic his stack of fossilized bones, Doctor Stovall has reconstructed his idea of the new genus as follows: *Saurophagus,* measuring 42 feet from teeth to tail and boasting a height of 16 feet when standing erect, had a bulk which equaled that of a *small* house, or perhaps Paul Bunyan's bull! And when you imagine an animal as big as a house with sharp front claws eleven inches long and a mouth that opened to a width of four feet, displaying numerous saw-bladed teeth six inches long, you have reason to be glad that your appearance on earth was postponed to the Recent geologic period.

The joints of this dinosaur were close-fitting, indicating an active creature, although a modern lion could probably have run circles around him. Evidently he had the power to leap upon and bring down sluggish herb-eating animals much larger than himself, although Doctor Stovall personally doubts that his new dinosaur lunched on creatures *almost twice* his size—doubts even that the popular theory that the *Tyrannosaurus rex* performed such feats.

"Any creature, even a silly dinosaur, would use some caution and judgment about picking a fight," Doctor Stovall remarked with a smile.

Despite his strength and power and his technique in terrorizing the enemy, *Saurophagus* would never have been able to pass the medical test of a military draft board, neither would Mrs. *Saurophagus* have qualified as a "perfect 36." They were hopelessly overweight, and it is improbable that any amount of dieting would have remedied the situation. Overactive glands may account for their stupendous size, as in the case of other dinosaurs.

Be that as it may, *Saurophagus'* powerful forelegs and eleven-inch claws distinguish him as the most predaciously developed dinosaur of his day, and it is even possible that, weight for weight, he may have been a more terrible fighter than the celebrated *Tyrannosaurus rex,* who came much later.

Inspecting the pit where *Saurophagus* was found. Preliminary studies reveal its length to have been 42 feet. When standing erect the creature was 16 feet tall, and its mouth opened to a width of four feet

All photos by H. M. and E. L. Ayers

A CARIB COVE: picturesque Salybia Bay on the British island of Dominica in the Lesser Antilles, showing the boulder-strewn strand where fishing boats are beached through rough surf

On Sunday, November 3, 1493, Columbus and his followers made the first landfall, after leaving the Canaries, in their second voyage to the New World. Almost simultaneously, four islands hove into sight. The loftiest he called Dominica, in honor of the day; the others were named for his ship, the *Marie Galante,* for the Spanish monastery, Our Lady of Guadeloupe, and, to mark the attainment of their desired goal, la Desirada.

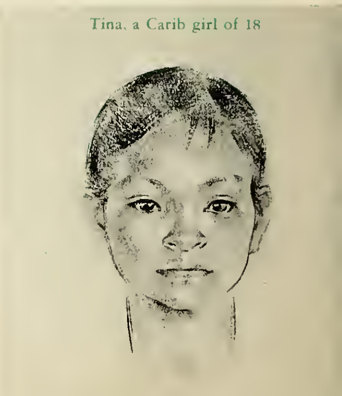
On the following days, he and his crew made contact with some of the inhabitants—the second group of "American Indians" to become known to history. Those encountered on the first voyage, the Taino of Haiti, had already told Columbus about these warring "Caripһúna" (from which our words Carib and cannibal have been derived), who by advancing through the Lesser Antilles had at that time occupied the most easterly part of their island.

Again it is Sunday, November 3, and now, from the only spot where a single native "Indian" may yet be found in the entire island chain from Florida to the delta of the Orinoco, I am looking out across the timeless Atlantic where Spanish ships were spied just 447 years ago by some long-forgotten ancestor of the men and women around me here today. For there are still Caribs on Dominica,—though they and their Taino foes have long been extinct in the other islands. Here, in the last Carib Reserve, the records of bygone days are enhanced by many living traits. It is not hard to retrace the centuries in imagination and reconstruct a scene we might well have witnessed, had we, as unobtrusive strangers,

Carib boy, Abraham John, 12

Carib woman, Alcine Joseph, about 65

Tina, a Carib girl of 18



COLUMBUS SAW THEM FIRST

They were an energetic race then, and powerful—our words "cannibal" and "canoe" stem from their language—but today the few remaining Carib Indians are a doomed people, soon to add the bones of their culture to the fast mounting heap left in the wake of civilization

By DOUGLAS TAYLOR
With drawings by HESTER MERWIN

"JOLLY JOHN," Chief of the Caribs until his death several weeks ago

visited this coastal strip in the days before the Conquest.

Then as now, we might have followed a tortuous path worn in the red volcanic clay of a hillside or in the rich black loam of decayed vegetation. On either hand great hardwood trees, whose gnarled roots provide steppingstones in the dank mire or a stairway on steep declivities, rise 100 feet into the moisture-laden air, their evergreen foliage forming a dense screen from the blazing noonday sky. Far overhead in an ungainly flight, parrots whir and scream their Carib name, *"cooriwhek, cooriwhek!"* While from some hidden branch or dark gully the mournful, reiterating notes of a mountain whistler *(Myiadestes* sp.) or the unearthly coo of a native dove put the lone traveler in mind of the spirits of the forest.

There is little else to break the heavy silence. The island's only two native mammals are not in evidence: the *manicou* (a native opossum) is asleep in his nest in the treetops, and the agouti *(Dasyprocta aguti)* is hidden safely from all but a dog's nose. True, we might meet with a hunter advancing

(Above) MIMI ETIENNE, a descendant of the Indians who greeted Columbus in 1493. *(Below)* A young Carib whose face typifies his race

(Below) DOMINICA is the last refuge of the Caribs

stealthily between his curious mute dogs *(áuli)*, bow in hand, his naked body of the same color as the dead leaves beneath his feet. And from him, had he unexpectedly chosen to be communicative, we might have learned much of what the forest meant to the men of his race. He might have spoken of bird calls and snares, of the manner of catching young parrots alive by stupefying them with the fumes of burning pimentos, of "honey-trees" where the tiny stingless native bees deposit their aromatic syrup in pockets of black wax. But more likely that native hunter would have sought to instruct us by telling of strange "precautions"—charms practiced on man and dogs and restrictions to be observed before, during, and after the hunt—rules a man must know before he can hope to become a successful hunter.

The Carib has always preferred the danger of the sea or the mystery of the forest to the monotonous labor of planting, weeding, and gathering. Most of such work he has left to the women.

Here and there in our walk we may chance upon the stout bole of a centenarian *gommier (Dacryodes hexandra* Gr.) lying hewn in the graceful form of a dugout canoe between its fired stump and severed head, waiting, amid a heap of chips, to be hauled with gaiety and song to the coast, there to be further shaped and fitted for a new and roving life.

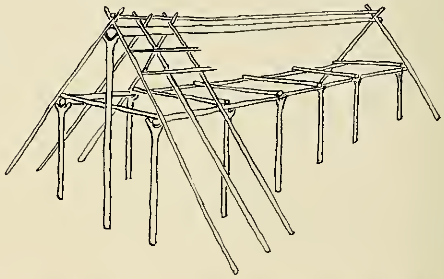
We would find clearings, too, where charred stumps and rotting logs stood out blackly in the yellow sunlight amid a purply green field of manioc. To such clearings, felled and burned by the men, the women came to plant or weed. They trudged back to the coast in the evening, their loads of manioc or sweet potatoes, pumpkin or corn, slung from their foreheads in long, narrow knapsacks of woven palm roots.

Thus the Carib's life was, and largely still is, patterned by three elements: the "high woods," in which game is becoming scarce and difficult to get as the tall trees retreat before the woodsman's ax; the "gardens," which are still cultivated by the primitive system of burning the soil and which must follow the forest inland, leaving behind an impenetrable waste of tangled weeds; and lastly, the sea, which bore the Caribs, like others before and after them, to these shores.

On the last mountain ridge the trade wind hits us full in the face with a refreshing tang of salt and ozone. Two thousand feet below, the Atlantic spreads glitering eastward, and toward the northeast the shadowy trapezoid form of Marie-Galante bars the horizon. In deeply wooded valleys and ravines between the headlands, run clear, crayfish-filled brooks that may, after heavy rain, "come down" as raging and impassable torrents.

Two essential considerations have ever governed the Caribs' choice of a site for their dwellings: the proximity of running water for bathing and drinking; and a view of the sea, their only highway. The Caribs are sailors by tradition as well as by taste, and it is interesting to note that we get our word "canoe" not from the birchbark craft of the Indian but from the Carib *kanawa*, a dugout, whose length —believe it or not—was upward of 60 feet. Its sides were raised by the addition of planks, and it was about eight feet wide in the middle. This 60-foot "canoe" carried two masts, each supporting one sail, and could accommodate 50 or 60 men at the paddles. The other type of dugout used by the old Caribs was, and still is, a smaller craft of similar construction. This *ukuni* or *kuriala* was used for fishing and short journeys. The ones made today vary in length from fifteen to 30 feet, 20 feet being the most usual size.

In the old Carib settlement a central long house, or *tabwi*, built near the mouth of a valley, formed the nucleus of what was usually no more than an extended family group. This building, which attained upward of 24 by 60 feet, served as armory, men's club, and bachelor's residence, and was usually supplemented by a guesthouse of similar construc-



tion but smaller. Two stout forked posts stuck in the ground supported the ridgepole. On either side of these came a row of smaller forks supporting a wall plate that ran the length of the house. Upon the latter rested a series of tiebeams from which the hammocks were slung. Over this framework came the long rafters, which went into the ground and crossed above the ridgepole, where they were held in place by a slighter pole resting above the crossing.

The individual houses, or *mwinã*, rarely measured more than fifteen feet by twelve feet and were of simpler construction. They were dispersed, at the owners' fancy, at various heights on either side of the valley. Each had a courtyard of beaten mud and a surrounding fringe of vegetation where such domestic plants as cotton, calabash, annatto, and herbs of medicinal or magical virtue formed a screen that hid the house and its occupants from the gaze of the indiscreet stranger.

Had we arrived in the evening, when men and women were home from their various occupations, we should have been welcomed by the one whose duty it was to receive strangers. We should have been led to the guesthouse and served with cassava-bread, *túmali* (pepper and manioc-water sauce), sákuti (a manioc beer), and whatever meat or fish, fresh or barbecued, was on hand, set before us on little basketwork tables. We should have drunk out of a half calabash that might have been lacquered and decorated with such designs as cross-hatching, Greek key, diamonds or crosses. We should have sat on long low stools carved out of a single piece of wood. Only when we had finished eating would the Chief and elders come to greet us individually, and in order of precedence. Their greeting would have been a pat on the shoulder and a *"mabwika!"* which has about as much significance as our "how do you do?"

A SCENE showing the vegetation along the coast of Dominica A CARIB FAMILY before their typical thatched dwelling

A CARIB FAMILY, representative of the only native "Indians" that can be found in the entire island chain from Florida to the Orinoco

All photos by H. M. and E. L. Ayers

(Left) DOUGLAS TAYLOR, the author, standing between "Jolly John," the chief who recently died, and Jimmy Benjamin

A DUGOUT CANOE, being stretched amidships by water and stones. The Caribs gave us our word "canoe" and distinguished themselves in the building of enormous dugouts 60 feet in length. *(Above)* Abraham John, age 12

(Below) A DEVOTEE of the traditional arts: a native making mahoe sail cordage. The Caribs were one of the few groups who had developed the use of the sail before the coming of white men to the New World

A CARIB YOUTH who, like three out of every four in the last remaining Carib refuge, is of mixed descent

THE OLDER CARIBS decry mixed marriages, but the younger ones feel no compunction. *(Above)* Mimi Etienne

All photos by H. M. and E. L. Ayers

(Below) ELWIN LUCIEN (age 45) and child, seated beside his hut

If we ourselves had arrived from the Guayanas, our hosts' appearance and manners would cause us no surprise. The islanders, like their kindred on the mainland, were mostly sturdy men of rather short, stocky build, with Mongoloid features straight black hair cut in a fringe across the forehead, and light reddish-tan complexion. Used only to a climate where clothes serve more as adornment than any useful purpose, the Caribs' principle covering consisted of a coat of vermilion paint composed of crabwood oil and annatto, and reputed to prevent sunburn and insect bites.

Two languages in each family

What perhaps would have struck us first was that the men and women did not speak the same language. We would have been told, had we inquired, that the Caribs' forefathers were a branch of the mainland Galibi. Driven from their lands, they had set sail under the leadership of a small though indomitable chief. They had landed in these islands where, after killing the native warriors, they had taken their women to wife. Since that time, their daughters had preserved something of their mothers' tongue.

The Caribs believe that a mother endows her child with its body, while the father's contribution is its spirit. This belief may explain two ancient and widespread American-Indian practices, known as the "couvade" and "cross-cousin marriage." When a man got his first-born son, he took to his hammock, abstained from all food for five days, and thereafter fasted partially for a further period. Even today the young Carib observes certain restrictions intended to safeguard the welfare of his newborn child.

Unless he were a chief, the newly married man went to live in the home of his bride's parents, who, because of the custom known as cross-cousin marriage, were often his own paternal aunt and her husband. Here he passed a sort of probationary period of one or two years, hunting, fishing, and clearing gardens for his father-in-law. His wife followed the usual household routine of fetching wood and water, baking cassava and brewing manioc beer, weaving hammocks, bands and loincloths, and going to the beach to carry home her husband's catch.

After this period, if all went well, they usually made a home of their own. If they should not agree, the man returned to his father's home, while any children remained with their mother.

Although there was a chief in each settlement and one, or sometimes two, supreme chiefs for the island as a whole, their authority was not conspicuous. These chiefs used neither titles nor insignia. They were chosen from among the elders to play the role of paternal arbiter because of superior knowledge or endurance rather than for wealth or family. In wartime, special leaders were chosen to command forces and fleets, and these had to be obeyed throughout the expedition. But in peace, within the family, as within the tribe, commands were practically unknown, and the only sanctions were those of personal or family vendettas.

Usually a quiet, gentle, and easy-going people, the Caribs are given to nursing their wrongs in fits of melancholy and to unreasonable caprice, which under the influence of drink may develop into violent rage. In the old days such was often the origin of murder or even of a war raid. Luckily, these fits were quickly spent. We are told that those prisoners who escaped the first violence of the Caribs' anger were brought home and treated by their captors as their own people. The first missionary fathers to come to Dominica in the seventeenth and eighteenth centuries also relate that the Negro slaves acquired by the Dominica Caribs were much more gently treated than by the run of white masters. In fact, these French fathers —Du Tertre, Rochefort, Breton, Labat—despite their almost total failure to make proselytes, gave the islanders a very good name. Although they deplored their laziness and indifference in matters of religion and acculturation, Breton, who spent 20 years among the Caribs in Dominica (first settled by whites in 1760) declared them to be hospitable, polite, honest, and truthful, adding that "be it said to their glory and to the confusion of Christians, they never behave publicly in an immodest manner."

Few legends have withstood misplaced missionary zeal and the general breaking up of Island Carib culture. What little survives points to a common origin with that of the Guayana tribes. Several tales current in Dominica mention a giant snake that can crow like a cock and in whose head a stone of dazzling brilliance is set. The old Caribs relate how this creature would appear in human shape to their wise men, helping, advising, endowing them with charms, and even on occasion begetting the early progenitors of their nation. One of the latter, Bakámõ by name, had, they say, the body of a snake with a man's head; he was carried out to sea where he became the constellation of that name (our Scorpio). Other stories identify other constellations and heavenly bodies with early culture heroes, but never as objects of worship.

Medicine men

There existed a class of men called *bwayé,* or *piayé,* who, in order to become "wise," submitted to a severe and often painful apprenticeship, which enabled them to fulfill the role of doctor, priest and sorcerer. They acquired from their masters one or more familiar spirits, which they evoked by incantations and offerings whenever the need for consultation arose. I have spoken to old Caribs who remember such séances. They tell me that offerings of cassava and rum* were placed on tables on one end of the *mwinã*, which was completely darkened. The *bwayé* would sing and mutter, until the spirit "fell in" with a thump. The spirits spoke in strange voices, and "you could not tell what they were saying, but you could hear the 'glou-glou' sound as they drank the rum." When the house was re-opened, the offerings appeared to be intact and were consumed "early in the morning before eating" by those who so desired. The spirits, I was told, consumed "only the soul of the offerings."

Like their kindred in Guayana, the Island Carib still believes that the woods, rivers, and sea are the homes of particular kinds of spirits. On occasion, these may show themselves in a benevolent light, but their appearance is more often of evil omen to man.

Trade

No doubt even before the coming of white men a barter went on between the mainland and the islands. Crescent-shaped ornaments of a gold alloy called *carácuri*, green stone charms, and no doubt certain raw materials and products made of them must have been acquired from the mainland either by war or in exchange for something, perhaps canoes, that the islanders made with greater facility. But all in all, each island and even each settlement in the island was independent of others for their everyday needs. Hardwood was varied and abundant for all purposes, but iron and bronze were unknown, and stone-cutting implements such as axes, adzes, and knives were tedious both to make and to use. For that reason fire was often used to fell a big tree. Nevertheless the Caribs, or their Taino predecessors, used to manufacture by primitive means and through months of labor not only weapons and tools, but also pierced cylindrical beads and carved figures of stone. Whenever possible, the Carib made use of natural objects: thus, his fishhooks were usually a kind of thorn, his arrow points of wood or reed hardened by fire, his scalpel, the pointed tooth of an agouti set in a leg bone of the same animal. Fishbones provided him with needles, necklaces, and boring instruments. The women made some pottery when suitable clay was at hand, and calabashes of all shapes and sizes provided the kitchen with a varied array of buckets, pans and dishes, boxes and bottles.

*Introduced by white men. In earlier years native beers were used.

Meat and fish are roasted directly in the fire, or smoke-dried on a wooden grill over it. The basis of the Carib diet is manioc. Because the tuber of this plant contains a cyanic poison, it has to be rendered harmless by fire before it can be eaten. Without necessarily crediting the Carib with the original discovery, we must marvel that a plant which is poisonous to eat should have been made edible by a process so complex. The tubers are peeled, washed, and then grated into a vessel rather like a small, six-foot dugout canoe. The resulting pulp is next squeezed in a long, stocking-like contraption of close-woven basketry, called *matapi*. Then it is sifted through a basketwork sieve, or *hebichet*, and finally baked on a stone slab either into thick, round cakes of cassava-bread, or by constant stirring, into a coarse meal. The water squeezed out of it soon deposits a fine starch, which may be added to the meal or used separately. As for the remaining manioc water, it can be boiled together with pimento and other seasoning to form what is known to the present-day Creole as pepper pot or cassareep, and to the Carib as *túmali* or *syúti*. After being sufficiently boiled, the manioc water is reduced to a thick brown sauce, which has the quality of preserving any meat cooked in it. For drink, certain thick cassava cakes were formerly chewed by the maidens and spat into a vessel containing water. After a few days' fermentation, this mess was strained and drunk under the name of *ouíku* or *sákuti*.

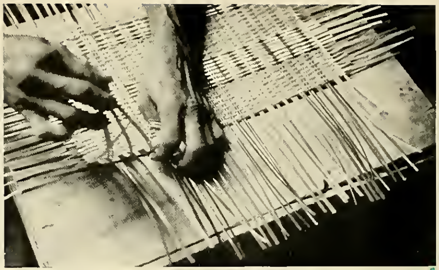
Apart from their household duties, the women looked after the gardens, collected fruits and berries, made crabwood oil and paint, decorated pots and calabashes, painted the men, spun cotton, and wove hammocks. The hammocks sometimes attained twelve or fourteen feet in width and were closely woven on a simple frame without—according to Breton—either heddles or shed-stick!

Besides hunting, fishing, and clearing land for gardens, the men made dugout canoes, paddles, sails, and fishing line from a species of bromelia, together with the axes and adzes used in their making. They carved war clubs, stools, bowls, and cassava troughs out of red or yellow hardwoods. The same sort of war clubs are used nowadays for killing fish, and are called by the same name, *bútu*. Besides this the men made most of the basketry and other utensils used by the women. It is small wonder that they had but little conception of the passage of time and the value of strange articles.

Outside influences on the Carib

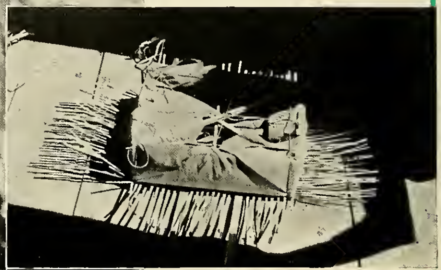
Although contacts between Carib and European or Carib and Negro must have been few and far

A NATIVE weaving the outer layer of a waterproof basket



A CLOSE-UP of the weaving shows artistic workmanship

All photos by H. M. and E. L. Ayers



A BANANA LEAF lining goes between the inner and outer basket covering

THE COMPLETED BASKET, fitted with handles, is a useful object of trade between at first, acculturation began at an early date, as is shown by the "Caribized" words of Spanish origin included in Father Breton's dictionary of 1665. There were at that date Caribized words for horses, cows, pigs, goats, and rats, guns, knives, nails, needles, plates, iron and silver. The words for clothes, hats, shoes, and smallpox had also been adopted into the Carib's idiom, and it seems probable that the things they stood for, despite inborn conservatism, had influenced his culture to some extent.

As long as the Carib had to depend upon his own efforts to produce not only food and housing, but also his tools and weapons, utensils and ornaments, he maintained through tradition and invention a relatively high standard, which doubtless would have improved as time went on. But when he was confronted with the products of a technique far beyond his comprehension and ability, a technique which included guns and steel axes, he naturally abandoned his native crafts, to devote himself more and more to the production of articles for exchange or sale. Unfortunately, most of his products had little value to the Europeans except as curiosities; and so the more he produced, the less he received in exchange. When he was unable to improve his technique,—and this usually was the case—, the Carib could only lower the quality of his work. Moreover, not all of the European products that appealed to the Carib were as useful to him as guns and steel axes. The labor expended for the purchase of clothes, hats, shoes, rum and so on was simply lost, because these things replaced nothing in his old economy. Time hitherto devoted either directly or indirectly to the production of food or comfort was henceforth used, for example, in cutting timber and building canoes to sell to the white man. This process, which is not yet complete, has led on the one hand to a lamentable deforestation, paucity of game, and impoverishment of the soil; and on the other hand, it has led to frequent visits to the town, from which the Carib returns without anything to show for selling his canoe except a sick headache, or at best, some gimcrack and useless product of "the export trade." I had almost reversed the order, and said, "at best a sick headache," for the Indian thoroughly enjoys getting drunk, while the more solid goods hoisted upon him merely delude his misguided vanity.

The retreat before civilization

Innate shyness and conservatism as much as European musketry drove the Carib to the more rugged isles, and in them to the least accessible parts of the windward coast. After the last of their number in St. Vincent had perished in the volcanic eruption of 1902, Dominica remained the red man's sole island of refuge.

By that time, bows, arrows, hammocks, and native pottery were forgotten, and had been replaced (among those who could afford them!) by guns, beds, and cheap crockery; but the Caribs' voluntary isolation, coupled with their paltry commercial value and hard-dying reputation as "dangerous savages," ensured them a relative independence that since then is slowly being broken down by the incursion of Negroes.

It is in the past 40 years that this small group has suffered what is perhaps its greatest loss of integrity—its language, or languages. Doubtless to some extent mutually corrupted, these two idioms subsisted side by side until about the end of the first decade of this century. Both succumbed before the French Creole patois of the West Indian Negro and "colored man." Even today, when their memories of what they laconically term "the language" are jogged, old men and old women of the Reserve still often give different words for the same concept. But with the last Carib speakers there doubtless disapeared many cultural links with the past that never can be replaced. The use of a common idiom leads inevitably to a community of notions and mental attitudes. And so it is that the Island Carib of today knows little about his own culture and nothing about our culture except, as it were, through Negro eyes.

Intermarriage

Although the older Caribs sometimes declare that *"mékeru k'hínsi kasi kámukuru"* (Negroes stink like grass gourds), the younger generation feels no compunction at interbreeding. Out of 400 inhabitants of the Reserve today, 300 are at best, as they themselves admit, *"bâtards Caraïbes"* (half-breed Caribs).

The girls no longer take easily to the old ways, and demand, like their colored sisters, hats, shoes, and sewing machines. The boys learn just enough at school to lose interest in the old pursuits, and far too little to have a chance of success at the new ones. Few are those who still take readily to fishing, and fewer still are those who have any skill or liking for the hunt.

Basket making and canoe building of an inferior quality, together with sawing boards and scantlings, continue chiefly because they are usually the only available means of obtaining the money to buy the products of the colored trader. Many still yearn for a roving life, but it is to the plantations and sugar mills of Guadeloupe, Santo Domingo, and Cuba, or to the oil refineries of Curaçao that they aspire, rather than to the rivers and forests of their Guayana forebears.

domestic animals, which are docile and accessible. Every home has a picture of its own familiar dog or cat or cow or horse. But how many of these photographs of pets possess that quality of telling more than size, shape, and external pattern of the animal? Pictures which portray, in addition, individual characteristics, racial or hereditary instincts, moods, capacities, and vagaries are worth while, and they can be got.

I have been matching human wits against animal craftiness since I was old enough to shoulder my dad's big ten-gauge duck gun, and that is several decades ago. For 20 years my duties as a field naturalist required (among other things) guns, traps, and labels. A camera was something in the nature of a luxury. But from the moment it became my privilege to discard the guns for the camera, I have discovered there is infinitely more satisfaction and glory in shooting an animal with a lens than in stopping a leaping life by a high-powered bullet. Incidentally, I am not a reformer. Hunting is grand sport, providing a temporary freedom and pleasure to unnumbered millions who have come by the urge to track down and kill through the brave blood of hunting ancestors. But I do believe that, with most of us, a saturation point is reached. And when that

(Left) A MULE DEER

HIDE AND SQUEAK!

—if you want to get good animal photographs

By H. H. SHELDON

With photographs by the author

NATURALISTS ARE curious eggs. And there are, in these United States, millions of embryos of curiosity. This expanding curiosity regarding Nature and her ways sends into the wilds its volunteer army, superficially trained in wildlife and woods lore, and armed with every type of camera from miniature to movie.

Curiosity and encyclopedic knowledge of the wilds and its creatures are not enough to capture that universally sought rarity, a good bird or animal portrait. If the amateur naturalist is consistently to bring-'em-back-alive on film, he requires not only time, patience, and no small amount of hard work, but an intimate knowledge of the domestic habits of wild animals and birds, plus something more.

That this "something more" is essential to good animal photographs is immediately apparent when one considers the scarcity of real portraits of

time comes, the camera ranks as a more potent weapon than the gun, requires a more subtle type of hunting skill, and provides more lasting pleasure. Curiously enough, experience and skill in rifle hunting are fundamental assets in acquiring skill in camera hunting. And of those requirements conducive to that "something more" requisite to animal photography, one of the most important has been brought directly from the sport of hunting with a gun.

This important equipment is in reality a lure. It is used by naturalists the country over to decoy birds and animals within range of either gun or camera. Like most important things, it is so simple as to conceal its own importance from the uninitiated. In the realm of "ologists" it is known as "squeaking": simply a matter of compressing the lips and sucking in at the corner of the mouth. Some of us have perfected it to greater degree than others, not because of anatomical advantages, but by the canny use of imagination.

A naturalist can identify any bird or animal by its song or cry. In addition, he knows which birds and animals prey upon which others. Combining these two sets of facts with a little imagination, he can learn to produce a squeak which will imitate a robin in distress, the squeals of a trapped mouse, or the whimper of a lonesome pup. Cupping the hand at the corner of the mouth controls or amplifies the volume. With a little practice, anyone can become an expert squeaker-upper. Since the day, years ago, when I first beheld this stunt in operation it has been my most potent lure in outsmarting wise old Mother Nature. Deer and hound, hawk and chicken, skunk and house cat —they all fall for it. Birds and animals are as curious as naturalists, and are intrigued by any sounds which do not frighten. I have squeaked the wariest hawks to within a few feet of me, likewise some of the most sensitive and fearful of animals. I have stopped the weasel in his tracks to about-face and sit up like a rabbit almost in my lap; muskrats to turn in midstream and swim right up to my hand; and on the wild deer to pose for me, stamping their feet in exasperation at the sounds of a fake tragedy. I have squeaked the timid ground squirrel from his subterranean haunts to pop up for a three-foot shot; and the badger, like the weasel, becomes a sucker for the squeaks of a rabbit in distress. The handsome skunk is unsuspicious of this sort of lure, and will present his better end for a portrait.

I could go on adding up the times when the squeak has produced salon winners,—but wait. There's a string attached to this squeak. And a literal string, at that! For not all animals are as brazen as the weasel, or as indifferent as the skunk. Nor would a ground squirrel pop up from his burrow if you squeaked him up with camera in hand for a three-foot close-up. But if your camera is set for a three-foot shot, while you and your squeak are hidden behind a bush some 30 feet away, the ground squirrel will be more than apt to surface for a look-see. One did for me. I pulled the string, the shutter clicked, the ground squirrel screamed as he scurried down under faster, it seemed to me, than the 250th of a second at which I shot. But the squeak, string, and shutter were perfectly synchronized, and an interesting photograph was recorded.

At this point those who have not tried it will be tempted to believe a telephoto lens is the thing with which to get good animal portraits. A telephoto lens is a real advantage whenever the subject is in the open for a clear and unobstructed long-range shot. But it cannot see the small, shy animal peering up through high grass, nor the larger animal separated from the camera by thick undergrowth. To catch these, the camera must be near the subject while the photographer and his squeak and string are at a hidden distance.

(Above) AN INTIMATE MOMENT: mule deer and fawn, taken on Verichrome at 1/100 second and f:6.3

A little ingenuity is required to invent a gadget to release the camera shutter by means of a string or thread. For one, a Contessa Nettel, I have contrived a brass band that is adjustable and can be slipped onto the camera in a few seconds. To this band is riveted a piece of clock spring, also a two-inch strip of brass, which acts as a trigger to release the spring. The string is attached to the trigger. When ready to use, the cable shutter release is removed from the camera; the band is slipped over the camera so that the spring fits over the shutter plunger; the spring is then pulled up and cocked by the trigger. A pull on the string (I use a level silk fish line) releases the spring, which snaps against the plunger and releases the shutter. This may sound a little like a Rube Goldberg design, but actually it is quite simple. Best of all, it works. I have taken photographs from a blind a distance of 150 feet from the camera, though 30 or 40 feet from the camera is more usually the case. Here again, distance from the camera is largely determined by the temperament of the subject, and by the type of country in which one is hunting.

There is no copyright on this hide and squeak method; but if you use it, I am sure you will get pictures you will want to copyright.

(Below) A GROUND SQUIRREL at his hole

One-Man Explorer

Without benefit of base camps and elaborate supply lines, Harry Raven has ventured alone into some of the world's least known jungles. These exploits rank him among the great fieldmen of our time, while his laboratory studies in Comparative Anatomy have brought him international scientific fame

By D. R. Barton

A few years ago, visitors lunching in the American Museum restaurant were not infrequently disconcerted by a peculiar grunting sound which seemed to be overtaking them from the rear. Native New Yorkers, inured to the unexpected and accustomed to the cacaphony of metropolitan civilization were perhaps less apprehensive than the sprinkling of celebrated world-travelers. But even New Yorkers turned to stare when the curious sound turned out to be the "hunger cry" of a chimpanzee who entered the restaurant riding a kiddie-car.

Quite the calmest person in the room was the chimp's companion, a mild-mannered, unobtrusive gentleman of medium height whose bald head, close-cropped moustache and conservative dress bespoke a professional man, possibly a family physician, certainly the last type on earth Hollywood would cast as an intrepid explorer. Yet Harry Raven had known what it was to lie near death in the African jungle, leagues from the nearest white man, and he had become, for a time at least and in his own fashion, a wild man of Borneo.

But the chimpanzee held the center of the stage. She rode her kiddie-car on into the curators' end of the dining room, where she was ensconced in a high chair and served two helpings of ice cream. It is generally believed that she was the first ape to be accorded quasi-membership on the Museum's Scientific Staff, though some people regard the matter as controversial. At any rate, the curators were unanimously devoted to "Meshie."

Her foster father, Henry C. Raven of the Department of Comparative Anatomy, had brought her back from Africa and raised her with his own children at Baldwin, Long Island, where she delighted in the seasonal occupations of cycling and sleigh-riding, respectively. Raven probably derived a certain faintly malicious satisfaction from the momentary disruption which her grand entrance *en kiddie-car* never failed to produce, for his earlier experience with museum restaurants had been something of a disappointment.

To forestall any damaging miscon-

Blackstone Photo
Henry C. Raven

ceptions, it should be said immediately that he wasn't poisoned. Indeed it was not a matter of gastronomics but of degraded talent (or so it seemed to him at the time). Back in 1907 when the youthful Harry Raven, just out of Bay Shore High School, first applied for work in the Museum, Doctor Bumpus, then Director of the institution, told him that as far as taxidermy was concerned the Museum needed the Paderewskis of the art, not the run of the mill. Bumpus consented, however, to take him on trial. Soon thereafter, Raven's high spirits were considerably deflated when he was assigned the job of making plaster models of the Mitla ruins in Mexico, instead of work concerned more directly with natural history. This was in connection with curious ideas on interior decoration then buzzing in a number of important bonnets. Someone had suggested pre-Columbian ruins as the most appropriate motif for a Museum hostelry, and the machinery of the institution was solemnly set in motion grinding out archaeological facsimiles for the Mitla restaurant, now happily extinct.

Since young Raven had set his heart on being a preparator of animals he found this "building trades" assignment rather distressing. He was, it is true, given several tasks, such as collecting birds on his native Long Island, which were more in line with his aspirations, but as time went on he thought to better his circumstances by following Horace Greeley's historic success formula.

However, he never reached sunny California but obtained work in the Museum at Denver where he collected specimens in the surrounding region with Albert E. Butler, whom he had known at the American Museum. The expedition continued until the fall of 1911, when he returned to New York and not long thereafter received a letter from the Smithsonian Institution in Washington asking if he would like to collect in Borneo. This was more like it. Raven accepted at once and Dr. W. L. Abbott of Philadelphia, whose work he was to take over, suggested a British tramp steamer—that is, if he were looking for "a little excitement."

Raven presently discovered that Doctor Abbott was given to understatement. The freighter's Captain signed him on as ship's surgeon. Purely, Raven supposed, as a formality. His prospects were somewhat clouded, however, before the ship had cleared Sandy Hook. The freighter was alleged to be carrying a "general cargo," but at this point he was rather dismayed to find her taking on 25 tons of dynamite.

It never went off—at least not in Raven's immediate neighborhood—but the crew provided explosives enough. Before they had lost sight of land the first mate sprang a toothache. By chance Raven had a set of dentist's hand pressure drills which a friend in the profession had given him with the idea that they might come in handy. Raven had signed up for quite a stretch in the East Indies and he inferred that he was being invited to fill his own teeth. So why not practise on the mate? The latter agreed. Raven daubed a little carbolic acid into the cavity and proceeded to attack the more or less anesthetized molar with much gusto and considerable natural skill. He cut away as much of the decayed matter as he could and filled up the cavity with gutta-percha. The mate was so pleased with the results that he refused to consult a professional dentist at any of the ports of call.

This feat established Raven in the eyes of the Chinese crew as a true healer. One night a messenger informed him that one of the stokers was "pretty sick." Raven made his way below with the Captain and found that the stoker had received a nasty bash over the head with a meat axe. It seemed he demanded hot tea from the cook at 3:00 A.M. Raven took a few stitches in the scalp and sealed it over with balsam in the old time seafaring fashion.

Later that same day Raven was standing on the bridge with the Captain when one of the boys came up and said, "Cook, him want medicine."

"Probably killed him," grumbled the Captain.

They found the cook rather badly cut up. He had watched the stoker warily, but the sly fellow hid a mechanic's hammer in the washing bucket, and the moment his erstwhile assailant's back was turned, out came the hammer and down went cookie under a series of savage blows which cut to the bone, though fortunately not through it.

A day or so later, Nature tried her own hand at trouble making and raised a terrific storm. Waves broke over the entire ship, tore away the awnings from the Captain's bridge and forced the crew to throw over considerable cargo. Various repair jobs were undertaken near Gibraltar and on the way to Algiers, but no sooner had they put out to sea again than the ship was waylaid by an Italian warship. Turkey was at that time fighting Italy, and the Italians were looking for a deck cargo of war materials. They sailed alongside, inspected the deck, then signaled the freighter on with best wishes.

In due time, Raven caught his first glimpse of the South Seas and the sight stirred his pulse. It seemed almost beyond belief that the youth who had so lately felt himself in a prosaic rut at the Museum should now be cruising through the fabulous waters of Conrad and Kipling.

South of Suez

To keep the crew occupied, the Captain ordered a rust-chipping bee, passing out hammers and swinging a scaffold over the vessel's side. This monotonous *corvée* under a blazing sun is apt to bring on what the French Legionnaires call *le cafard* (the cockroach: akin to our "bats in the belfry"). Presently one of the sailors went berserk, and while he was apparently calmly at work flaking off rust, he suddenly flung his tool down at the sea and jumped overboard. The freighter slowed and swung about as quickly as the maneuver could be negotiated. Raven, who had bought a pair of binoculars in Algiers, was told to keep the man spotted until a lifeboat could be launched. But the auxiliary craft proved so desiccated that its seams were open and it leaked like the proverbial sieve. Meanwhile the sun-struck sailor was swimming along quite as if he were born to an aqueous medium. Indeed, he was so content with the cooling brine that an oarsman had to bat him over the head before he could be corralled. There was little time to lose, and they barely made the ship before the waters closed over the lifeboat's gunwales.

As the freighter slid into Singapore the smells of coconut oil cooking and of the Chinese quarter in general were everywhere on the soft tropical breeze. Raven thrilled at this first approach to the true Orient. He was now definitely east, not to say south, of Suez and he became convinced that if the worst and the best were all one in these parts, it would be good enough for him.

Before long he went to Java where he obtained all the necessary permits to collect in Borneo, to which island he made his way by another steamer. His mission called for a broad general collection. All manner of birds, mammals and other animals, great and small, were grist for the Smithsonian's mill.

This initial trip into the interior by river boat took but two months of the six years he was ultimately to spend in the East Indies. He lived almost entirely on canned goods for six months until he got the hang of things. Then he began to "go native" for fare, as it were. He bought a 27-foot *perahu* with a huge tree root anchor and rope made out of coconut fiber, for the sails, and in this craft he voyaged for hundreds of miles along the coast of Borneo accompanied by a Chinese boy and two or three Soloks. These tribesmen were outlaws who had once made their livelihood in the Philippine slave trade until the United States armed forces took a hand in these affairs. They felt quite indignant over their extra-legal classification, and Raven had to assure them that his expedition had nothing to do with American policy in the Pacific. He adapted himself readily to their diet and general way of life, and within a few days they were all fast friends.

On shore Raven obviated the problems of overnight camping by simply putting up in native villages along the way whenever these were available. Once he stumbled on a cluster of huts at sundown and asked the affable old head-hunter chief if it would be agreeable to collect some of the animals that abounded in his territory. The chief suddenly frowned. Raven, who has a gift for languages, questioned him further in Malay, trying to find out what the trouble was. It appeared the local potentate was dead set against bringing any striped animals into the village before the rice had grown to be a foot in height. Any other kind was perfectly all right. Raven never batted an eye at this puzzling distinction, while assuring his prospective host that he hadn't the slightest intention of collecting striped animals until the rice was a foot high. The chief brightened instantly, and thereafter all was serene.

During this trip, Raven was the only white man in the whole region. In fact, much of the wilderness he explored was uninhabited even by natives; and many a time he trudged out of the virgin forest onto a perfect Robinson Crusoe ribbon of beach to watch monkeys come down out of the trees at low tide to catch crabs. On moonlight nights he would gather his native helpers, and, armed with fish nets, they picked their way along a chain of magically illumined coral reefs which had probably never before supported the tread of a human foot.

The jungle yielded all kinds of exotic vegetables and greens, and they lived off the land entirely except for rice which they kept stored in the boat together with cured meat and fish smoked over their own campfire

Hunting was hard work in these uncharted, trailless regions, but in time Raven had collected an astonishing array of creatures — unobtrusive rodents and bats, monkeys, orangutangs, bears, birds—in addition to such spectacular animals as the clouded leopard, which he considers the most beautiful cat of all. Because the country was practically unexplored it was natural that Raven should discover many new species, and he even had one genus of bird (*Coracornis raveni*=Raven's bird) named for him.

Inland

After more than two years wandering in Borneo, he bought a schooner and sailed to the Celebes to continue general collecting on that mountainous island. But here the character of the terrain obliged him to use pack ponies rather than river boats. As in Borneo, his commissary consisted of taking pot luck among the natives, whose cooking was very much to his taste. But here the pickings were sometimes pretty slim. For the first World War was in full swing by this time and the British had cornered most of the rice in that part of the world for their labor conscripts. The repercussions of this act were felt even in the most remote villages. Prices shot skyward and people sold all they had, saving little or nothing for themselves. As a result, Raven's Borneo-trained appetite stood him in good stead. He had learned to enjoy broiled squirrel, at which even the natives turned up their noses, saying it was only a rat with long hair on its tail. He had also devoured turtle eggs, although their whites remain in an absolutely gelatinous condition no matter how long you cook them. And what with one thing and another he was prepared never to flinch at whatever articles of diet fortune provided.

While in the Celebes, Raven took up the habit of chewing betel nut. He was supposed to pick up ethnological material in addition to his zoological collecting. This end of the expedition interested him greatly but he found it very difficult to persuade the natives to part with some of their more sacred talismans and charms. It was their custom, however, to carry suchlike in little bark cloth purses, in which they also kept betel nut and "mixings" (lime secured from burnt sea shells and a rather villainous black tobacco). Raven's chewing was not so much part of his program for going native as it was wily subterfuge. He thereby won the right to borrow a "cud"—the men were always hospitably offering their little purses to him—and he would rummage around, ostensibly selecting a toothsome morsel of betel nut but accidentally-on-purpose coming up with some charm or relic which might be traded for. He got quite as accustomed to the betel nuts as to turtle eggs and although he never exactly relished the taste, he managed to make a good showing without doing any particular injury to his teeth. The natives, of course, gradually rot their own dentition, of which they take very poor care at best. Raven frequently saw them sitting on the ground filing away their teeth with a stone in order to procure a level biting edge. They regarded his own jagged incisors as unmodish "monkey's teeth" and would keep on rasping until they had ground away the enamel and some of the dentine. Raven, needless to say, drew the line at this point. However, he did accidentally take part in one rather harrowing episode which seems to supply proof positive, if any be needed, that practical jokes are seldom worth the candle.

A native girl had offered to open a durian fruit for him, and Raven, as dubious reward for this kindness, decided to play a trick on her, which involved seizing the blade of her knife in a loop of cloth and by a quick flick of the wrists snapping the blade out of her hand. As so often happens, the trick missed fire, and the blade of the knife, instead of flying off at a tangent, missed its aim and struck almost clean through the girl's thumb. Mortified, Raven dressed the wound as best he could and offered to take the girl to a doctor on the coast who, he told her, would cut the member off and sew it over nicely. This proposition did not attract her at all, so he continued to treat the patient himself and after a time found, to his relief and considerable medico-scientific excitement, that there was still circulation in the splinted digit. By careful binding he was able to restore the thumb almost to complete function—a feat of which he felt justifiably proud. He was still a good "ship's surgeon."

As a matter of fact, this surgical skill, like his interest in traps and animals, had been typical of Raven since early school days. During high school he frequently accompanied a veterinary surgeon on his rounds and had performed a number of operations under his direction. Indeed he might well have followed this profession had not his all-absorbing hobby, taxidermy, led him to seek work at the Museum.

However, his interest in animal anatomy had never slackened. Moreover, the skinning and dissecting work on his specimens only served to whet his curiosity concerning the function and evolution of musculature and internal organs throughout the animal kingdom, so that when it came time to leave the East Indies his compass already pointed in the direction of comparative anatomy.

Hollywood Africana

At the outbreak of the first World War, Raven went back to the United States but there seemed little immediate likelihood of America's entering the conflict, so he returned to the East Indies. Then when he got news that America had finally gone in, he tried to get back again but had a very difficult time of it since many Dutch boats had been interned. Arriving by way of Hawaii, he found that he had already been drafted, though by the time he was ready to go to camp the Armistice had been signed and he was left stranded in the midst of civilization.

But Raven was not long for these parts. After a semester at Cornell as a special student in zoology, he took ship* for Africa, again serving the Smithsonian Institution as a general collector. This second expedition was sponsored jointly by the Smithsonian and Carl Laemmle's Universal Pictures Corporation, which had dispatched a lavishly accoutered staff of cameramen, actors, and a director to make "educational" films on the Dark Continent. But to get such pictures, Raven avers, they would have had to use a distinctly different type of men from the ones they took.

Both Raven and Doctor Schantz, a botanical colleague, advised them on photographing game and other natural history subjects, but the Hollywood men had a mind of their own and went off at a rather bizarre tangent which Raven felt would bring them to no good end. He was shocked, though not altogether surprised, to receive a telegram, brought several miles to camp by a native runner, stating that Armstrong, the leader, and Stoll, an actor, had been killed in a railroad accident which took place in a part of the country they might better not have entered in the first place.

After this trip, Raven returned to his original starting point, the American Museum, as a student of Doctor

*The *City of Benares*, recently sunk in the Atlantic while carrying refugees.

William K. Gregory,* then recently appointed Curator of the Department of Comparative Anatomy. It was not long before Raven was assisting him in various projects, among which was the plan for an Australian Hall in the Museum, favored by President Osborn. At Doctor Gregory's insistence Raven was more or less drafted for the proposed expedition, and from that time forward he became Gregory's right-hand man in the laboratory and classroom, as well as chief operator in the field.

Australia

In Australia, Raven found many strange creatures that Gregory had lectured about. He caught flying phalangers by night, and with the help of dogs, curious burrowing marsupials by day. He hunted the Tasmanian devil and trapped the echidna, a queer egg-laying mammal. The unique duck-billed platypus was also entered in his ledger, as were an amazing variety of kangaroos, ranging in size from little "hoppers," at full growth no bigger than rabbits, to giant 200-pounders. Of all the Australian animals, these kangaroos are the most significant from the evolutionary standpoint, though the whole fauna sends Darwinians into transports of joy.

By this time, Raven was prepared to settle down and write a monograph on the entire tribe of kangaroos as object lessons in evolutionary radiation. He succeeded in getting out several articles, one for the *Encyclopædia Britannica,* but after a year or two at the Museum fate contrived to toss still another expeditionary opportunity into his lap. Captain Bob Bartlett was Greenland-bound on the celebrated schooner *Morrissey* and Raven yielded to the temptation of exploring northern latitudes in general and the anatomy of narwhals in particular.

Whales, indeed, virtually flung themselves at him. He had scarcely resumed his magnum opus on the kangaroo when a young sperm whale swam into New York harbor and was killed in Brooklyn's Gowanus Canal, of all places, whence it soon found its way into the Museum. No comparative anatomist could pass up such a boon, and Raven set about dissecting it at once. The huge cadaver was placed in the new but unoccupied Hall of Ocean Life, and there the scalpel work proceeded until the late Doctor Sherwood,

*See "The Evolution of an Evolutionist," by D. R. Barton, NATURAL HISTORY, April, 1941, p. 234.

then Museum Director, threatened to have both Raven and his specimen fired summarily into the street. The operations had been conducted within olfactory range of his office.

Pedagogue

Try as he might to devote some of his time to the material for the proposed Australian Hall, distractions multiplied at such a rate that he could give it little more than a lick and a promise. New York University invited him to lecture for a year, and immediately thereafter Columbia stole him from under its rival's nose to serve as Doctor Gregory's faculty assistant. His dissecting work, always the marvel of his colleagues and his most absorbing interest, was beginning to attract considerable attention. Within the year Johns Hopkins offered him laboratory facilities for the purpose of broadening his knowledge of human anatomy which he felt necessary to a proper study of the apes, a project then looming large in Gregory's program.

1929 found him back in Africa, leading an expedition to collect gorillas for anatomical study at the Museum and Columbia. This proved an extremely difficult assignment and though Raven eventually secured several large males, he failed to bag a single female. But he did not give up without a struggle that very nearly cost him his life.

Plodding deeper and deeper into the less habitable areas of the Cameroon forest, Raven found every effort to secure female gorillas thwarted by the protective habits of these gregarious animals. Whenever he surprised a herd containing the coveted specimens, they would melt silently into the impenetrable foliage while a giant male covered their retreat with reckless charges. Month after month Raven pressed on after these apparent will-o'-the-wisps until a combination of hookworm, malaria, and sleeping sickness "made it a little difficult to do much hunting."

Raven had had malaria in the East Indies and once before in Africa. And when the fever came upon him again he thought he had merely a trifle more severe case. Dosing up with the usual quinine, he let it go at that, ordering his "boys" to set a camp chair for him in a likely clearing. He was too weak to stand but he knew that a half-dead white man is a better shot than these particular natives, and he *did* want those specimens.

Later it was found that what he had was the dread sleeping sickness, contracted from the bite of a tsetse fly. Not that he did much sleeping. Apparently, the chief drawback is that you *can't* sleep. The patient is subjected to a blinding headache which keeps him up all night, allows absolutely no rest, wears away all resistance and reserve fat, and finally through sheer exhaustion produces a coma (the "sleeping" part of it) which may lead to death.

Presently Raven lay delirious on his cot in a native hut with nothing but witch doctors available for 50 miles around. Then came the coma from which he woke suddenly to find a crowd of bug-eyed negroes standing over him. Said one of them, "If this white man not dead today, he be dead tomorrow." Raven was beginning to believe them. He remembered that a funeral every ten days was normal in this locality, and he thought that perhaps it was high time to send for assistance.

He also directed his camp boy to keep the kettle boiling always on the fire and the minute he seemed to be going into a stupor to make him a cup of strong tea. He hoped under this rather mild stimulation to keep alive until the messenger could walk the 50 miles to a Presbyterian Mission station where lived a certain Doctor Lehman. The latter arrived the next afternoon on a motorcycle and hustled Raven onto a conveyance, which transported him to the hospital at the Mission. There, under Lehman's skillful treatment, he partially recuperated and helped the latter in his surgical work. Raven found this experience most helpful in his study of human anatomy.

Actually it was almost a year before he was able to move about with any celerity, and even when it came time to board ship for home he had to spend most of the voyage on the bunk in his cabin, leaving the care of an astonishing traveling companion to a delighted crew.

This companion was the same individual who later startled patrons of the Museum restaurant and who is now immortalized in bronze and oils, not to mention the silver screen. Her name, "Meshie-Mungkut," was bestowed by natives shortly after Raven purchased the young chimpanzee from hunters who had killed the mother. They are Ndjem words meaning "the little swaggerer" or "the bluffer" and it referred to her habit of puffing out her chest and swinging her arms as though she were as big as a mountain. Meshie was not the first of Raven's expeditionary pets. There were black monkeys in the Celebes and another chimp on his first African expedition, whom he had taught to eat with table implements within 24 hours of her capture. But Meshie was far and away the most successful.

Celebrity

While the acrobatic young chimp was ranging spryly over the entire ship, Mrs. Raven anxiously awaited the return of her ailing husband. On the appointed day she went up to Boston to meet the boat, and it was not until then that she had any inkling of Meshie's existence. Raven, lying thin and pallid on his bunk, simply indicated his simian companion and remarked, "Uh, this is Meshie," thereby conveying his intention of adding this muscular and remarkably hirsute primate to his human family. Mrs. Raven, being the wife of so inveterate an explorer, was accustomed to such turns of fancy. Her chief concerns at the moment were his own welfare and the disheartening suspicion that his children, aged four and seven, would not recognize their father. The suspicion was well-founded. A pater familias who spends two years in the malaria-ridden tropics must be prepared to face the consequences. On the other hand, there was the delightful experience of rediscovery, not to mention the joys of establishing Meshie in the family bosom.

The latter undertaking was a huge, even a howling, success. True, during one of her rare sprees, she ripped most of the electric wiring out of the Baldwin house and bent the gas meter away from the cellar wall, but by and large she was highly tractable, quite helpful, in fact. Under close supervision she was delighted to hold the baby and feed it with a spoon, and was the constant playmate of the older children. Mr. Raven has recorded most of her household adventures in previous issues of this periodical.* Both these were written before the amazing lecture tour took place.

Doctor Sherwood, who had objected so strenuously to the Gowanus whale, adopted a far more gracious attitude toward the sweeter-scented Meshie. Indeed, he was so overjoyed by her impromptu performances in the cura-

*See H. C. Raven, "Meshie, the Child of a Chimpanzee," Natural History, March-April, 1932, p. 158; "Further Adventures of Meshie," *ibid.*, November-December, 1933, p. 607.

tor's dining room that he insisted on billing her for a Members' Children's lecture, with Raven as interlocutor.

The "act" went over with a resounding bang and rapidly climbed the ladder from matinée to evening bookings (adult Members' lectures), then soared to the big time circuit in suburban communities around New York.

Meshie toured with Mr. and Mrs. Raven in the family automobile, frequently cranking down the window to extend a hairy arm in the direction of a dumfounded but bravely saluting "Good Humor" man. As soon as the latter had recovered his customary bland composure, he inevitably offered a sample of his wares free of charge. Thus did Meshie outdo her lord and master by contriving to live off the land in the wilds of the U. S. A.

No trouper ever enjoyed success more than Meshie. She became enormously at home on the stage and took all the sittings for movie cameramen, portrait painters, and sculptors, in full stride. Paramount bought her film rights, and "shorts" of her activities have been exhibited on all five continents, to the delectation of the world at large. There is no telling what undreamed-of heights the "act" might have attained, had not the team split up owing to the senior partner's ungovernable wanderlust.

In 1934, Raven had to keep an appointment with Mr. Arthur Vernay to collect in Burma, and so took leave of his family. Nor could he resume the even tenor of his ways at this journey's end. For there were other expeditions in the offing: to New Zealand and Australia with Michael Lerner (1938) and with the same sportsman to South America (1941).

Then, too, there remained the vast clutter of unfinished business in his office and laboratory—the monograph on the kangaroos, the papers on the narwhal and other cetaceans, the monograph on the gross anatomy of the gorilla, the incomplete dissections of the numerous "wet" (pickled) specimens he had brought back from many far-off places.

All this and murder, too. For he has recently been enjoined as an expert witness to identify as human bone fragments, the sad remains of a slain child. Nor was this his first interruption via the law. Not long ago a kangaroo was injured, *mirabile dictu,* in a Minneapolis elevator. The creature was allegedly a "trained" performer who "boxed" professionally with its keeper. This worthy had brought suit on the

Continued on page 61

INFORMATION TEST

A few informational high spots that may be gleaned from this month's NATURAL HISTORY

Correct answers on page 64

1. The Indian boat from which our word "canoe" is derived was 60, 16, or 6 feet long?

2. When you order a clam or oyster cocktail, always look in the shells. They may yield a pearl that will bring you a fortune.
True........ False........

3. Is there any record of live whales appearing in the middle of New York harbor in recent years?

4. What insect that will make its appearance this June spends only the last 1/200 of its life above the ground?

5. The costliest gem is the
(a) Pearl
(b) Ruby
(c) Diamond

6. What sea "monster" written about nearly 2500 years ago was not generally identified as an actual creature until 70 years ago?

7. There are three gems in a gold ring whose total weight is 240 grains and two carats. One of the gems is a one-carat diamond and another a one-carat ruby. What is the third gem?

8. Burial grounds have yielded archaeologists pearls of great beauty.
True........ False........

9. Where is there a gorge comparable to the Grand Canyon within 130 miles of Manhattan?

10. The 20-foot statue of Buddha illustrated below disappeared overnight because
(a) It was made of something edible
(b) It was solid gold, and bandits made off with it
(c) An edict demanded the destruction of all figures of Buddha

WHY DID IT DISAPPEAR OVERNIGHT? A remarkable statue of Buddha about 20 feet high, photographed in Chinese Tibet by the well-known explorer and correspondent, Harrison Forman. (For explanation see Answer to Question 10, on page 64)

YOUR NEW BOOKS

A HISTORY OF 8 SCIENCES • ADVENTURE AND JEWELS
NEW HANDBOOK OF THE HEAVENS • ROMANTIC ZOOLOGY
FLIGHT OVER AFRICA • LIVING TREASURE • KUKULCAN

THE ANTARCTIC OCEAN

- - - - - - - - - by Russell Owen

Whittlesey House, $3.00

AS the second in a proposed series on the oceans of the world, this book sets a standard which, if followed by the others, will make that series an important contribution to geographical literature. Geographers may hesitate to accept the author's term, "Antarctic Ocean," as there is no body of water so designated; but it is doubtful whether anyone can read this book without agreeing that the author has reason for his choice of title. As he uses it, the term would apply to those portions of the adjacent oceans where antarctic weather and conditions prevail, probably best delineated by the average limits of drift ice.

Writing with his usual clear and interest-sustaining style, Mr. Owen traces the course of human thought and knowledge of those latitudes from the earliest philosophical discussion concerning the nature of the south polar regions, to the work of the latest expeditions. In doing this, he sticks to his objective, a history of all the recorded voyages in antarctic waters, describing briefly, but adequately, the exploration work done on land. In closing this scholarly and entertaining volume he shows how ridiculous are the various political claims to various portions of the Antarctic continent.

JUNIUS BIRD.

FOCUS ON AFRICA

- - - - by Richard Upjohn Light

American Geographical Society, $5.00

TRAVEL tales from the tropics dwell all too often on physical discomforts, or they rhapsodize on the supposedly limitless resources of the lands traversed. Doctor Light's magnificent volume, on the contrary, presents an expert survey of a vast segment of Africa by a surgeon who is also an aviator and an accomplished geographer. The illustrations consist of 324 photographs, all but 85 of them from the air, and mostly taken by the author's wife, Mary Light, who went along as copilot, photographer and radio operator.

The Lights' air journey of ten weeks took them from the Cape to Cairo and on to Tunis. After zigzagging northward to Lake Nyasa and Zanzibar, they circled over the highest snowy peaks of eastern Africa, and then followed the Nile to the shores of the Mediterranean. Three days on the ground were devoted to the lions of the Serengeti. Their six-place Bellanca monoplane was equipped with every necessary instrument, and operated with rare skill.

Doctor Light's text is far more than a narrative of the flight. It includes most valuable discussions of the geology, history, populations, and economics of the countries along the way. Grass-burning, overgrazing, and soil erosion are serious problems in Africa, as are water supply and tsetse fly control.

The book is divided into nine chapters, mainly on geographic lines, each with its maps and photographs. To me the most exciting views are those of the summits of Kilimanjaro, Mount Kenya, and Ruwenzori. If you prefer animals there are pictures of elephants, lions, antelopes, and other game. Large urban centers, mines, rivers, farm lands, and native villages are all featured.

After Egypt, photography was forbidden for military reasons, and in Corsica the Lights' plane was so badly damaged by a storm that flying had to be abandoned. The closing chapter is on aviation in Africa, and then follows a copious Bibliography. For a vast panorama of eastern Africa throughout its entire length, sharply focussed with pen and camera, one could ask nothing better.

JAMES P. CHAPIN.

LIVING TREASURE

- - - - - - - by Ivan T. Sanderson

Viking, $3.50

THIS volume makes the third of what might be called the "Treasure" series, the other two being *Animal Treasure* and *Caribbean Treasure*. They are all written after the same pattern, and are well-phrased accounts of field studies dealing with a wide range of fauna and flora and spiced with graphic accounts of narrow escapes.

Animal Treasure, the first to appear, gained the author not only a host of readers and some very enthusiastic reviews, but also some severe criticism from experienced field naturalists who believed that the factual structure was unequal to the strain imposed by the heavy demands of journalism. To state the case briefly, no story lost anything in the telling.

In the present book Sanderson is telling of experiences in Jamaica, British Honduras and Yucatan. He finds many interesting creatures, he goes about his work in the field in a methodical manner, and he explores and develops hypotheses for the correlation of fauna and environment. He expounds an ability to predict the appearance of an animal, having seen its environment, or to describe the environment upon looking at an animal brought in by a native. This faculty can be trusted within limits and most naturalists soon observe enough to have the basis for it. It seems to this reviewer, however, that much more refinement is claimed in the Sanderson analysis than can be proved by the very examples he gives.

Sanderson and his associates work at a high tempo, they are enthusiastic, they believe in their mission. In the Introduction the author states that while they take their work seriously they do not take themselves seriously; and this probably is the reason for the rather surprising contrast between the highly journalistic accounts of personal hazards and the serious philosophic passages. The intention to reduce pomposity is commendable but the alternative has its pitfalls as well.

H. E. ANTHONY.

NEW HANDBOOK OF THE HEAVENS

by Hubert J. Bernhard, Dorothy A. Bennett and Hugh S. Rice

Whittlesey House, $2.50

THIS *New Handbook* is an entirely rewritten version of the *Handbook of the Heavens*, written by members of the Junior Astronomy Club of the American Museum of Natural History, and published a few years ago. The original book, although intended for the beginner in astronomy, was highly commended by leading professional astronomers throughout the country, and went through seven printings. The new book is twice as large and, although adapted to beginners, it is much more scientific and exact—particular attention being given to lucidity in the text. It has better star charts, in which all of the objects mentioned in the text are incorporated.

Of great interest to the amateur are the extensive observing lists of double stars, clusters, variable stars, and nebulae. These lists contain the most useful information, in the most complete detail, that this reviewer has ever seen in a book of this kind. In the case of double stars, for example, the following data are given—name of star, location, magnitude, position angle, distance apart, and colors of components; as well as remarks attracting the attention or curiosity. Pertinent data are also given for star clusters and nebulae, and for variables.

The book includes fascinating chapters on introduction to the heavens, stars around the poles, autumn and winter skies, spring and summer skies, stars of the southern skies, planets, comets, meteors and the sun and moon.

The chapter on the moon has been greatly enlarged, and is the best that we have seen. There is a new chapter on rainbows, auroras, and other wonders. There are precession directions for plotting the paths of planets and invisible objects. Also, there is an improved and highly correct Glossary, as well as Appendices on asteroids, sidereal time, etc.

All in all, the authors are to be congratulated upon an excellent, dependable, and most useful book on astronomy for the observer, and for teachers of astronomy.

CLYDE FISHER.

THE LUNGFISH AND THE UNICORN: An Excursion into Romantic Zoology

- - - - - - - - - - - by Willy Ley

Modern Age, $2.75

DINOSAURS may not be extinct, but penguins are and lungfish should be. With such paradoxes Mr. Ley beguiles the reader into a pleasant sojourn in the borderlands of zoology. For anyone who does not require that romance be amatory, the subjects of this book are really more romantic than those of most novels, and the literary quality meets the standards of fiction writing.

Mr. Ley here finds zoological romance in three broad topics: mythical animals and their possible basis, animals that have become extinct in historical times, and ancient types of animals that have not become extinct. In the first category are unicorns, giants, dragons, basilisks, and sea serpents. This section ends with the remarkable hypothesis that the "sirrush" of ancient Babylon is a dinosaur possibly still surviving in Africa. The recently extinct animals are the usual interesting lot: urus, great auk (the original penguin), ground sloth, dodo, passenger pigeon, etc. Then come the so-called living fossils, in which the recent discovery of *Latimeria*, a living fish of a group thought to have been extinct for some 60,000,000 years, takes its place. Gondwanaland is used as a peg on which to hang discussions of a number of archaic (or in some cases merely rare) animals, some of which have nothing to do with the Gondwana theory.

If the book were not so good, there would be less reason to wish that it were better. Errors of fact and of judgment occur, but these are generally unimportant and it would be quibbling to emphasize them. It is a more serious fault that evidence that might be admissible in a court of law but that is entirely inadmissible in a scientist's study, is insistently accepted by Mr. Ley, who upbraids scientists who do not suffer from the same confusion. The charm and worth of the book remain, but a few grains of salt should be sprinkled over some of its pages.

G. G. SIMPSON.

KUKULCAN, THE BEARDED CONQUEROR

- - - - - - - - - by T. A. Willard

Murray & Gee, Los Angeles, $5.00

THE Maya have fascinated Mr. Willard from his youth and he has taken advantage of a brilliantly successful business career to find out more about them. In this, and several other books, he has shared with others his enthusiasm. In an era when the amateur of the arts and sciences has almost disappeared, Mr. Willard's writing has a very real place. His intense personal interest is fresher than the cold objectivity of the professional scholar or the padded casuistry of the feature writer.

Kukulcan, the Bearded Conqueror is not an academic study of the latest research on the Maya. There are no records of scientific excavation nor bibliographic delving. On the other hand, Mr. Willard tells what interested him and how two early explorers, E. H. Thompson and T. Maler, inspired him with their own almost passionate enthusiasm. Mr. Willard sees the Maya as living people, not as an example of social patterns. His book is for the reader, not the student. I wish that there were more people, like Mr. Willard, who find archaeology interesting as an avocation. *Kukulcan* is a good beginning for those who think archaeology might be entertaining, if it were not for the way in which most archaeological books are so devoid of personalized human interest.

GEORGE C. VAILLANT.

DEVELOPMENT OF THE SCIENCES,

- - - Edited by L. L. Woodruff.

Yale University Press, $3.00

THE history of science in any of its branches is a fascinating subject. It is always interesting to trace the development of our knowledge and understanding in any field. This volume is the second series of public lectures sponsored by the Yale University Chapter of the Gamma Alpha Graduate Scientific Fraternity given during 1939-40. The presentation is not technical but designed for the layman; consequently the publication is for the general reader.

The discussions are by eight well-known members of the faculty of Yale University, and comprise the fields of mathematics, astronomy, chemistry, physics, geology, biology, psychology, and medicine. They are not written in the journalese style of the hack writers who often undertake such tasks, but each is written by a specialist in his field—by one who has the broadest dependable background, impossible in the all-round scientific writer or editor. It is obvious that one person cannot be a master in eight fields.

It is now amusing to read the prophecy of the famous French mathematician, Lagrange (1736-1813) that mathematics as a field of research was nearly exhausted and that "at the universities the chairs of mathematics will sink to the undistinguished level of those, for instance, in Arabic." In times past this feeling has no doubt been shared by workers in other fields. In the nineteenth century, what physicist dreamed that we would be forced back to a semi-corpuscular theory of the nature of radiant energy? Or, that we would see the atom split? Or, that we would see the transmutation of the elements?

In these encyclopedic chapters one finds much of human interest,—in fact they consist of thumbnail biographical sketches of the great scientists who are responsible for the development of science. Many absorbing stories are incorporated in this volume.

CLYDE FISHER.

THE JEWELED TRAIL

- - - - - - - - by Louis Kornitzer

Sheridan House, $2.75

SOMEWHERE in this book the author says, "This is not a treatise on gems, but a slice of gem studded autobiography." And the reader who has seen his previous books, *The Gem Trader* and *The Pearl Trader* will know what to expect in this work. A life spent in the many phases of the gem business must supply an endless number of anecdotes to be recounted in an autobiography—more dramatic and more exciting, perhaps, than most because of the high stakes for which the game is played. But otherwise the book might as well deal with coffee, spices, or jute. In it we learn little about gems and, as before, we find the lack of that scientific background, so essential to a true appreciation of our gems. Mr. Kornitzer's attitude is probably the universal approach of a successful gem dealer well versed in his trade: what will sell and what it will bring. He has no knowledge of the events which brought his wares to the places where they were found and little appreciation of the subtle differences between so many of the popular gems. This ignorance leads almost to a disdain for those who are concerned with such matters, though Mr. Kornitzer does not hesitate to refer to others more expert than he when something unusual, such as the pink beryl whose history he recounts, turns up in his business dealings.

Readers of this book should expect only what was to be found in the previous writing of this author. Interesting anecdote succeeds interesting anecdote. Malay pearlers elbow Chinese explorers or London robbers from a fast-changing scene, world-wide in its scope. Like those other works it is good adventure and romance, but here, also, the reader must be very wary in accepting Mr. Kornitzer's scientific statements as fact. But he spins good yarns in which various gems play their parts as "props" in these little dramas from life.

F. H. Pough.

The Audubon Guide to Attracting Birds

- - - - - Edited by John H. Baker

Doubleday, Doran, $2.50

The authors of this volume have had the advantage of long-continued contact with the public for which they write. They know not only what it wants, but also what it ought to have, and experience has prepared them to speak with authority.

Roger T. Peterson supplies the first seven of the book's twelve chapters. He writes of the methods and equipment of identification in the field, bird photography and banding, attracting by planting, feeding, the use of nesting boxes, providing water, and creation of watered areas. Under these headings he presents a fund of useful information and advice much of which is not to be found elsewhere.

Richard H. Pough, in "Our Attitude Toward Predators," discusses "the balance of nature concept," a subject in which theory and practice do not always harmonize. The same writer also gives an informing chapter called "Trespass and Your Rights." The Editor, Mr. Baker, describes various types of bird sanctuaries and the methods to be employed in their maintenance,—subjects on which he is especially qualified to speak. He also gives us an outline of the organization and field covered by the National Audubon Society, of which he is the Executive Director, and tells us how we may best support its widespread and varied labors.

Pages 226 to 247 contain definite information in regard to planting for birds and the book concludes with a carefully compiled Bibliography. Even this outline of contents will impress us with the importance of this aid to the establishment of better relations between birds and man.

F. M. Chapman.

THE TALL TRUTH

Who Was the First Horticulturist?

By C. H. Curran

Associate Curator of Diptera, The American Museum of Natural History

Photo by L. C. Peltier

One of the strangest teams in nature: the yucca and its moth

Man prides himself upon the glories of his scientific achievements. As a horticulturist, he has accomplished much, but he is still a beginner and many of his successes have been due to accident, not intent.

In his attempt to increase the yield and beauty of plants, man has crossed carefully selected varieties, and in doing this the flowers must often be pollinated by hand. In order to prevent the flowers from being pollinated from free pollen in the air or by random insects, they must be kept covered.

Thousands upon thousands of years ago the yucca moth began doing what man has only recently learned to do—to pollinate flowers according to a fixed plan. The result is that neither the yucca nor its moth can live alone. The development of this strange relationship is truly one of the most extraordinary things in the world of nature.

To observe the yucca moth at work you must watch just as dusk is falling or on very dark days, because it is a nocturnal insect and hides during the day in the yucca flowers, which are closed in bright light. They open in the evening, and the silky white moths come out and fly from flower to flower.

The first thing the moth does is to visit the stamens and begin gathering a mouthful of pollen. The moth's mouth has become modified to perform the job of gathering and holding the pollen. Having gathered a pellet of the pollen, she flies to the pistil of the flower and presses the pellet into the forked end of the pistil, ensuring a new generation of yuccas. Then, very deliberately, she lays an egg on the pistil, and off she flies.

The egg produces the young caterpillar, which crawls into the developing seed pod of the yucca and there feeds upon the seeds until it is mature. When fully grown, the caterpillar makes its way to the ground and builds a tough, silken cocoon in which to spend the winter. The following year a new moth emerges just in time to repeat the process in a new crop of yucca blossoms. Everything is perfectly timed.

The yucca has become so dependent upon the moth that its flowers cannot be fertilized in any other way. And the moth cannot fertilize any other kind of flower. Nature has so arranged things, furthermore, that the caterpillars do not eat all of the seeds. We can truly say that the yucca moth was the first creature to make a plant truly dependent upon it and that, as far as we know, it was the first horticulturist.

You do not need to go to desert regions to see this remarkable team at work, for yucca plants are grown as ornamentals over most parts of the United States. It is a safe bet that if you walk up to a yucca plant and knock the top of the flower shoot sharply you will see several silvery-white moths fly out. These are the insects that control the well-being of the yucca plant, the insects that are responsible for the next generation of yuccas and which in turn are indebted to the yucca for life itself.

ONE MAN EXPLORER

Continued from page 57

claim that his pugilistic protégé could not be replaced. But Raven testified that *all* kangaroos of that species can "box." When sufficiently prodded by a human antagonist, it is natural for them to brandish their forelegs in a manner vaguely resembling the fistic maneuvers proper to the manly art of self-defense, and about all the "training" required is to tie boxing gloves on their paws.

In one sense the present state of international anarchy is a boon to Raven's reputation as a scholar. At least it keeps him within the confines of one hemisphere, and we may now hope to see an enviable procession of scientific documents flow from his pen. Behind him lies a unique career of exploration wherein he has established himself among the truly great fieldmen of our day. His future is brightened by the opportunity now at hand to assimilate and organize the well-nigh unrivaled wealth of data he has accumulated with quiet distinction in his laboratory from many far-off islands and from the depths of African forests.

MORE THAN A TRIGGER FINGER

By Charles H. Coles

Chief Photographer, American Museum of Natural History

Is your equipment ready for your American camera safari?

VACATION time is almost at hand. No matter where you travel you will want to bring home with you the fleeting beauty you encounter. Nothing spells distance and enchantment quite so strongly as strange wildlife,—living pictures of animals completely different from the familiar life of your own "back yard."

Taking movies of wild animals in our national parks is also one of the finest ways of seeing these conservation areas. You will have to get off the beaten track to catch the wary game—but what pictures you can get if you're lucky! Wildlife has interest, motion, grace—everything that a film should contain.

Using regular equipment

The ordinary spring-driven movie camera taking 8 or 16 mm. film is ideal for making wildlife pictures. The portability and lightness of these cameras leaves little to be desired in the way of ease in transportation.

There are two ways of using cameras that are equipped with single lenses without telephoto equipment: in the hand while stalking the game, or on a tripod with remote control on the starting button.

The hand-held camera must be grasped firmly, with the elbows pressed close to the body so that the picture will be sharp and steady upon the screen. Dropping to one knee and resting the elbow of the arm supporting the camera on the bent knee will give an even more solid support to the camera.

A tripod is usually too slow in operation to use when stalking game. By the time the legs are extended the quarry has fled. A single-footed "tripod," called a unipod, sometimes works out very well if kept attached to the camera. When detached it makes a good walking stick. Using this device, the weight of the camera is taken off your arms, so your strength can be used to prevent side sway.

When working rather close to large game it is a good idea to have another person on the lookout for arrivals from other directions. With your eye glued to the finder of the movie camera, you don't have much opportunity to see what is sneaking up behind you, which is perhaps where the best picture is to be had.

Several types of camera grips have been used to facilitate free-hand filming of moving subjects. A hand grip is available that screws into the tripod bushing on the bottom of the camera. It affords a comfortable cylindrical handhold of generous proportions. Holding your camera by this hand grip makes it incidentally an effective club if one of your camera subjects decides he doesn't like photographers, but any animal large enough to be dangerous has rights you will do well to respect.

One filmer has rebuilt a gunstock to take his movie camera so that the familiar shooting stance enables him to utilize the accuracy as well as freedom of motion of his once favorite weapon. He has even rigged up a mechanical linkage so that a pull on a normally placed trigger on the underside of the gunstock depresses the starting button of his movie camera.

If you have found where wildlife is likely to appear within a reasonable time, such as near a salt lick, you can set your camera on a tripod and arrange a remote control so that you may operate the camera from a distance. If your camera operates with a release lever, a cord can be your remote control. With the camera upon a firm tripod, a cord may be wound around the release lever, then led down to the ground and through the loop of a metal skewer which has been pushed into the ground under the tripod. The cord is then run back to where you are going to sit, wait, and hope. A pull on the cord will start the camera and probably cause the wildlife to start also. Cameras operated by pressing a button require a more complicated remote control device that should be constructed by a competent mechanic.

Long range filming

Many animals lead such an aloof existence that it is almost impossible to get close enough with ordinary movie lenses. Rocky Mountain goats prefer the high life in the summer and manage to remain sound in limb although they leap about on rocky crags that would almost worry a housefly. The only way to make satisfactory pictures of such unsociable creatures is with telephoto lenses.

Telephoto lenses come in various sizes, graded according to how much magnification they will achieve. The longest lens usually offered brings a 16 mm. camera apparently six times closer to the subject than it would seem to be. That is, any animal upon which you train this lens appears six times larger on the screen than it would appear if filmed with the regular one-inch lens.

Even more powerful lenses can be adapted to a movie camera by a machinist. When the lenses become too long, however, they require complicated supporting arrangements to prevent them from sagging and pulling the front of the camera out of line.

The trouble with too powerful a lens is that it is hard to get it to point exactly where you want. Unless some means is provided for looking right down the lens to see what it is pointing at, your aim may be pretty bad. Focusing becomes difficult, atmospheric haze interferes, and the image loses its sharpness with excessively long lenses.

The six-inch objective is, therefore, the most powerful telephoto lens normally supplied for small motion-picture cameras. It combines reasonable power and sharpness with not too great physical size. A lens of this type is also excellent for aquatically minded animals when you don't happen to have a boat handy. Movies of birds and small mammals are also much easier with such a telephoto lens. Your close approach with movie camera is then unnecessary, with the result that shy creatures feel less afraid and get used to the intruder more easily. A tripod is strongly recommended for all telephoto work.

Try some real animal films this summer. They make grand film fare for young and old, and the joy of making them is unsurpassed.

ALONG the Rhode Island shore, osprey nests were not difficult to find but were generally inaccessible. This tree was scalable, but the nest contained merely one egg and the parent bird flew menacingly about the intruder

A SINGLE YOUNG OSPREY, not quite old enough to fly but well able to show his anger, occupied this nest. His portrait is shown in the other photographs

LETTERS

—*Continued from page 2*

SIRS:

Possibly your readers would be interested in seeing some photographs of a bird which they may have observed from a distance without knowing exactly what it was.

If you have stood on the shore with the sea breeze flinging salt into your face and craned your neck to watch a bird that was neither gull nor eagle climb and wheel into the blue or flap straight as an arrow over the trees and inland to its nest, clutching a dripping fish in its talons and uttering a peculiar scream,—that bird was probably an osprey. The accompanying photographs were taken without any telephoto lens, in Rhode Island.

The nature lover may easily understand my desire to follow one of these majestic birds to its home. Being a photography fan, my purpose was not to rob the nest but to secure some good pictures. Consequently, after splashing around for a whole afternoon in a salt water marsh with an ornithologist friend, who was looking for bitterns and some kind of tern, I demanded that before the summer was up he should lead me to a colony of osprey nests.

Our first trip was essentially exploratory and took us to the eastern shore of the Sakonnet River from Tiverton to Little Compton. We used an ancient Model-T and ventured down all the side roads, which were none too good, to find the water. The nests were rather easy to spot, and often the birds themselves would unwittingly direct our gaze. As we bounced along one road, a large female suddenly fluttered out of a near-by tree. She circled and returned now and then to the nest. Her behavior was so strange that we stopped the truck, and I resolved to climb the tree.

The job proved difficult, and I was rather glad to have a sheath knife, because the owner of the nest was persistently diving and making a noisy row. Fear kept her

HE SHIFTED UNEASILY from leg to leg and hissed with rage

SPREADING HIS BEAUTIFUL WINGS to their full three-foot span, he seemed ready to leap at the intruder and sink his talons into an arm. The parents did not oppose the visitors but appeared rather to be deliberately trying to entice the young bird to fly

at a distance, however. Imagine my surprise to find only one egg. The smell of rotten fish was terrific. I slid back to the ground disappointed.

Another time I spotted a whole family of fledglings raucously playing in complete security at the top of an old water tower. When we approached, the young immediately became quiet. The parent birds glided to separate roosts at opposite ends of the field and communicated in shrill screams. Sometimes the male would fly above our heads and behave fiercely. But a rotten wooden ladder terminated in space about 30 feet up, and once more my hopes were dashed.

It was not until our second expedition "into the field" that we met with rare success. At the edge of a pasture we discovered a fine nest in a climbable tree, something very infrequent. We could see what appeared to be an adult bird over the edge, but he never took flight. We were amazed to find that it was a handsome young osprey, restlessly moving about in his ample quarters. He was about 40 or 45 day old and apparently had not yet learned to fly. He shifted uneasily from leg to leg and hissed with rage at the intruders. His yellow eyes gleamed defiance. From time to time he spread his beautiful wings, which were over three feet from tip to tip, and seemed to threaten to leap at one of us and sink his talons into an eye. We left him unharmed. We noticed with surprise that another osprey flew from tree to tree at the far end of the field, but made little fuss. We had expected active resistance. I surmised that the parent birds were deliberately trying to entice the young one to fly, though I may be mistaken. At all events my curiosity was satisfied, even if I did not get a photographic record of the osprey's development from the egg to the flying bird.

R. Z. ZIMMERMANN, JR.

Philadelphia, Pa.

Continued on page 64

LETTERS *Continued from page 63*

PUMAS, WOLVES, AND GILA MONSTERS

Two letters have been received recently by NATURAL HISTORY, illustrative of contradictory statements in natural science and of the unfortunate tendency to generalize. The questions posed by these two readers are simplified below, and Dr. J. E. Hill of the Department of Mammalogy in the American Museum attempts to answer them.

Absolute answers frequently cannot be given, if indeed there are any absolutes in the behavior of animals. However,—

1. *Did pumas (also called mountain lions, cougars, or panthers) spring out of trees on horses, sometimes even when a man was riding a horse?* This is extremely unlikely. It is not the custom of pumas to spring from trees on their prey; they usually stalk it and then charge in for the kill. Possibly in the early days of settlement pumas may have attacked men, but in recent years only a very few cases are known, and in each instance the animal was incapable of securing its normal prey. Without a reliable eye-witness, we must reject this story as being quite unlike all observations by trustworthy persons.

2. *Does the male puma or mountain lion act like a good father or does he kill the young if he finds them?* There are two contradictory opinions on this question and insufficient information to decide completely and finally. Also individual pumas may behave differently, just as individual men behave differently.

There are cases recorded of the male puma being found in company with female and young, but the young in each case were not newly born. No one has reported, to my knowledge, a case of the male killing the young. Males fight other males, sometimes to the death; from this it has been inferred that they kill cubs. Individuals might conceivably do so under certain circumstances, but it is not proven. On the other hand most available information indicates that the male does not stay, at least when the young are very small, in the family group and does not secure food for the young.

3. *Did, or do, American wolves ever attack men?* Before rifles were common it is quite possible that wolves occasionally attacked men; there is no reason why they should not have done so. American wolves are not importantly different from Eurasian wolves, and in the Middle Ages there were man-killing wolves in many places in Europe. Today a child, an injured man, or one without a gun might be attacked, and if wolves were in a pack and desperately hungry they might attack even an armed man. However, few wolves are now left anywhere and these have learned to be secretive and cautious where man is concerned, for wolves are highly intelligent.

4. *Are Gila monsters deadly poisonous?* Human beings are not all equally injured by poison, some individuals are much more resistant than others. There are several cases recorded where persons have died from the bite of this poisonous lizard. The venom is as poisonous as that of most rattlesnakes, but the means of getting the poison into the blood and tissues is much less efficient in the Gila monster. A single bite, rather than the chewing and worrying required to get enough venom into the tissues, would probably be more painful than dangerous.

* * *

SIRS:

. . . I like your magazine very much and wish to take the opportunity to tell you how much I like it. It is one of the first-class magazines of the country.

CLARKSON POTTER.

Mendham, N. J.

* * *

HONOR

DR. GEORGE GAYLORD SIMPSON, eminent in the field of paleontology, has received the distinction of election to the National Academy of Sciences, whose membership embraces a selection of the most celebrated names in science. Readers will recall numerous articles by Doctor Simpson in NATURAL HISTORY, which give evidence of the breadth of his interests as well as his outstanding gift for exposition. He is a member of the American Museum's Department of Paleontology, in whose interests he has made numerous expeditions, particularly in South America, and his scientific writings have contributed important new knowledge on the history of mammals and other subjects. His popular book on Patagonia, *Attending Marvels*, has had an enthusiastic reception by the general public.

Answers to Questions on page 57

1. The Carib Indian's *kanawa*, or dugout canoe, was upward of 60 feet. See page 42
2. False. The pearls of our edible clams and oysters are practically worthless. See page 22
3. Yes. A young sperm whale. The creature met its death (March 13, 1928) in Brooklyn's Gowanus Canal and may now be seen in the Museum's Hall of Ocean Life. See page 55
4. The periodical cicada. After sixteen years and ten months underground as an embryonic animal the insect enjoys about one month of adulthood in sunshine. See page 34
5. (b) Ruby. See page 23
6. The giant squid. Many a mythical sea creature no doubt owes its origin to this ten-tentacled calamary. See page 11
7. The pearl, because the pearl is the only gem measured in terms of grains instead of carats. See page 22
8. False. Pearls, from graves have usually lost their delicate sheen. See page 22
9. A gorge comparable in size to the Grand Canyon is known to exist under the ocean 130 miles off New York City. Its lowest extremity is over one mile below the surface. See page 28
10. Buddha disappeared because it was of butter. This astonishing 20-foot statue was made for the annual Festival of the Fifteenth Day of the First Moon. It was brought out at dusk on the day of the Festival and by morning had melted to a shapeless mass from the heat of numerous butter lamps placed at the base for illumination, according to Harrison Forman, who took this unusual photograph.

September **NATURAL HISTORY** 1941

Pigeons in Modern Warfare · Gems · Before the Aztecs

Treasure Island of Animals · Margaret Mead · Colbert

VOLUME XLVIII, No. 2 FIFTY CENTS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The American Museum of Natural History, 79th Street at Central Park West, New York, N. Y.

LETTERS

From a magazine editor:

". . . Your new number, just out, is a dandy. Each one seems to be better than the last. . . ."

* * *

From a scholarly shut-in in Denver, Colorado:

". . . The entire contents of the magazine is attractive and interesting; and the book reviews at the end are done in a way which lends value to the criticisms which one finds there. In most magazines one finds criticisms covered by one individual, and unless he has a distinctly open mind his views are liable to be rather biased in many cases. This work in NATURAL HISTORY is assigned to specialists in the various fields of literature, which makes these reviews particularly valuable."

HAIR. Sometimes a dozen feet in length, locks like these identify their owner as a Nukwa, or priest of Bonism, pre-Buddhist religion still found in Tibet. The priest's "crowning glory" is usually coiled atop his head like a snake, symbol of immortality. The unusual photograph was submitted by the explorer and correspondent Harrison Forman

SIRS:

On 28th April last you wrote me a very nice letter in reference to my inability to send money over to you for my next year's subscription . . . mentioning that you would refer it to the Membership Secretary . . . To my astonishment and deep gratitude I received a letter yesterday [July 10th] stating that my membership has been paid for until November, 1943.

I am commencing to write and thank the different people concerned in this wonderful gift to me. I think the generosity and most unexpected way you Americans have of dealing with matters is most overwhelming, and I appreciate it from the bottom of my heart.

One of your readers also very kindly wrote me and asked me if he could send on his copies when he had read them. Of course, I do not deserve this further honour, and I am acquainting him with the above facts, but I would like to say here and now that your magazine is read here by many people before I send it on to New Zealand, and we all think it most interesting. It has added to the pleasure of people in many lonely places, and we are all grateful to you.

Esther Buck.

Newcastle Girls' High School
Hamilton, Australia.

* * *

Sirs:

. . . For some time now, I have very much enjoyed your magazine. Its articles are so attractively written and the pictures so skillfully planned and arranged.

Louise Green.

Washington, D. C.

* * *

Sirs:

. . . I appreciate your beautiful and valuable magazine tremendously. I have been filing the copies ever since I subscribed. I very carefully read the articles which interest me and copy extracts from them. Then I make a bibliography of all the articles so I can find the material I want whenever I need it.

It seems to me that you have the most beautifully illustrated mazagine of any nature publication. Your covers are certainly exquisite. I often wonder how you can publish such a beautiful magazine at the price for which it sells. . . .

John Y. Beaty.

Arlington Heights, Ill.

* * *

Sirs:

I had hoped to contact you personally while at the Museum last Wednesday,—but the sheer grandeur of the North American Wing drove all else from my mind until far too late in the afternoon. It would be difficult to say which was the greater thrill—the finished groups in their breath-taking beauty and perfection of detail, or the glimpse backstage where the miracles are wrought.

Among other things, I wanted to say to you how greatly I have appreciated and profited by the articles on photography by Mr. Charles H. Coles. Thanks to his remarks on the use of the Wratten 2-A filter with daylight Kodachrome for sky-lighted and cloudy day shots, I have achieved artistic results. . . . I hope that he is to be a regular contributor.

As for the magazine, each month I put down the current issue with the feeling that now *this* number can never be surpassed and each succeeding month does just that!

I have been visiting the Museum at intervals ever since I was a child, when it was easily housed in one building. How gloriously it has fulfilled and exceeded the promise of those days! It is always new—never static. It never fails to give me a lift; but last week it had a special message as I walked through those great workrooms. It came home to me suddenly that here in the beloved city where I can no longer live, was one of the very few groups of scientists left in the world whose talents are still being used in the accumulation and spread of knowledge for the common good instead of senseless, hateful destruction. It gave me a swift new vision of what America means, of the manner of men she heeds, and of the appreciation and opportunity she offers to those who had their beginnings elsewhere. The newspaper headlines, full of wars, strikes, organized minorities and political chicanery, might all be of another world entirely.

My guest turned to me suddenly and said, "Can you imagine a plane dropping bombs on this place?" I can, and the thought makes me wish desperately that I were again young enough to wear a uniform.

Hugh Wightman.

Hartford, Conn.

* * *

Sirs:

Some time ago there appeared in one of the popular digest magazines, in an article entitled, "Fish Cannot Read or Write," these words: "Fish are color-blind—scientifically proved." Now, if that isn't a case of Ripley!

Will you kindly advise if such is the case and if so, how proved scientifically? Any information will be greatly appreciated by a number of interested persons. . . .

Harry Curry.

Binghamton, N. Y.

This "fishy" question is answered by Dr. Frank A. Beach of the Museum's Department of Experimental Biology, as follows:

Mr. Harry Curry is quite justified in questioning the accuracy of the statement, "fishes are color-blind." This unwarranted generalization is probably based upon the results of a series of experiments conducted 30 years ago by a German investigator named Hess. As a result of several investigations Hess did conclude that a number of species of fishes are color-blind. However, a great number of more recent experiments indicate that this conclusion was incorrect.

Several studies prove that minnows are able to distinguish 20 different colors. The minnow can be trained to accept food that is held in red tweezers and to refuse the same food held in green tweezers. Mud minnows can learn to leap from the water to seize food offered under a blue light and to avoid bait presented under a red light. Gray snappers possess the same ability. Even the trout, to which Mr. Hough specifically refers in the article, has been shown to possess color vision. Other

Continued on page 127

Natural History Magazine's full color covers are available on the same heavy paper that is used on the Magazine at a cost of 5¢ each, plus a charge of 5¢ for postage on any order up to ten copies.—Ed.

MUSEUMS IN THE EMERGENCY

During the last few years Museums have been criticized as old-fashioned, out-of-date, lacking in verve and splash and modernity. The critics have called many of the exhibition methods stuffy and conventional and have lamented the slow and careful pace to which Museum staffs have held in the modernization of exhibits. The high-pressure salesmanship of modern advertising has been recommended to us. We have been urged to think more of influencing the masses of our visitors and less of fidelity to our materials.

And in the midst of this, we find ourselves as a country in an emergency, when it is necessary to think about problems of morale and national enthusiasm. Those who seek to find among the American people the enthusiasm for national ends which is so essential, find that again and again they are faced with cynicism and apathy, in people who feel they have been over-propagandized, over-sold. The tricks of the propagandist have been labeled and displayed, the machinations of the advertiser are known to everyone, the public is dishearteningly canny, suspicious of every means of communication open to those who would fire the imagination of the people with the importance of the present hour. Dishearteningly suspicious they are—except of Museums. The Museums, almost alone among the various means of communication that have been exploited to push and prod people about, to make them feel, or want, or buy, have remained uncontaminated. Because the staffs of Museums have insisted on saying: "Is this true?" instead of asking: "Will this make a hit?"—they have kept the people's trust.

Those who enter the doors of our Museums do so in a faith that they will not be tricked or deceived, that no one will seek by high-powered lighting arrangements to make the facts of science other than they are. They go out from the doors of the Museum believing in one of the foundations of democracy—that it is possible for an individual, by slow, honest, exact study to find out more about man and the world in which he lives. For an hour or so they have been able to trust their eyes and let their minds rove over materials which have not been arranged to impress, to convert, to push them around, but merely to tell them as much of the truth as is now known, and that quietly.

So at this moment, when America needs the strong deep enthusiasm of every citizen for the democratic way of life, the Museum which has refused to give up its faith in the materials of science, the Museum which has scorned to substitute emotional appeals for orderly demonstration, finds itself with a definite place in the national program. As a place that the people trust, it is now a place in which they can renew their trust in science and in democracy.

Margaret Mead

Assistant Curator of Ethnology,
The 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

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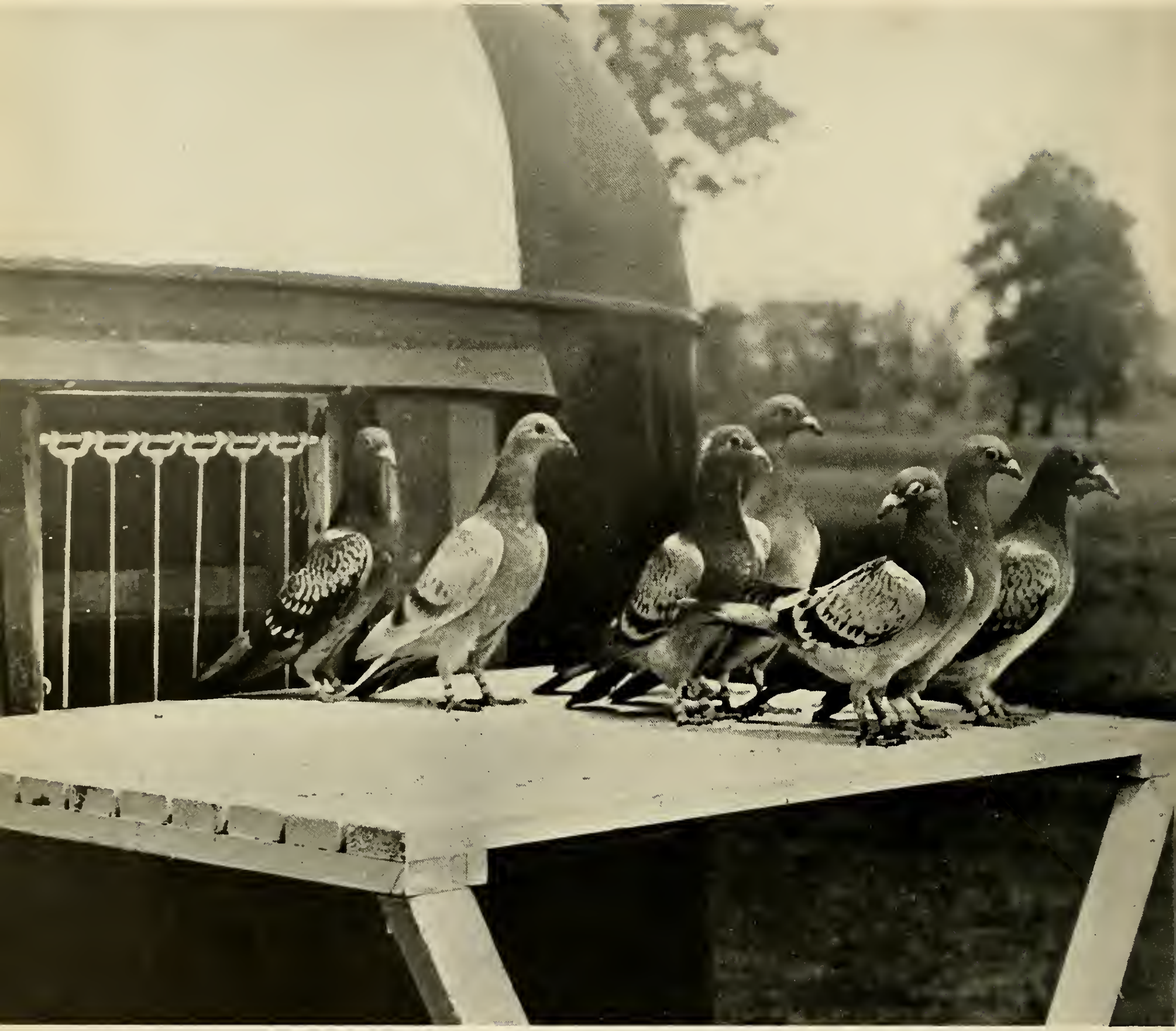


Smoke, darkness, and the din of battle fail to daunt the world's most remarkable messengers, who perform new aerial wonders in the service of the nation—all for a little affection and a handful of corn

In the rush of war preparations, Uncle Sam's feathered battalion has not been forgotten. Despite the advances in mechanical communication, the Signal Corps of the United States Army is adding thousands of new pigeons to the skeleton force now in service. Normally numbering only a few peacetime men, the group of army pigeon handlers called pigeoneers has been greatly increased, with the men hard at work drilling the large batch of recruits that have been streaming into the government lofts during the last few months.

The importance of the homing pigeon has been understood since Brutus, besieged by Antony, hit on the idea of dispatching a pigeon to Octavius for reinforcements. The Dutch brought the birds to central Europe for the wars in the Netherlands, and William the Silent used thousands of them at the siege of Haarlam in 1573. Later, during the siege of Paris by the Germans in 1870, the work of the pigeon was so effective against the invaders that falcons and hawks had to be trained to break up the system of communication.

It is significant that at the start of the present war the English War Department ordered every loft in the country visited and the pigeons forced to fly. Native birds went back to their own lofts, while Ger-

FEATHERED BATTALION again takes wing

By RORY O'SHANE

(Left) HOMERS AT HOME on the open-air "porch" of an Army trailer unit: pigeons whose messages may be expected to reach their destination when no other methods of communication are possible

man homers had to wing their way back across the Channel. The heavy damages inflicted in the last war by foreign agents and sympathizers working with German birds evidently had not been forgotten.

Home patrols, likewise, now maintain a vigilant lookout for solitary parachute jumpers. The Nazis have a neat little trick of flying agents across the Channel at night and dropping them off by parachute. Along with the agent comes a wicker basket housing two or more pairs of homing pigeons. These are lodged in previously selected lofts and released with messages for the German Intelligence when the occasion arises.

Not to be outdone, the British have adopted an old stunt which was originated toward the end of World War I. Small gas balloons are fitted with metal rings that open automatically at a predetermined time. Pigeons are placed into baskets equipped with small parachutes. When wind and weather permit, the baskets are snapped onto the metal rings and the balloons sent sailing into enemy occupied territory. After the elapse of a certain amount of time, the metal rings part, allowing pigeons and baskets to shoot gently to earth. Within each basket is a message asking friendly French, Dutch, Czech or other allies for definite information valuable to the English. The finders are instructed to slip the message into a container on the pigeon's foot and release the bird. The next morning English bombers may be unusually fortunate in locating amunition factories, airdromes and troop concentrations.

Pigeons also are doing yeoman service with the British Navy. Mine sweepers and trawlers, not equipped with wireless, carry them along for emergencies. When danger looms in the North Sea or English Channel, the birds are sent winging from 50 to 100 miles to shore for help.

The Signal Corps of the United States Army occasionally used pigeons to carry messages prior to the World War, and in 1886 an American Signal officer predicted their extensive use and recommended that official provision be made for their maintenance in the Army. It was not until 1917, however, that actual provision was made for a section to be created in the Signal Corps to operate a pigeon messenger service. The major powers engaged in World War I prior to the entrance of America were successfully using thousands of pigeon messengers on all fronts. The homer's ability to spring into the sky, spiral the field once, and shoot instantly off at terrific speeds over artillery barrages and clouds of poison gas, made the winged messenger priceless when wires were down and human runners unable to sneak past enemy sharpshooters.

Recognizing this, American war chiefs scrambled to press into service men who could mobilize and handle pigeons. From the ranks of America's 16,000 bird fanciers developed the finest group of army pigeoneers in the world, with the result that by the end of the war many thousands of American pigeons were in active service in France, and every Army camp in the United States had a government loft. Besides the 110 lofts in the States, there were many on the Mexican border, in the Panama Canal Zone, and in the Hawaiian Islands.

Records show that the Signal Corps birds were more successful in delivering messages than either the telephone service or human runner. Despite obstacles ranging from enemy snipers and trained hawks to poison gas and bad weather, the Signal Corps completed delivery of over 90 per cent of the pigeon messages entrusted to it.

Fort Monmouth, New Jersey, under command of Major General J. O. Mauborgne, is the nerve center of the Signal Corps' system of scientific breeding and

Three Lions photos

(Right) A THIN TOUGH TISSUE in an aluminum capsule bears the message just received by this soldier via pigeon special delivery. Long documents are set in large type and photographed down, then enlarged at the destination

training. Its years of painstaking research and experiment are slowly, but surely, developing a breed of war birds which will surpass any yet known to modern warfare.

The development of the bird's homing instinct to the highest peak of intensity was, and still is, a major goal. Contrary to popular belief, all pigeons are not imbued by nature with the requisite degree of homing instinct and intelligence. The renegades and numskulls among them must be weeded out to preserve the purity of the strain.

Army trainers are not greatly concerned with an explanation of the homing instinct. Taking it for granted, they are concentrating on systems of selective breeding and training that will intensify the trait.

The training routine requires patience and persistence. Teaching the birds how to "trap" is the first essential. A pigeon able to fly 500 miles is useless for communication if it refuses to enter the loft with the message when it gets home. Too much valuable time would be lost coaxing the bird to come close enough to be caught.

When the "squeakers" are able to fly—about four weeks after birth—the initial lesson in trapping begins. The pigeons are kept in the loft for 24 hours without food, then taken a few yards outside the loft and released one by one. At the same time a pigeoneer inside the loft loudly rattles a tin cup full of grain, causing the hungry birds to swoop instantly for the loft. This process is repeated until the association of food and loft is indelibly fixed in the minds of the pigeons. To encourage the association, pigeons are always fed immediately upon entering the loft after a flight.

The lofts are kept in sight for the first practice flights, with the distances increased to a matter of miles as landmarks begin to register with the pigeon. When mating season arrives the training grind is increased in rigor, since pigeon men know that a pigeon's speed and accuracy are heightened when there is a family waiting for it in the home loft.

Group flights with recording of each bird's speed is the next step. Wicker baskets holding 15 to 30 birds are hauled great distances from the Fort, and the birds liberated as a unit. Automatic clocks punch out the split second of release and arrival, superior pigeons being easily identified since each bird is banded with a seamless aluminum leg band bearing a registered number.

Over a period of years these methods of breeding and training have resulted in striking improvements of speed and stamina. At one time a sustaining flight of 200 miles a day was considered excellent, and a mile-a-minute clip the absolute tops. Today, however, the pigeon who falters at a 500-mile-a-day stretch is not considered worth his salt, while fast Army birds have breasted the breezes at over 70 miles an hour.

Another feat has been in the field of night flying. A pigeon will fly from sunrise to dusk, then will pick out a convenient tree or pole and wait for the break of dawn. Averse to the idea of having vital messages delayed while the bird caught his forty winks, the Signal Corps, following the World War, conducted experiments to ascertain if homing pigeons could be trained to fly at night. The experiments were successful and as a result, the Army now has a body of trained flyers who can be relied upon to carry messages either by day or in the darkest of nights.

A large number of new mobile lofts have recently been procured by the Signal Corps which are equipped with distinctive combinations of colored lights to aid the night flyers. Although it is not an easy matter to resettle a bird in a mobile loft, kindness and patience will do the trick. The younger the bird, the easier it is to remove old associations and inculcate new ones.

The pigeon is hobbled and released on the roof of the mobile loft, hungry, of course, where he can respond quickly to the rattle of grain in a tin cup. After several days of this exercise, the birds are unhobbled and released at gradually widening distances with constant retrapping until the new loft becomes the target of their homing instinct.

The Army uses several different means of transmitting messages. The older style of fastening messages to the bird's tail feathers has been supplanted by slipping messages written on thin tough tissue into a small aluminum capsule sealed to the bird's leg. The Signal Corps is also able to send larger documents and photographs by fastening the package so skillfully about the bird's breast that wing movements are unhampered and wind resistance not increased. The most recent technique consists of setting the message up in large type, then photographing it down. The film is inserted into the capsule and then dispatched. At the receiving end the film is removed and the message re-magnified into a readable state.

Signal Corps pigeons may also be used as aerial photographers for the Army. German and Japanese War Colleges are reputed to have been using Neubronner's panoramic camera to obtain aerial pictures by pigeons. The Signal Corps is aware of the possible application of the pigeon to aerial photography, but as yet no formal adoption of this method of combat reconnaissance has been made. One of the devices for taking aerial photographs by pigeon consists of a tiny two-inch aluminum camera which is attached to the pigeon's breast with an elastic band. As the pigeon soars over the countryside, two inset cameras,

(Above) LADY MABLE, a Signal Corps thoroughbred who raises her boys to be soldiers. Through years of painstaking research, the United States Army is developing a breed of birds that will surpass any yet known to modern warfare

Photos by U. S. Army Signal Corps

FUTURE ORDERLIES. In five weeks these nondescript "shavetails" will have the full plume and sheen of thoroughbreds and be learning how to carry messages for generals of the United States Army

FUTURE MILE-A-MINUTE MEN: five-weeks-old messengers to be, who for the first time come out of their streamlined loft to gaze into the realm which they may have to share with war planes and high artillery fire

Three Lions photo

Unsung heroes of World War I, operating from one of the old-fashioned pigeon trailers, or *arabas,* which followed the French Signal Corps to the front lines. The same wagon, accommodating about 100 birds, was used at first by the U. S. Army

one working forward and the other backward, snap two dozen exposures at regular intervals.

The mechanism of this camera consists of a tiny rubber ball operating a small lever connected to the shutter. The rush of air passing through the ball releases the lever, thus clicking the shutter, and the pigeon brings back to General Headquarters an excellent idea of enemy terrain, position of troops, and location of batteries.

Nothing yet conceived by man approaches the intelligence of the pigeon's flying scheme. The bird will skirt fogs and shift from water to land routes with an uncanny instinct for better flying conditions. In mountainous regions he swoops into valleys where there is less wind resistance. When bucking strong headwinds, the bird tacks as cleverly as the master of a racing sloop, or it will climb miles to avoid strong air currents. On reaching home, if storm prevents him from landing, he will hover above for hours until he spots an opening, then he will drop like a stone for thousands of feet to reach the lighting board of the loft.

A dream of military commanders since the days of Alexander the Great has finally come true through recent experiments conducted by the Signal Corps

Photo by U. S. Army Signal Corps

Pigeon message center: a modern unit in a streamlined army, capable of travel at 60 miles an hour. Signal Corps birds have proved more successful in carrying messages than either the telephone service or human runners. Under the highly intensified program, the birds are learning new tricks and will assume wider duties in the Pigeon Section at Fort Monmouth, New Jersey. The Signal Corps now has military pigeons that will actually carry messages two ways. These new Signal Corps homers can be dispatched from Division, Army, or Corps headquarters with messages addressed to front-line units, which they will deliver at mile-a-minute speed. Remaining at the front-line positions for approximately ten minutes, these pigeons will then return with answers to their communications, delivering them safely to the starting point. Officers and soldiers of the Signal Corps are close-lipped about divulging information about this, but it is known that a flock of these especially trained pigeons has successfully responded to their training at Fort Monmouth.

Thus today, the pigeon, one of the oldest implements of war, has kept pace with every development of the military. With greater efficiency than ever, it is still carrying on where the streamlined mechanizations of man might fail.

Nor does it ask much in the way of compensation. As a French general has commented, "No wires to string, no big plants, no necessity for lives lost as linesmen work under fire—and no expense. All he asks is a little affection and a few handfuls of corn."

Photo by U. S. Army Signal Corps

(Above) WAR GAMES, somewhere in the United States: blue-bloods being trained to carry messages through smoke and din of battle

Free Lance Photographers Guild

TRAILER APARTMENT: interior of one of the mobile field units, where, on returning from more serious strife, each pigeon knows his own "pigeon hole" and will fight vigorously to defend it

Three Lions photo

(Right) LOFTS at the pigeon "nerve center" at Fort Monmouth, N. J. The lofts are connecting, and each has nesting quarters, roosts, screened porch, and a landing platform painted a distinguishing color

Courtesy of U. S. Army Signal Corps

Champion of Champions

By JOHN K. SHAWVAN

Major, U. S. Signal Corps

IN him centers the accomplished dreams of military commanders since the days of Hannibal and Alexander the Great. He is the fastest two-way military homing pigeon, the champion of champions among the Signal Corps' homing pigeons in the United States Army. In fact, one could go further and say he is the champion of all the homing pigeon messengers of all times in the history of the world.

So we introduce to you Mister Corrigan. He is a true blue-blood, and army officers know all about his ancestry for 525 pigeon years of life. The histories of 167 famous champion racing pigeons appear in his pedigree, and among them are the names of many great winners and famous army messengers. His great-great-grandfather, "Always Faithful," was recorded in the "Hall of Fame" as a national champion many pigeon years ago.

Since the history of the world began, military victories and defeats have frequently hinged upon messengers. The military message from Marathon to Athens gave us the Olympic games, and a message from Napoleon to Grouchy, had it been delivered, might have avoided two world wars. One from Custer to Benteen might have saved 700 lives and blotted a catastrophe out of our history books. Mister Corrigan could have carried them all with the grace and ease of his beautiful wings and would have brought back the answer at mile-a-minute speed.

On last March 25, an officer of the Signal Corps of the United States Army believed that he could teach and train a thoroughbred homing pigeon to leave its loft and carry a military message to a point many miles distant, deliver it, and immediately return to its loft with the answer.

Mister Corrigan, then a five-weeks-old squeaker, was selected with 22 of his feathered schoolmates to attempt this mission. Sixty-one days later, rising in the air on his now full-grown and powerful wings from his concealed pigeon loft on the military reservation at Fort Monmouth, New Jersey, he winged his way to a group of four officers tensely awaiting his arrival at a crossroads on the outskirts of Freehold, an airline distance of twelve miles from his pigeon loft. Entering a small container on the ground between the officers, Mister Corrigan delivered his message, and five minutes later he was again in the air with the answer on the return trip to Fort Monmouth. The feat had been accomplished, and from that day on no military unit of the United States Army could be severed from communication with higher command by enemy activities. Mister Corrigan had become the champion of champions, the first and fastest two-way military homing pigeon in the world.

The exact technique of the training of Mister Corrigan remains one of the most closely guarded American army secrets.

WATER FLEA CIRCUS—Through the magic eye of the microscope, you can observe the antics of scores of different tiny actors, the clowns and "aquabats" of the water fleas. An amazing pageant in which one mother can produce thousands of daughters but not a single son—until cold weather threatens her "act"

By MYRON GORDON

Fellow, John Simon Guggenheim Memorial Foundation

IN early spring, soon after the last traces of ice have disappeared from fresh-water ponds, the life story of daphnia begins again. The water flea embryos stir in the black egg cases, which, invisible in the mud and decaying leaves, have wintered in the bottom ooze.

A few degrees above freezing are enough to liberate the embryos from their tough horny egg capsules. At first all the young that are born are daughter daphnia; not a single son is hatched. Eight days after birth a young female water flea has reached ripe womanhood. On the ninth day of her life, in spite of complete sexual abstinence (there is not a single male in the colony), her tiny eggs within the brood chamber hatch into diminutive embryos. On the virgin mother's tenth day of life, she gives birth to about a dozen female water fleas. As soon as the young are released they start life on their own and soon produce a line of daughters of their own. On her thirteenth day the founder mother daphnia produces another dozen young, three days later another dozen, and so on.

When Louis E. Wolf, of the Experimental Fish Hatchery of the New York State Department of Conservation at Rome, N. Y., was a student at Cornell University, he kept an hour by hour and day by day lifetime record of the remarkable reproductive powers of these creatures. He raised individual water fleas from embryos to adults in half-pint milk bottles containing a suitable culture medium. Several times a day he fished a daphnid out with a wide-mouthed medicine dropper, placed it in a drop of water on a glass slide under a microscope, and recorded the progress of its development. In this way he discovered that *Daphnia magna*, a *big* daphnia one-quarter of an inch long, produces about 100 young in about ten broods in a lifetime of about 40 days. One matriarch gave birth to 40 broods in a lifetime of 130 days. If, in a period of 90 days, all the descendants of this female were to live and each in its turn were to produce others in normal quantities, over twelve billion water fleas would be born, enough to form a single-strand belt of daphnia around the earth.

Many species of water fleas far exceed the reproductive powers of *Daphnia magna*. For instance, at the same temperature (77° F.), *Moina*, a tiny humpty-dumpty shaped daphnid one-sixteenth of an inch long, reaches adulthood in half the time; and at 95° F. it develops from birth to motherhood in just 38 hours.

No wonder a pond that appears sterile one day may be swarming with tiny aquatic animals the next. Daphnia are creatures of opportunity. Those that live in temporary bodies of water never know when their aquatic world will end. Thus, as if to forestall extermination of their species, they make the most of their time by multiplying. Yet mere multiplication, especially of females only, would be of no avail in the face of drought or severe frost, for their bodies cannot resist these forces. Nor could their shriveled or frozen bodies be revived when better conditions returned.

Daphnia survive drought and frost by means of their weatherproofed eggs. These eggs cannot be produced by females alone, but require for their creation the usual mating of male and female. Where do the males come from? Virgin females produce them when either frost or drought threatens.

When the temperature falls, respiration is reduced, the growth rate slowed. Similarly, when drought is impending, the water of the evaporating pool becomes charged with organic wastes, oxygen is decreased, carbon dioxide increased. Perhaps these radical chemical changes have a direct effect upon the developing eggs of virgin female daphnia. Whatever the actual forces may be (scientists are still working on this problem), drought and frost are anticipated by the water fleas in the production of sons as well as daughters.

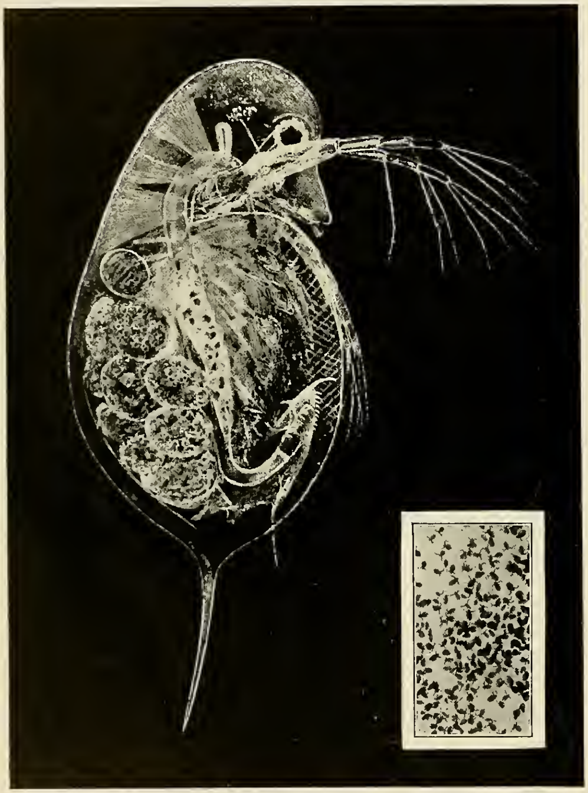
The males are puny creatures, much smaller than the females, each with an amazingly enormous eye with which better to search out a mate and with long, specially developed claspers with which better to embrace her.

After mating, the mother daphnia's eggs no longer develop into ten or more embryos. The nourishment contained in a dozen eggs is pooled into one or two, which become much larger than the unfertilized eggs produced in former broods. The fertilized eggs become covered with a dark horny substance produced by a special gland. Thus protected, the eggs resist drought and frost. At this point, even should the mother daphnia die and her body decompose, the horn-covered eggs survive and hatch when favorable conditions return.

Commonest of all daphnia, *Daphnia pulex*

Daphnia longispina, actually the size of a pinhead

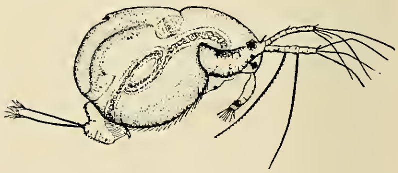
The giant daphnid, *Daphnia magna,* 1/4 inch long



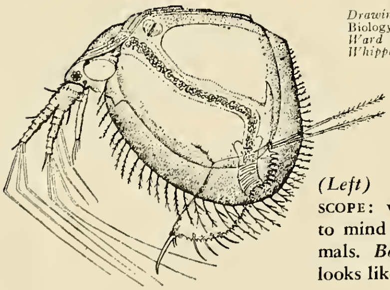
Photograph by D. J. Scourfield. Courtesy of Dr. Chauncey Juday and The Aquarium.

(Left) IN 90 DAYS one female water flea and her descendants can theoretically produce several billion offspring. But most of them are eaten by fishes and thus help keep a balanced life on earth. The large oval bodies are eggs. Life-sized individuals are seen in the insert

(Below) THE LONG SPINES on the antennae of *Drepanothrix dentata* are used in locomotion like ski poles

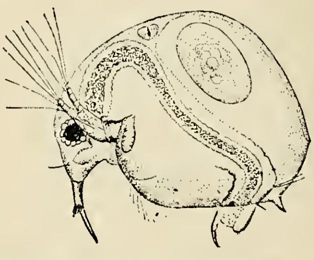


(Below) ILYOCRYPTUS is loath to lose its outworn shells and sometimes looks like a cash-clothes man wearing several coats and hats



Drawings from Fresh-Water Biology, *by Henry Baldwin Ward and George Chandler Whipple (John Wiley & Sons, 1918)*

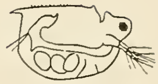
(Left) UNDER A MICROSCOPE: water fleas suggest to mind various larger animals. *Bosmina longirostris* looks like a toy elephant



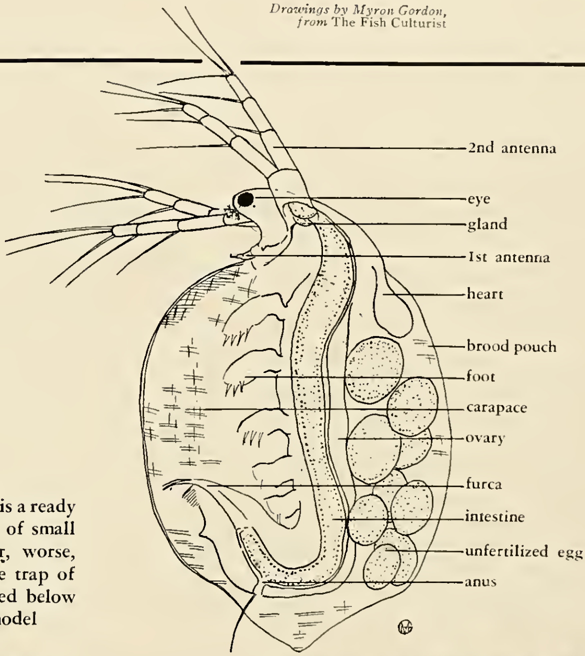
Highly prolific *Moina macrocopa*

Scapholeberis mucronata swims on its back

Elephant-faced *Bosmina longirostris*



Drawings by Myron Gordon, from The Fish Culturist

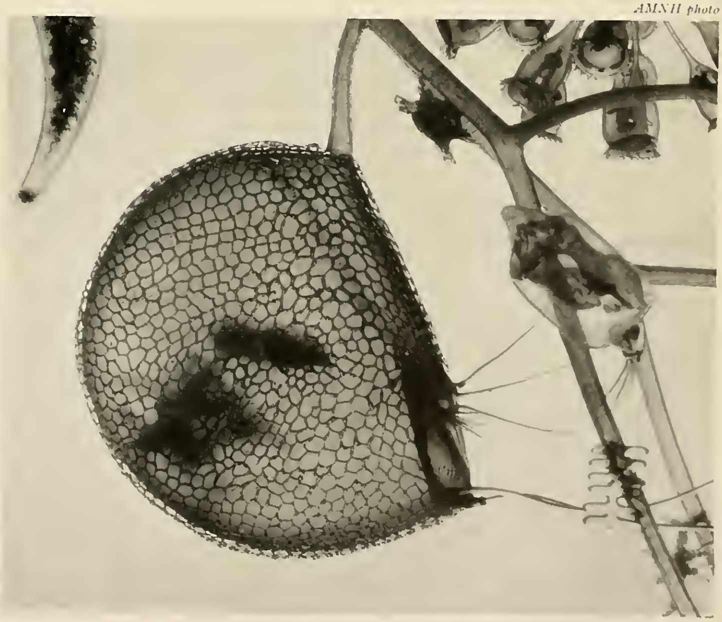


MAIN ANATOMICAL FEATURES of the monkey-faced water flea, *Simocephalus*

(Below) THE PERSECUTED WATER FLEA is a ready victim of tiny hitch-hikers in the form of small clinging rotifers as shown below. Or, worse, it may be ensnared by the bladder-like trap of the water plant, *Utricularia,* represented below *(right),* highly enlarged, by a glass model

Courtesy of Frank J. Myers

AMNH photo



The winter eggs in their protected packages are known as ephippia, which literally means "saddles." Anyone who has seen a daphnia carrying a dark ephippium on its back can readily appreciate the aptness of the term. In many species of water fleas the ephippia are equipped with numerous small hooks and spines which serve the same purpose as the hooks and spines on the seeds of plants. They become fastened to the feet and bodies of wading birds and mammals that wander into the pool. Thus the hitchhiking weatherproofed egg cases are strewn over a large area. Many drop off in inhospitable, arid places, but a few may be brought to another pond far away. Even should a single ephippium be successfully transported to a new aquatic home, it might suffice to start a new colony because of daphnia's parthenogenetic (virgin birth) method of reproduction. This accounts for the world-wide distribution of some species, *Daphnia pulex* for instance.

Back in 1669 when the microscope was still a newly invented gadget, a Dutch physician by the name of Swammerdam amused himself by examining life in the waters about his home. Swammerdam was one of the first to see a daphnia and all its elaborate internal organs. He thought that daphnia were related to the fleas, or insects. Superficially water fleas do look and move like real fleas, for they have a hard-shelled, compact little body and they move through the water in a series of hops.

In those days it was the custom to name an animal new to science in a phrase that appropriately described it, so Swammerdam called the creature under his lens *Pulex aquaticus arborescens*. This may be translated freely as "water flea with branching arms." But as their characteristics and habits became better known, Swammerdam's *Daphnia pulex* and other water fleas were placed closer to the shrimps and the crabs.

Like shrimps and crabs, water fleas molt periodically, shedding their tough, horny, and sometimes slightly calcified outer covering. The horny covering extends to the branching antennae, and these appendages have given water fleas the group name of Cladocera, those with "branched horns." Like shrimps and crabs, cladocerans pass, momentarily at least, through the soft-shelled state, at which time they are particularly weak and helpless. Furthermore, just as moths and butterflies pass through the larval stages as caterpillars, and frogs as tadpoles, the shrimps, crabs, and water fleas pass through their larval stages as nauplii. These immature creatures are the common denominators of the crustacean group. The nauplius of cladocerans, with but two known exceptions, never leads a free life, but is tucked safely away within its mother's brood pouch. When a daphnia is ready to be born it is a miniature edition of its parent. America's foremost expert on Cladocera, who is also President Emeritus of the University of Wisconsin, Dr. Edward A. Birge, says that there are hundreds of species of water fleas in the United States and probably thousands in the world.

Most daphnia are extremely small, 1/100th of an inch in length, but they make up in numbers what they lack in size. As a group they represent one of the most important links in the chain of living food organisms from microscopic plants to man. Cladocerans convert the almost invisible yet inexhaustible supply of bacteria, diatoms, and algae into a form and size more edible to larger carnivorous aquatic animals. The tiniest larval fishes feed on tinier water fleas, larger fishes eat the smaller, and so on until they become the food of our food fishes.

The vast assemblage of microscopic water plants in seas, lakes, and ponds are compared by Dr. James G. Needham, Limnologist of Cornell University, to the quick-growing ever-present edible weeds, berries, grasses and other forms of low herbage found on land. In water and on land, plants are the mainstays of animal populations. Doctor Needham compares the millions of microscopic cladocerans to the hordes of small plant-eating rodents that infest the fields. The larger herbivorous water fleas, like daphnia and their associates, he compares to the vast herds of hoofed animals of the plains.

On one occasion in Mendota Lake in Wisconsin, Doctor Birge reported that, "The surface waters were crowded by the daphnia, and great numbers of perch were feeding on them . . . along the shore as far as the eye could reach." Taking a sample of the water in the densest part of the swarm, he found 1,170,000 *Daphnia pulicaria* per cubic meter. "Even larger fishes do not disdain these animals," he says. "The great spoonbill *(Polyodon)* fills its stomach with *Bosminae*," but only those large fishes equipped with straining devices can utilize these small creatures directly.

Under a magnifying glass, most water fleas are funny enough to be put in a circus. Walt Disney probably never meant to make Dopey of the Seven Dwarfs look like one of the daphnia, but Dopey certainly bears a resemblance to some of them, and so do his brothers.

The body of a water flea is covered by a cloak that extends without much of a break over its head. Its coat looks like the oversized parka that Dopey wears, except the daphnia's outfit is a bit better fitting and it has no loose tails trailing behind.

The facial expressions of many water fleas resemble those of toy elephants, monkeys, porkers, pug dogs, parrots, and the Seven Dwarfs. Sticking out in the region of what would be our shoulders and extending over their heads is a pair of antennae that looks like a pair of arms. These add to the resemblance these creatures bear to the animals pictured in nursery books.

The antennae of insects, shrimps, and crabs serve as feelers, but water fleas use their antennae as arms, and it is with strokes of these wing-like appendages that they are able to swim about. Just as you may recognize your friends from afar by the mannerisms of their gait, many water flea experts can often recognize some cladoceran species by the way they move about. *Daphnia pulex,* for instance, has long antennae, and their slow beat makes this creature progress through the water in a series of hops; it bounces up and down and moves forward like a mechanical horse on an amusement park race track. The antennae of *Bosmina,* the water flea that looks like a toy elephant, are short, and, because they are waved rapidly and continuously, the little animal moves through the water smoothly. The heavy-bodied *Simocephalus* (literally "monkey-faced") has a rotating unsteady motion that is produced by rapid strokes of its long antennae.

"The spiny haired one," *Drapanothrix,* has stiff spines attached to its antennae, and it pulls itself forward over plants like a skier with the aid of his ski poles. Another curious water flea, *Ilyocryptus,* lives hidden in muddy places. Its antennae are short and point downward; with them it drags itself over the bottom. The scientist who discovered *Ilyocryptus* found that it is not only a "hider in the mud" (for that is what its name means) but is a slovenly creature to boot. For instance, it is loath to cast off its outworn shells; these pile up on its back in several layers like hats and coats on a cash-clothes man. Furthermore, as these mud dwellers creep through the mire, they become covered with vegetable growths and filth. No wonder the scientist Lieven called one of them not only *Ilyocryptus* but *sordidus,* too.

Daphnia has two pairs of antennae, but only the second pair is used in swimming. The antennules (the first pair) are hardly developed at all in the females; they remain as mere sensory stumps near the mouth. In the male *Daphnia,* antennules become well developed; they become long, powerful, and turned like grappling irons. They serve to grasp and embrace the females.

The water fleas are nonconformist in the use of their appendages. Feet that serve the crabs for the customary function of getting around and which are used by shrimps as oars in swimming are used by water fleas for breathing and food gathering. Their five or six pairs of thin, leaf-like feet are equipped with long, fine hairs. They wave continuously to and fro, producing a current which flows through the half-opened shell, bringing with it fresh water for respiration and food. Breathing valves are located at the base of the feet. The mouth receives particles of food in the form of tiny plants and decomposing matter. The long fine hairs of the feet are kept scrupulously clean by constant grooming with a comb of stiff bristles located on the lower part of the abdomen. Behind the mouth, near the entrance to the alimentary canal, water fleas have a gland that aids in the digestion of their food. Owing to the transparency of their bodies a particle of food may be traced as it passes down a short intestine and emerges as waste matter through the anus. The artist who drew the pictures for the book *Through the Alimentary Canal with Gun and Camera* might have watched a daphnia at dinner. All these processes can be observed with a low power microscope. Or, if you happen to be in the American Museum, the antics of a living daphnia can generally be seen projected on a screen from the microvivarium.

The rhythmic beating of the tiny heart of a daphnia is always a fascinating sight to an amateur microscopist. Somewhat like a simple water pump, the heart sucks blood through a series of valves that come directly from the body spaces. When the heart constricts, the valves close and the blood is forced forward in a stream. Although there are no blood vessels, the flow of blood always follows the same course. As it passes, nourishing the organs, a corpuscle may break ranks to grapple with an enemy fungus spore and put it out of action.

After the beating heart, the constantly "roving" eye of a daphnid is likely to attract the attention of anyone peering at a water flea under the lens. As an embryo, each daphnia has two eyes, but as it grows older the two lateral eyes fuse along the mid-line. Like the compound eyes of insects and crustaceans, the eye of a water flea is made up of many tiny segments—like cells in a block of comb honey. All these creatures have mosaic vision. On the outer fringe of their intensely black eye, water fleas have a number of small crystalline lenses which reflect the light in a peculiar twinkling way. The cyclopean eye is moved by three pairs of muscles which give it a squinting effect. All in all the comical daphnid appears as cockeyed as a one-sided Ben Turpin.

A stout nerve connects the eye to the brain, which, although tiny, is good enough to cause the animal to scoot frantically for cover when a small fish lunges at it and misses. Many fine, long, hair-like spines over the body give the water flea the feel of its environment. Sensitive spines near the mouth allow a cladoceran to discriminate between edible and inedible particles brought to its mouth by its feet. A water flea may take diatoms only when diatoms and blue-green algae are available. It may even "change its mind" and reject a particle of food that it has partially chewed.

Cladocera are found in all sorts of waters, but lakes and ponds contain more species than do rivers. Shallow, weedy backwaters of lakes with fairly constant water levels attract most kinds. Here they find warmth, shelter in the weeds, abundant food, and security against drought. *Daphnia* and *Moina* are found in turbid, temporary pools, especially near farms, where food is plentiful at least while the water lasts. Only a few species live in or near the bottom mud of lakes. Cladocera that inhabit open water of large lakes are usually carried over from year to year parthenogenetically, that is, by virgin birth; the males are rarely seen. In some species the males have never been discovered.

There is hardly a more defenseless creature in the world than a water flea. It is the Number One food organism of the aquatic world. Not only the higher but the lower animals feed upon it. So lowly an animal as the *Hydra,* which is hardly more than a simple tube of cells, takes a water flea by stretching out a sting-bearing tentacle, stunning and then forcing the wriggling prey down its blind-alley gullet. Even the single-celled *Stentor,* a funnel-shaped protozoan representing the most primitive of all animal groups, preys upon daphnia. This is deep disgrace, because cladocerans are among the extremely few multi-cellular animals that are eaten whole by single-celled ones. But the greatest indignity to which a water flea may be subjected is to be snared by the bladder-like traps of *Utricularia,* a lowly water plant.

Leptodora, the tiger, is a renegade member of the otherwise meek fraternity of Cladocera; it is a ferocious killer. Like a pike with jaws snapping rushing in suddenly among a school of minnows, *Leptodora* appears out of nowhere to ravish the dense, swarming masses of water fleas. In keeping with its stealthy, raiding tactics, its body is phantom-like, transparent, and hardly visible except for its enormous black eye. After a successful raid, the tiger-daphnid's body takes on the color of the devoured victims, for these may be seen packed tightly in its cellophane-like alimentary canal. In keeping with its power as a beast of prey, *Leptodora* is a giant among the puny water fleas, for it is three-quarters of an inch long. For speed to seek out and overtake the darting, hopping, jumping, elusive water fleas, the rapacious raider is equipped with a powerful pair of great antennae. With slow flapping of these wing-like antennae it may cruise easily through the water seeking its quarry and then, by an increase in the tempo of the beats, speeds to make the kill.

It is fitting that this black sheep of the mild water flea clan be placed in a cladoceran family of its own. Unlike most cladocerans, its young, immediately upon hatching, fend for themselves as nauplii. As *Leptodora's* whelps grow older these wolves among the lamb-cladocerans refuse to burden themselves with the confining cloaks that are characteristic of other daphnia. *Leptodora* means "insignificant coat"; its long, slender, streamlined body, freed of encumbrances, is as trim as a sleek pursuit plane.

The ease with which water fleas are kept, bred, and their internal machinery observed, has made these transparent, diminutive creatures as useful as guinea pigs in biological laboratories. Experimental evolutionists, led by A. H. Banta of Brown University, have worked with water fleas for over 20 years at the Carnegie Institution of Washington's station at Cold Spring Harbor, Long Island. They have just issued a short statement of their results which covers several hundred pages. Every year dozens of learned papers are published recording the scientific results of investigations with Cladocera. As might be expected, many of these deal with the economic importance of water fleas to man. Methods of improving the culture of these valuable creatures on fish farms as food for young bass and other fish are constantly being suggested. Some papers deal with phases of daphnia biology that seem to be of purely theoretical interest. For instance one scientist studied the influence of supersonic waves on them. Another treated them with X-rays; still another tried to find out whether water fleas were attracted to, or repelled by, particular bands of the spectrum, visible and invisible to the human eye.

The famous Russian physiologist, Metchnikoff, observed some of the earliest demonstrations of phagocytosis in *Daphnia.* He watched their reactions to the invading spores of the fungus *Monospora.* When swallowed, these sharp-spined fungus spores pierce the water flea's intestine and escape into its body cavity. Here the spores come in contact with the flow of the creature's blood. The spores are stopped in their tracks by fighter blood corpuscles which, amœboid-like, engulf the enemy and put it out of action.

Today, water fleas are going to play a part in the medical division of our defense program. Many invaluable drugs must be checked on living organisms before being used, in order to establish the exact potency and toxicity of each newly manufactured lot. Daphnia, with all their sensitive organs visible to the pharmacist, have been found to react quickly when microscopic but calculated doses are administered to them.

A FLOWERLIKE ANIMAL EATS A FISH

Photo by Dever from Black Star

The photographic story of a remarkable event that may be seen on the floor of any shallow sea, in which a sedentary animal robs its prey of motion and then consumes it

IN DANGEROUS TERRITORY. Though the translucent tentacles of this group of sea anemones are almost flowerlike in their beauty, they are a living trap for the fish that ventures among them. No trouble appears to be brewing here, but turn the page to see the anemone's voracious habits

WHEN the fish comes in contact with the tentacles, it is seized and stupefied by action of a poison. Thousands of sting cells arm each tentacle, and each sting cell is equipped with a long hollow thread. On contact with prey, the thread is squeezed inside-out like the finger of a rubber glove, to bring into action the barbed tip

(*Left, below*) ENFOLDING THE FISH in its long feelers, the anemone draws its prey, powerless in the multiple grip, into the body cavity

(*Middle, below*) AS IT DRAWS the fish in, the anemone extends itself, reaching its body forward and surrounding its captive

Photos by Leonhardt from Black Star

(*Right, below*) ALMOST LOST TO SIGHT. The anemone has pulled itself like a stocking around the fish

(*Above*) THE SEA ANEMONE pours digestive fluids into its body cavity and absorbs the imprisoned fish as nourishment. It is now ready for its next meal. On the rocks below are young anemones, which have developed from larvae thrown off from the adult above

GEM FOR AUGUST

You may choose sardonyx, the gem Good Queen Bess used as a token of friendship, or the yellow-green peridot

By FREDERICK H. POUGH

Delicately carved sardonyx cameo

THE MOST FAMOUS of all sardonyx gems is the one in the ring which Queen Elizabeth gave the Earl of Essex as a token of her friendship. When, under sentence of death, he returned it to her as a sign of his peril, it fell into the hands of a foe, and Essex was executed. The stone has great historic value, which few gems can match, certainly no other sardonyx.

Sardonyx is one of the varieties of quartz, that protean mineral of which we have already spoken. Amethyst is a crystallized variety; bloodstone is a microscopically crystalline variety; and sardonyx is likewise cryptocrystalline, which means that distinct particles are scarcely recognizable even under the microscope. The name is derived from a brown color, the "sard," and "onyx," which means (finger) nail and refers to a resemblance in the luster of this translucent material to that of a nail. The ancients probably made no distinction between carnelian, a reddish variety of quartz, and sardonyx. Today we mean, by this name, a variety which consists of colored bands, one white, one brown. Like many of the quartz gems, it is relatively common and inexpensive.

Cameos are frequently cut in this material. The white layer is partially removed to leave a white figure standing out upon a brown background. This work must be done with the greatest of care. Good cameos are made only by true artists, for the material is hard to work and does not permit any mistakes. Before the days of electrically driven tools, cutting was an even more laborious art. Today people are likely to undervalue the effort, patience, and skill that have gone into the cutting of such a gem. Nowadays, pressed glass "cameos" are given away for box tops.

To the people of the Middle Ages the sardonyx was one of the most potent of therapeutic gems. Even now it is used in Persia in the treatment of epilepsy. The layers of sardonyx may be cut in such a way that an eye is formed, and such stones, known as eyestones, were used in eyes of idols. Eyestones were often believed to have a beneficial effect in the treatment of sores. Sardonyx was supposed to inspire eloquence in the wearer and to symbolize marital happiness, probably from the harmonious combination of the two contrasting bands in a single stone.

An alternative stone has been proposed for August,—the yellow-green peridot, which rarely receives proper appreciation. Peridot is the gem name of the mineral chrysolite, a member of the rock-making mineral family of olivine. Chrysolite olivine is an iron magnesium silicate that

A peridot crystal from St. John's Island in the Red Sea, the most important source for this gem and one known to the ancient Egyptians

forms in many rocks; the dark color distinguishes the rocks as *basic*, as opposed to the light-colored *acidic* granitic rocks. Olivine is usually so embedded in the rocks that the crystals are shattered and cracked. It readily becomes transformed into another, softer mineral. The gem localities are very few; in reality only one or possibly two important localities for this gem exist. The first is one of the oldest known gem localities, a place which was known to the Egyptians. This completely barren desert island in the Red Sea is known as St. John's Island. It is composed of volcanic rocks in which are found chrysolite crystals, sometimes over an inch in length. Crystals seem to be reasonably abundant at the locality, but the operation of the mines is so expensive that they are worked only occasionally. Workers living on the island must have all of their supplies carried to them,—even their drinking water comes from the mainland.

Small peridots have been found with garnets on the anthills in the West, and many of the beach sands of Hawaii are composed of small fragments of this gem. However, stones of any size are rare, and the beauty of the peridot can only be realized in the larger specimens. Recently, fine green stones from Burma have appeared on the market, but few details of this occurrence are available.

Peridot is an old gem and is frequently mentioned in the Bible under the synonym chrysolite. But there is great uncertainty about the nature of Biblical chrysolite, and many authorities believe that it is what we now call topaz. The ancients may well have had peridots; and a description of

Marquise-cut peridot—95 carats

an island in the Red Sea where the stones were found is very significant. According to Siculus, the stones glowed in the dark but were invisible in the day. Their location was said to be marked at night by an inverted vase, so that workers could return by day to dig the stones from the rock in which they were embedded.

Peridot was thought to be very effective as a charm, if set in gold. Then it kept away the evil spirits of the night,—but only if strung on a hair from a donkey's tail and worn on the left arm. It would seem that peridot was rather weak; other stones required less stage setting. The suggestion is made that the effectiveness was derived from a resemblance to the light of the sun and that the power was that of the sun's rays, dispelling darkness and evil spirits.

GEM FOR SEPTEMBER

ing Curator, Geology and Mineralogy,
American Museum of Natural History

Sacred among gems is the regal sapphire, whose frequent six-rayed star defies man's best attempts at synthesis

THE SAPPHIRE of the ancients is not the same stone as that which goes by this name today. In all probability their sapphire was lapis lazuli. Moses is supposed to have been given the Ten Commandments engraved on slabs of sapphire, but since pieces of such size are utterly impossible, only lapis could fit the description in this passage. Azurite, too, probably went under the name sapphire before the more precious lapis lazuli was discovered. In each case the name has been applied to the most precious known blue stone.

The sapphire we recognize today is a blue variety of the mineral corundum, whose red variety is known as ruby. There are other shades of gem corundum and they are known as "fancy sapphires." But the jewelers' stone for September is the blue sapphire, fourth member of the regal group: diamond, emerald, ruby, and sapphire. Just as the ruby owes its color to the chromium impurity in the normally colorless aluminum oxide, the sapphire owes its shade to iron and titanium. We know a great deal about the coloring of the corundum gems because we have been able to approximate them synthetically. However, the violet of amethyst, the gray of smoky quartz, or the green of fluorite are still unsolved mysteries.

Much as we know about the synthesis of the corundum gems, we have not quite been able to get nature's coloring into the stone, and the trained eye can recognize the genuine stone by color alone. Anyone can learn to distinguish the other differences, —few synthetics pose any problem.

One popular variety of corundum has no synthetic rival. That is the star sapphire, a stone which has been popular in this country for many years but which has only recently been appreciated abroad. Consequently, the United States has for some time received all of the best star sapphires, and some of the finest deep blue stones ever seen have found their way to this country. The star of a star sapphire consists of six (or really three intersecting) rays of light seen in the depths of a rounded stone. The star made by these intersecting rays moves as the stone is placed in different positions. Seeming to be almost a living thing, the floating star has quite understandably been held in awe by primitive peoples.

The mineralogist points out that the star follows in its three directions the six-sided outline of the original hexagonal corundum crystal, and explains that it is due to the reflection of the light beam from the sides of three sets of parallel rods or tubes. These microscopic inclusions are scattered all through the gem but are invariably parallel to the crystal's structural directions; hence, the sum of the reflected rays always reveals itself as this six-pointed star. When a single direction exists in a stone, we get a cat's-eye, and if but two directions are represented we get a cross, as in some garnets. Six-rayed stars are common in rose quartz. Realistic imitations of the true star sapphire have recently been made from hemispherical quartz gems by coloring the bottom blue.

Sir Richard Burton is reported to have put a star sapphire to good use in his travels. In return for assistance rendered him by the natives for food, lodging and care of his animals, he gave them the privilege of gazing upon his star sapphire and deriving from it all of the good fortune supposed to ensue.

Sapphires were regal gems worn by kings to protect them from harm. Later they came to be regarded as ecclesiastical gems whose pure color was symbolical of the heavens. This most sacred of all gems was endowed by nature with great power. Sapphire was supposed to be as strong an antidote against poison as the emerald. The mere sight of a sapphire was said to kill spiders.

Most star sapphires come from Ceylon, but the best colored Kashmir blue stones are found in India. Australia, North Carolina, and Montana have all yielded some sapphires. However, the demand is principally filled by the Eastern countries. The best qualities are characterized by a velvety blue color, the shade known as cornflower blue being the most desirable. Some stones, notably those from Australia, turn dark, almost black, in artificial light and are less valuable than those of the Kashmir quality.

Other sapphires also change color in different lights; for instance, a stone which is blue in daylight becomes violet in artificial light. These stones are known as alexandrite sapphires, because the variety of chrysoberyl known as alexandrite changes under similar circumstances, but from green to red. Stories have been told of tests of virtue made with such a stone, under conditions predicated to bring about a desired result. Wearing of the stone for a few hours in daylight would bring no change, but as usually applied such a test could not end before dark, so a condemnation was certain when the stone was inspected by candlelight. It is to be hoped that victims soon learned for themselves some of the wonderful properties of this interesting September gem.

(*Right*) Blue-tipped yellow sapphire crystal from Ceylon

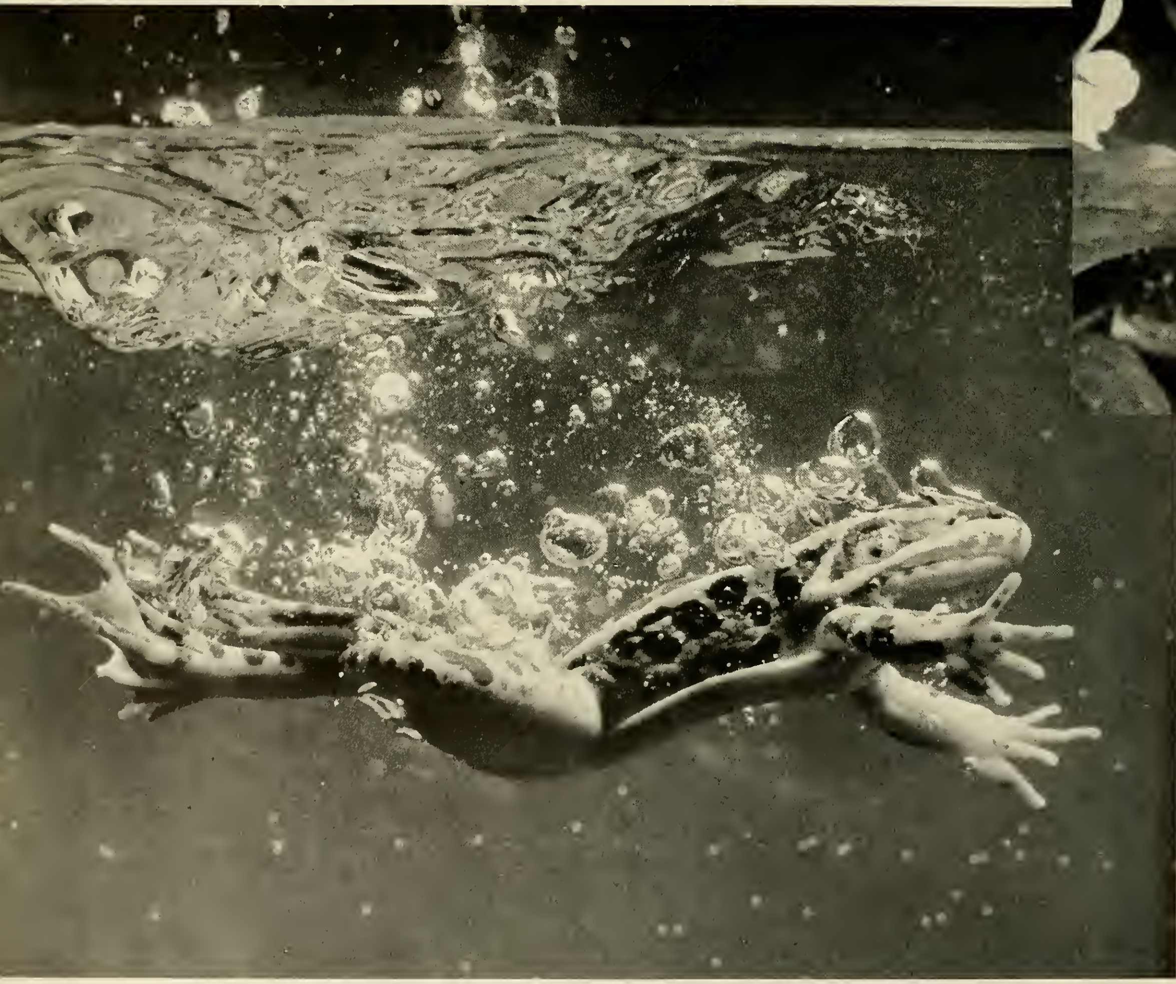
Carved sapphire fish with ruby eye. Light parallel bands across tail are characteristic of the genuine stone

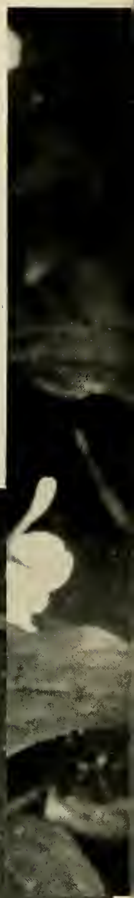
All photos AMNH by Coles

SEEING NATURE *through the* CAMERA'S EYE

By HENRY B. KANE

Underwater Bubble Dance of a Frog





A Bumblebee Takes Off

. . . and Lands—a 30,000th of a second photograph

Up Periscope

"STILT-JUMPER"
—A Katydid caught at a 30,000th of a second

Henry B. Kane photo

Songster and Dancer Unrivaled

By R. T. LITTLEJOHNS

Spectators who are unmoved by any other form of bird life stand spellbound before this gorgeous creature of the Australian forest

All photographs by the author, through Camera Features

ANY description of the fauna of Australia would be incomplete without reference to the lyrebird, which has emerged from comparative obscurity of a few years ago to become almost a national idol. In the last decade the attitude of the Australian public toward the wildlife of the country has changed most noticeably, so that we find almost every species of animal and bird increasing in numbers—even those which had appeared to be faced with extinction. Amongst those in greatest danger of extermination were all three of this country's most remarkable creatures, the koala, the platypus, and the lyrebird. The survival of the koala is not assured even now, as its numbers have reached that dangerously low level from which recovery is difficult. But the lyrebird is safe in those wide areas of mountain forest which, being unsuited to cultivation, may remain in the wild state indefinitely.

No apology is made for placing the lyrebird amongst the foremost natural history attractions of Australia. It is, without doubt, the greatest Australian songster and, in addition, is probably the most efficient of all mocking birds. Then there is the romantic dancing ceremony performed by the male bird on small cleared patches or "mounds," surely one of the most attractive natural history spectacles to be seen anywhere. With all these accomplishments to its credit the lyrebird undoubtedly would become more popular even than the koala were it not for its wild and elusive nature. This same elusiveness, however, ensures that the "artistry" of the species never will become commonplace.

The early history of the lyrebird is recorded in several books published soon after the advent of white man in Australia at the end of the eighteenth century. In these writings it was described variously as a pheasant and as a bird of paradise. Actually it is not related to either of these, nor to any bird found in any other part of the world. Even in Australia it is restricted to a narrow strip of country extending 1000 miles down the eastern coast of the continent,—roughly from Brisbane south to Melbourne.*

Both male and female are dark-colored birds about the size of domestic fowls. The head is small, the neck slender, the legs strong, and the feet enormous. The sexes are alike except with regard to the tail. In the female the tail is long but is composed of feathers of orthodox design. The tail of the male, however, besides being larger than that of the female, is a most attractive ornament and is what gives the bird its

(*Below*) WORLD'S BEST imitator: the Lyrebird, whose lyre-shaped tail befits one so musical. Its amazing voice masters almost every forest sound from the laugh of the "laughing jackass" to the rustling feathers of a flight of parrots

*Modern ornithologists recognize two species of lyrebirds, both residents of Australia, the one under discussion being the Superb Lyrebird, *Menura novaehollandiae*.—ED.

name, owing to its resemblance to the musical instrument. It is composed of sixteen feathers each about 27 inches long. There are two large outer feathers, each about two inches broad, gracefully curved and finished with a black curl. Between these are twelve filmy plumes, while the center of the tail is occupied by two fine wire-like feathers almost devoid of any webbing. The upper surfaces of all the feathers are dark colored, so that in its normal folded position the ornament is not conspicuous. The undersides of all the feathers, however, are silvery white, the broad outer ones being marked with bars of bright chestnut. The conspicuous undersides of the feathers are displayed during the dance, and it is only then that the full beauty of the tail becomes apparent.

The lyrebird lives almost entirely on the ground, using the trees only as roosting places at night. Worms, grubs, and beetles form its staple diet and are unearthed by industrious scratching in the soft mold. In this process the large, powerful feet are used to move quite heavy sticks and logs and to rake the undergrowth.

In April, at the beginning of the Australian winter, there is much activity among the male lyrebirds. Debris is cleared from old dancing mounds, or new ones are made where none had been before. Each male lays claim to a certain definite territory, over which he feeds and beyond which he seldom wanders. Within this territory he may make almost a score of mounds, on any of which he may decide to perform as the spirit moves him. In order to make a new mound it is often necessary to remove fern stems up to six feet in height, and great ingenuity and tenacity are displayed by the bird in carrying out this self-imposed task.

During the months of deepest winter the male lyrebirds fill the forest with melody practically from morning till night. It is at this season that the dance may be most often witnessed by those who are sufficiently interested to brave the discomforts of the sodden forest and to exercise a reasonable degree of patience.

THE DANCING of the male lyrebird on his dancing mound is even more wonderful than the song and is experienced less often. In constructing his mound, the bird often has to remove six-foot fern stems, and shows great ingenuity and perseverance

The vocal powers of the species are remarkable and are without equal, at least in Australia. This largest of all songbirds produces a volume of sound so penetrating that the song may be heard clearly from a distance of a quarter of a mile. At a distance of 20 or 30 feet the louder notes ring uncomfortably in the human ear. The song is in part original, in part a faithful mimicry of bush sounds, and for the re-

GOING INTO HIS DANCE. Suddenly there is a change in the song, and the bird sweeps his tail upright, to fall reversed over the body,—a gleaming silver fan

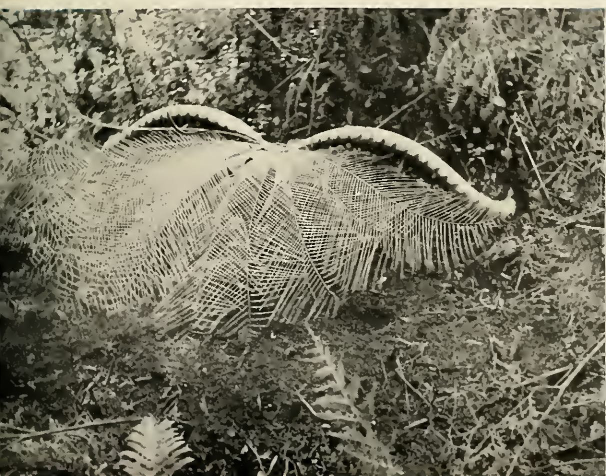
THE performer at times "shivers" the fan rapidly, causing it to resemble a miniature snowstorm. He faces here to the right

IN APRIL the lyrebird clears off old mounds or builds new ones, to the number of almost a score. He performs mostly in well-screened positions, making photography extremely difficult

WHEN FOLDED, the tail is well camouflaged and gives no forewarning of the sensational display to come. The lyrebird lives almost entirely on the ground

mainder it consists of semi-original items based on the songs and calls of other birds. The mimicry is indescribably faithful, the wonder of it, of course, being more fully realized by those who are best acquainted with the birds whose songs are imitated. Every inflection in the song of the original is reproduced with exactness, so that it would be impossible, by the sound alone to detect the deceit. The raucous laughing of the kookaburra (the Australian kingfisher, known as the "laughing jackass") is rendered with the same facility and faithfulness as is the high-pitched musical whistle of the pilot bird or the feeble scolding treble of the thornbills. Even the rustling of feathers, such as accompanies the flight of a flock of parrots, is reproduced in the wonderful throat. Again, the mimic may imitate the call of the boobook owl, a nocturnal sound, and the fidelity with which the peculiar "throatiness" of the original is imitated is uncanny. But undoubtedly the greatest accomplishment of the master mimic is the rendering of a whole chorus of kookaburras laughing in unison. The kookaburra provides much inspiration for the lyre-

RHYTHMIC NOTES mark time to the lyrebird's dainty dance, as he approaches the camera in full display



A FINAL burst of beauty rewards the photographer, as the song dwindles to a wheezing rattle and ceases

(*Left*) From the nest of the female, this scene shows a tree-fern gully typical of the forest in which the lyrebird makes its home

(*Right*) A five-weeks-old lyrebird, left alone in the nest, wonders what it is all about, as Mr. Littlejohns' camera records another phase in the life of Australia's greatest songster

(*Below*) The mother lyrebird about to feed the chick. She is solely responsible for hatching her single egg and caring for the chick, which is blind when hatched

Feeding: a remarkable photograph at 18 inches. Mr. Littlejohns spent ten winters making two cinema films. An electric buzzer accustomed the birds to the camera

(*Below*) Humpbacked, long-legged, and pinfeathered, the six-weeks-old chick has just left the nest, to follow its mother with tottering footsteps into the forest,—the homely premonition of a gorgeous creature

bird at all times, but just once or twice in a lifetime does one hear the chorus so elaborately and faithfully sung by the mimic that one must simply gasp in amazement. It is useless to attempt to describe this performance. It is wonderful beyond description.

Of the semi-original sounds, the most notable is an elaboration of the song of the gray thrush, which almost always drifts into bubbling notes suggesting the distant laughing of kookaburras. These two calls combined form a stanza of great beauty. Even in the midst of its feeding, the lyrebird frequently pauses to utter just this one call.

When the male bird settles down seriously to singing, he visits one of his several mounds or stands on a log or limb. Here he may give a performance of half an hour or longer practically without pause. In that time there is not a dull moment. Calls are repeated, to be sure, but the sounds reproduced are so many, so varied in tone and in volume, that the song is a complete entertainment.

The dancing of the cock on his dancing mound is even more attractive than the song. It is, in fact, always accompanied by singing, but, being performed usually in well-screened positions, it is witnessed less frequently than the song is heard. Anyone who witnesses the dancing ceremony is unlikely to forget the experience. Scores of people who are not particularly interested in natural history have become so absorbed in the artistry of the lyrebird that they may be found, week end after week end, at Sherbrooke Forest, near Melbourne, a place famous for its lyrebirds. During fourteen years devoted to a study of the species, the writer has witnessed the "dance" on many hundreds of occasions, yet its romantic interest thrills him as deeply as on the first occasion. It is unfortunately almost impossible to record the dancing ceremony adequately by photography. Certainly the motion picture is more efficient than any other method, and for this reason the writer spent ten winters making two cinema films. The more recent one, completed a few years ago, was made for the Australian Commonwealth Government and has been shown frequently overseas.

A gleaming silver fan

The highlight of the dancing spectacle is the transformation scene which marks the commencement. Usually the cock sings for some time with his tail folded. During this phase the tail is inconspicuous, as its upper surface is almost uniformly dark in color. Suddenly there is a change in the character of the song: the notes become wilder and perhaps less musical. Then the display starts and with an unhurried sweep the tail is raised upright and allowed to fall reversed over the bird's body. With the same movement the sixteen feathers spread fan-like, until the performer is hidden almost entirely by it. But it is no longer a tail of somber brown. With the sweeping movement the ornament becomes a gleaming fan of silver.

Determined, apparently, to ensure that its new beauty shall not pass unnoticed the erstwhile placid singer becomes at once a creature of great animation. Whilst the performer adopts a rhythmic sideward marching the tail may be "shivered" rapidly, so that the whole assumes the appearance of a miniature snowstorm. Then there may be curious jumps in regular series of two to the accompaniment of loud, challenging notes. There may be rapid circuits of the mound or, for minutes together, the snowy fan may be still, except for the vibration caused by the fervor of the singing.

After minutes have slipped away to a score or more, the song dwindles to a wheezing rattle and ceases. The wonderful tail rises to reveal the artist once more, and the feathers are folded so that their beauty is departed in a moment. There will be the invariable final shaking of the plumage as the actor steps from his stage to stride with dignity into the ferns.

The domestic life of the lyrebird is in keeping with the other remarkable phases of its existence. It is one of the few male birds in Australia which takes no part in the domestic activities. The female builds, unaided, the large nest of sticks and fibers. She also performs all the work of incubation and feeding of the chick in the nest. It may be said, in excuse for the cock, that his large tail would render the performance of some of the domestic routine difficult in the extreme.

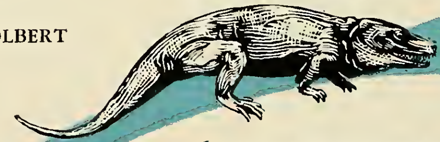
The nest is bulky and is built almost always on or near the ground. With an exterior shell of fairly large sticks and an inner lining of fern fibers, the home is a substantial domed structure so faithfully constructed that, even in the depth of winter, it is always warm and snug within. One egg only is laid each year. It is thick-shelled and rough, varying in color from light purple to dark stone and is roughly the size of a hen's egg. The period of incubation is about six weeks, which appears extraordinarily long. Receiving no assistance from her mate, the hen, since she herself requires a great quantity of food, often leaves the egg unattended for several hours a day.

The chick is blind when hatched and is covered, except on the neck and underparts, with sooty-colored down. Because it has no brother or sister with whom to share the food brought by an attentive parent, it grows rapidly. At the age of a couple of weeks it is able to signal resentment, when disturbed, by uttering a blood-curdling scream. At five weeks the chick has grown so considerably that it lifts the roof of its home in excitement when mealtime approaches. At this stage the gawky youngster has little claim to beauty, nor has it improved when, a little later, it tumbles from its threshold and follows its mother with tottering steps into the forest. For some time thereafter its history is obscure. It is not known with certainty how many years pass before the chick, if a male, attains the full ornamental tail, but it is certain that for at least two or three years he carries a long but unpretentious tail similar in every way to that of an adult female.

THREE ANIMALS T

By Edwin H. Colbert
Assistant Curator of Vertebrate Palaeontology, American Museum of Natural History
Drawings by Margaret M. Colbert

A primitive reptile, *Seymouria*



6 As time went on there was a gradual transformation from amphibians into the first *reptiles.* No longer was the land-living vertebrate bound to his ancestral watery habitat, for the reptiles laid protected eggs that could be hatched on land

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LAND

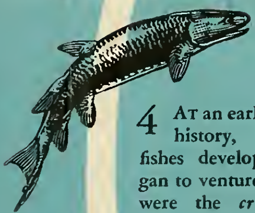
A primitive amphibian, *Diplovertebron*

5 The first *amphibians* had limbs and feet, transformed from the fins of their crossopterygian ancestors. Although they could walk across the land they were dependent upon water, for only in the damp marshes where they lived could their eggs be hatched

WATER

3 During the long passage of geologic time, the modernized *sharks* evolved from their acanthodian ancestors. The result has been the perfection of the streamlined body form for swift, sustained swimming in the open ocean *(below)*

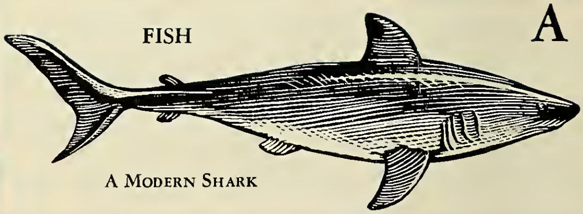
Eusthenopteron, a crossopterygian



4 At an early stage in vertebrate history, certain fresh-water fishes developed lungs and began to venture out on land. These were the *crossopterygians,* the ancestors of the amphibians

FISH

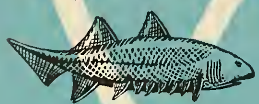
A



A Modern Shark

2 From the ancestral jawless vertebrates the first true fishes developed. These were the spiny "sharks" or *acanthodians,* freely swimming fishes adapted to life in the open water *(left)*

Climatius, an acanthodian



1 The first known vertebrates were small, jawless, fishlike animals called *ostracoderms,* living on the bottoms of ancient rivers and estuaries *(left)*

Cephalaspis, an ostracoderm

HAT WENT TO SEA

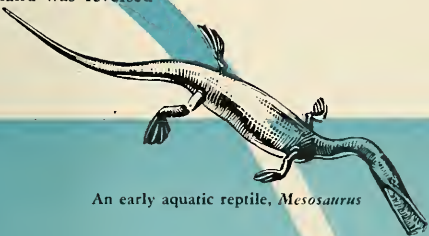
A mammal-like reptile, *Cynognathus*

9 YET the main trend of reptilian evolution was confined to the land. Certain reptiles, like *Cynognathus*, having descended from primitive types, became very progressive, or mammal-like

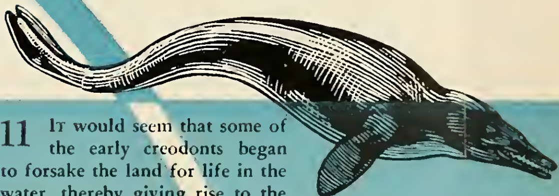
RTAIN REPTILES, finding the uggle for existence on land ifficult, began to return to ater to live. Thus in the aquatic reptile *Mesosaurus*, iginal trend of evolution vater to land was reversed

A creodont, *Sinopa*

10 FROM these mammal-like reptiles the early mammals evolved. The transformation of reptile into mammal was marked by the change from a cold-blooded to a warm-blooded circulation. Among the early mammals were meat-eaters known as *creodonts*



An early aquatic reptile, *Mesosaurus*



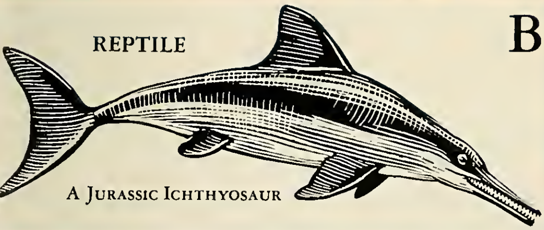
A primitive whale, *Zeuglodon*

11 IT would seem that some of the early creodonts began to forsake the land for life in the water, thereby giving rise to the primitive *zeuglodonts*—the ancestors of the modern whales, porpoises, and dolphins

8 *(Below)* THE CULMINATION of this reversal was reached by the *ichthyosaurs,* which although descended from land-living reptiles became thoroughly fishlike in body form—the result of streamlining

REPTILE

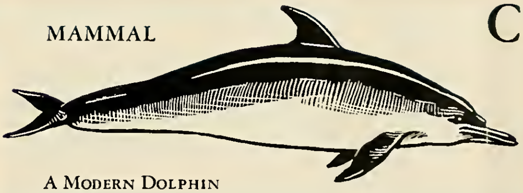
B



A JURASSIC ICHTHYOSAUR

MAMMAL

C



A MODERN DOLPHIN

12 AGAIN there had been a reversal in evolutionary trends, reaching its culmination in the modern *cetaceans* (whales and their relatives). Descended from land-living mammals, the cetaceans have become secondarily fish-like, streamlined for life in the ocean, as seen in the dolphin above

By roundabout routes involving 300 million years of evolution, three widely different classes of animals perfected an amazingly similar streamlined design when they met the conditions of life in the water

To the museum visitor, wandering through halls where ten thousand wings are folded and spread in multicolored hues, where Africa silently lives far from the sun-baked veldt, where the mammoths march in impressive array and where the great dinosaurs once again rear their mighty forms, the life of the world may seem to be bewilderingly complex. Nature's outstanding trait is the diversity of her children. Yet a closer study reveals that there is often a beautiful simplicity in many of nature's basic designs, and the resemblances that occur time and again in varied and unrelated forms are just as striking as the differences which are so apparent at first glance. For evolution is not only the development of many different kinds of animals or plants from a few primitive ancestral types, but also the parallel or convergent development of superficially similar organisms from different ancestral forms.

As an illustration of the latter let us look at three animals of different ancestry which at different times in the earth's history went to sea and partly because of their life under a common environment came to resemble one another. This particular type of evolutionary development is called "convergence" or "parallel growth" and is the opposite of "divergent evolution" or "adaptive radiation," in which dissimilar environments cause animals or plants of similar ancestry to develop along different lines of adaptation. Thus through adaptive radiation a little ancestral herbivore gave rise to the swift-running and grazing horses of the upland plains, to the ponderous, aggressive rhinoceroses of the veldt and jungle, and to the water-loving tapirs of the tropical forests. Conversely, through convergence, unrelated animals which develop under similar environmental conditions may become superficially similar. Such is the case with the three animals that went to sea, the shark, a fish, the ichthyosaur, an extinct reptile, and the dolphin, a mammal.

The similarities in these three animals are the evolutionary result of physical laws which set definite limitations upon the manner in which life may develop. A good flying mechanism, whether it be bird, bat, or airplane, must have wings for support in a rarified medium; while an efficient underwater mechanism, whether it be fish, porpoise, or submarine, must be streamlined in order that it may slip easily through a very dense medium. That is why there are perhaps no better examples of convergent evolution than among those animals that inhabit the sea, for an aquatic existence imposes physical limitations that are very definite. Let us first review briefly the beginnings of evolution among the vertebrates, or backboned animals.

It would seem that all life began in the water. (The transfer from the protection of an aquatic environment to the vicissitudes of life on land came long afterwards in the evolutionary story.) Therefore it is not surprising that the earliest backboned animals of which fossil remains are known were aquatic animals. These early vertebrates, which are called ostracoderms, were fish-like, yet they weren't actually fish, for they had not yet reached a true piscine dignity. They lived on the bottom of ancient rivers and estuaries, grubbing in the black mud of the shallow waters for their food. They were for the most part flattened of head, flexible of body, heavily armored and provided with a single pair of appendages projecting from the corners of their plowshare-shaped head shields. There were no lower jaws; instead, the garbage-like fare which nourished these ancient vertebrates was sucked in, vacuum-cleaner fashion, through a round mouth on the underside of the head. From this crude beginning, the animals with backbones evolved.

At a very early date the first true fish appeared, swift-swimming, primitive "sharks" adapted to a life in the open waters. And with their appearance the basic architectural pattern, so characteristic of almost all of the vertebrates, was established.

An aquatic animal, to be an efficient sustained swimmer, must conform to certain physical requirements in outward form. The body must be elongated and torpedo-shaped, with a rather rounded head, with the thickest part of the body a short distance behind the head, and from thence tapering to a point at the rear. This is the true streamlined design so often talked about and so seldom achieved by man in his mechanisms. The propulsive force of the well-designed water animal is supplied by alternating undulations of the body pushing backward against the water, thereby forcing the animal forward. In addition to the propulsive force, there must be an efficient control of movement and balance, which is accomplished among fishes in part by a series of fins: a pair on either side near the head (the pectoral fins), a pair on either side farther back on the body (the pelvic fins), and median fins along the back (dorsals), along the under surface of the animal (the anal fin), and at the hind tip of the body (the tail or caudal fin). This is the basic pattern for the jawed vertebrates, first established by the early sharks of lower Paleozoic age, some 400 million years ago.

In these early sharks the backbone extended through the upper part of the long, tapering body to the base of the tail, where it made a sharp, upward bend, to extend into the upper lobe of the tail fin. This primitive tail pattern, known as the heterocercal tail, is still preserved in the modern sharks. A widely gaping jaw, armed with numerous sharp teeth, large paired fins and well developed dorsal fins complete the picture of these primitive streamlined vertebrates,—evidently fast swimmers, swiftly gliding through the open waters of the ocean in pursuit of their prey. From a pattern such as this evolved the tremendous variety of modern fishes, culminating in such advanced models of the streamlined body pattern as are to be found in the modern mackerels and perches and their relatives, some of which are among the fastest swimmers known.

But such highly specialized fishes and their kind did not evolve rapidly. There were long geologic ages after the first appearance of the primitive sharks before these highly specialized bony fishes finally reached the height of their structural evolution. And in the meantime other animals with backbones were developing along other lines.

Toward the middle or the latter part of the great Paleozoic era, certain freshwater fish began to venture out on land, to try a new mode of life. The movement from water to land involved profound bodily changes; indeed, this new departure in animal life called for an almost revolutionary series of adjustments. In the first place, a new method of locomotion had to be developed in the land-living animal, for no longer could the body be utilized for pushing against a dense, watery medium. Secondly, the animal on land had to cope with a force heretofore of little consequence,—the constant downward pull of gravity. No longer was it buoyed up by the medium in which it lived. Also, it had to effect a new method of breathing: oxygen must be extracted from the air, not from water. Fourthly, the animal had to guard against drying up through the process of evaporation, which obviously was of no consequence to the water animal. Finally, it had to develop new methods of reproduction, whereby the eggs could be protected from the rigors of dryness and temperature consequent upon emergence from the water.

All of these new conditions of life were successfully met by the land-going fishes mentioned above, and thereby the first amphibians came into being. The paired fins of the fish, originally directing and balancing organs, were transformed into limbs for propulsion, while the dorsal and anal fins, no longer needed, were lost. The tail, originally part of the propelling apparatus, became in turn a long balancing lever. Thus the functions of the fins and of the tail were in a sense reversed in the change from fish to amphibian. The gills were reduced or lost, and lungs served for breathing. The backbone became strong to support the weight of the animal. The skin was kept moist, to prevent a drying up of the body, and reproduction was made possible by a return to the water for the laying of the eggs.

As time went on, certain of these amphibians developed a new type of egg, which could be laid on land, and new body scales were evolved to guard against the drying effect of the air. Thus the first reptiles were born, the forerunners of a large and varied group of animals that were dominant on land, in the water, and in the air for the great stretch of geologic time known as the Mesozoic era, or the Age of Reptiles.

Early in the Age of Reptiles—that period when the great dinosaurs dominated the land—certain reptiles returned to the waters to follow their fortunes. Here is where we see the remarkable effects of convergent evolution taking place. These animals, as they became ever more closely adapted to their watery environment, grew constantly more fish-like in their outward form. The body became torpedo-shaped and smooth, and the flexible neck of the land animal disappeared. The tail grew long, and around its extremity a new tail fin was formed. In this development of the new tail a curious change took place whereby the backbone extended and bent downward to enter the lower lobe of the tail fin. Here was formed a new heterocercal tail, but one that was a mirror image of the primitive heterocercal tail of the ancient sharks. The limbs, originally derived from fins, were again transformed into fins. A new dorsal fin grew on top of the body. The snout grew longer and became armed with numerous sharp teeth,—a return to the fish-catching type of mouth, first developed in the primitive sharks.

Thus the ichthyosaurs, the marine reptiles of Mesozoic times, whose ancestry can be traced from primitive fishes through the amphibians to land-living reptiles, returned again to the sea, and in doing this they became once more streamlined and fish-like.

"Fish-like" they were, but they were not fishes. Evolution had completed a circle, and there had been an apparent reversal in its trend; yet there was no real reversal, for structures once lost can never be regained. The ichthyosaur had become fish-like in form but by virtue of a transformation of head, body, and limbs from those of the typical land-living reptile, and by the manufacture of a completely new tail and a new dorsal fin. And although the ichthyosaur lived a fish-like existence, it breathed by means of lungs, inherited from its land-living grandparents. Such are the obvious clues to convergence in evolution as against a direct hereditary relationship. The resemblances are present, but the family history shows them to be of completely different origin. Through the long process of evolution, physical laws had imposed likenesses through mutation and selection upon unrelated animals living in the same type of environment.

Time elapsed,—the ichthyosaurs lived, evolved, and finally passed from the earth. In the meantime some of the land-living reptiles, living at the same time as the early ichthyosaurs, had given rise to a new type of vertebrate, the mammal. Certain reptiles through transformation produced animals that were warm-blooded and active, animals that were protected by a coat of hair, instead of reptilian scales. These new creatures gave birth to their young instead of laying eggs and suckled their young on milk; they were the mammals, the class of animals that includes most of our modern wildlife of forest and plain.

The early mammals lived on land, as had their reptilian ancestors. But at a fairly early stage in the history of the mammals, one group like the ichthyosaurs before them, took to a life in the open waters of the oceans. And once again the streamlined body form came into being, without relation to its earlier manifestations in fish and ichthyosaur. The body lengthened and became torpedo-shaped. The hair was lost and the surface of the skin became smooth. The flexible neck of the land animal disappeared. A new

Continued on page 112

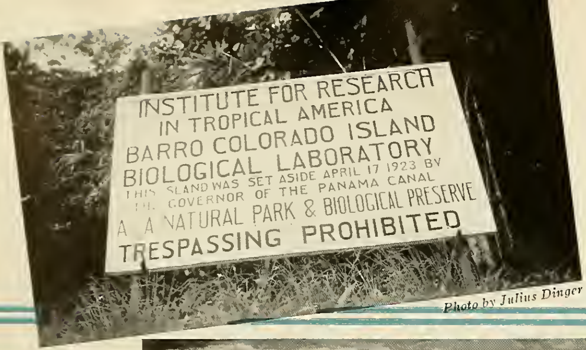


Photo by Julius Dinger

A Naturalist's

By E. THOMAS GILLIARD

THE native cayuco glided beneath the walls of towering trunks which leaned precariously in a haze of sifted moonlight. A big, dragon-like iguana, observing my silent approach, let go its footing high in the trees overhead and plummeted with a nerve-wracking explosion into the black water ten feet ahead of the prow. Crocodiles, which by day are so rarely in evidence as to seem almost mythical, were all about. Their brilliant ruby eyes, the danger signals of the night, reflected blindly into the beam of our searchlight. The fantastic howls of black howling monkeys made one shudder as they resounded from the crown of the forest. This was Barro Colorado by night.

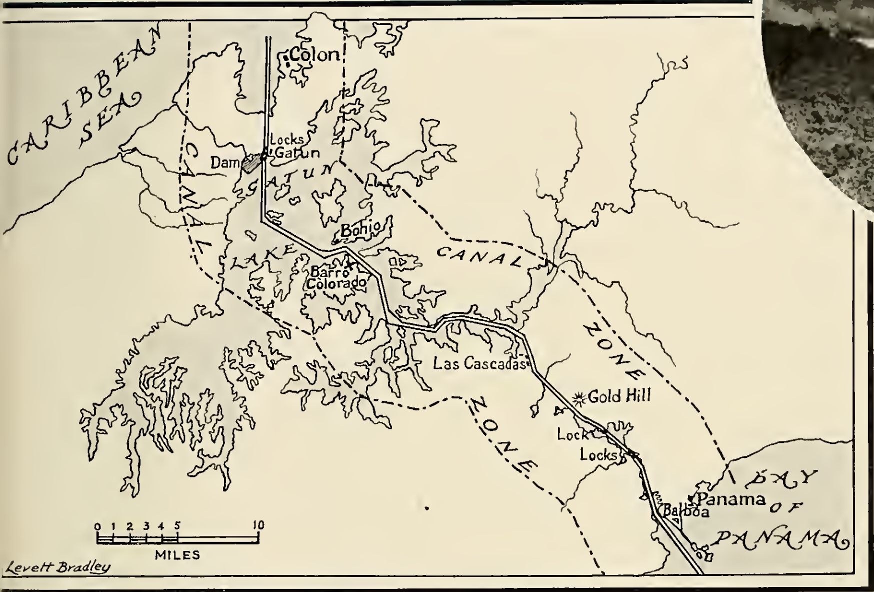
As I paddled on silently through the black waters of the vast, man-made Lake Gatun which forms part of the Panama Canal, the "Chief," Dr. Frank M. Chapman, kept up a ceaseless search of the banks, hoping to spot the eyes of the tapir we had set out to find. This animal is closely related to the large rhino, and besides being the biggest of South American mammals, with the exception of the inland porpoise, it is probably the best swimmer. Our hunt was futile, but as we were returning up the darkened inlet toward "Fuertes House"—our hospitable cabin deep in the jungle—a raucous series of whistles in several pitches broke forth from the giant trees on our left. This wood rail concert, sounding like a quartet of bagpipes, aroused some fond memory in Doctor Chapman, and before I could grasp the motive, he stood up in the precarious cayuco and began directing the "orchestra." There he stood with an imaginary baton leading the chorus from our dugout, and there was I, so amazed my mouth hung open.

Although the wood rails are usually silent, seclusive birds of the deepest jungle, they are quite vocal when their little-known mating dances take place. These dances occur when a sprightly male struts on his long legs out into his little clearing in the dead of night and puts on a song and dance to lure the more venturesome of spouses to his particular domain. The females, usually several of them, vie for attention by joining the chorus, which rarely lasts for more than a few seconds. But the Chief had stolen the show as far as I was concerned.

When we returned we sat on the steps for a long while, listening to the many noises of a tropical night, and I slouched against a post, puffing my last pipeful. It is astonishing how much noise the multitudes of living things around us produced. Off on the hill the

Mecca in the PANAMA CANAL

Barro Colorado's island laboratory lies at the crossroads of two hemispheres. Students of Nature have gathered here from all over the world to make biological history amid its tropical wildlife



Photos by Frank M. Chapmon

(*Extreme left*) AN AIR VIEW of Barro Colorado, a thickly forested island rising out of man-made Gatun Lake. Its tower looks out on ships like that above, passing along the great inter-ocean waterway, its jungles echo to the cry and bustle of a rich Central American fauna which found sanctuary here when canal builders flooded the environs

(*Below*) LABORATORY and camp, including Frank M. Chapman's famed "tropical air castle." The celebrated ornithologist is one of Barro Colorado's most regular visitors

(*Below*) A TROPICAL forest, 165 square miles in area, was submerged, making Gatun Lake one of the least navigable in the world

mournful wailing of a huge goatsucker was repeated at intervals, and the complete and utter sadness of this *poor-me-one* almost set me to pitying him. Infrequently the hollow clopping of a big tree frog or the eerie note of the spectacled owl broke through the incessant burr of the cicadas. Overhead, ringing with clear perfection, could be heard the many anvil frogs and, far off, perhaps a mile distant, the rumbling of the querulous howling monkeys. A kinkajou with its incredible shriek, so much like the scream of a strangling woman that it never failed to shock me, joined all of these sounds in a *Fantasia* serenade. But there were other more subtle noises, each telling its own particular story, which I, with my four short months of experience, could not fathom. The Chief, sitting there on the steps, often explained them to me,—explanations which were quickly delivered from the vast store of experiences gathered over a period of almost half a century of study and keen observation of animals, both here and in almost every country in South and Central America from Mexico to Tierra del Fuego.

I had read about Barro Colorado in Doctor Chapman's books and in his articles, and had hoped, like so many other young men, that some day I might see this mythical, tropical isle. But until a certain incident occurred six months before, I had never dreamed this longed-for boon would ever come my way.

A premature snowstorm was raging outside of Whitney Wing of the American Museum of Natural History when my phone rang. It was the Chief. I remember wondering what I had done wrong to warrant this summons to the sanctity of his "sanctum sanctorum." About five minutes later I stumbled out of his office in a daze. It would have taken Joe Louis to do a better job. You can guess what happened, and shortly thereafter I bid adieu to the vast collection of birds and mothballs and embarked with Doctor Chapman for the fabled Central American island.

Introduction to Barro Colorado

Seven days later in the blaze of a tropical sun and fanned by the cool Caribbean trade winds, we completed the last leg of our trip. Although we'd kept our business to ourselves on the way, it seemed that everyone knew "The Doctor." From the time we had boarded the good ship *Ancon* and gone down to our staterooms, where the Cockney cabin steward had greeted Doctor Chapman like a long-lost brother, our business had become increasingly the property of the curious passengers. Doctor Chapman was the "mysterious American scientist" who annually shipped all the way from New York, only to go into seclusion out on that jungle island for from four to five months.

On the dock where we landed we were hailed by Chichi, out-island boatman and warden, a sinewy little Latin whose knowledge of the channels and dangers of Lake Gatun was of inestimable value, and Fernando, a wary old bushman. Half an hour later the little inboard cabin yacht struck out through the placid *estero* toward the Panama Canal.

Here and there huge dead trees, killed when the Chagres Valley was flooded to form Lake Gatun and a major part of the inter-ocean waterway, protruded like the masts of derelict ships from the lake surface. Following the narrow open waterway, we rounded the bend and came upon a large body of water with big, slashing waves. Straight ahead, perhaps a half mile distant, were two big red and white buoys, and to our right, hardly a mile away, a tremendous ocean liner was bearing down on us. She was throwing big waves and heading for the buoys. We cut our motor and drifted till she crossed our bow. The ridiculousness of the scene made me laugh. It seemed as though I were looking at a toy exhibit in Macy's window. The big ocean vessel was cramming itself through a tiny mountain lake and soon disappeared around a bend no wider than Broadway. We crossed the Canal near Buoy 44, about midway between the Atlantic and Pacific, and headed speedily toward a low whaleback hump of land. The waves were throwing a spray completely over us as Doctor Chapman shook my shoulder and yelled a few words, pointing out a red cliff near the right tip of the island. "The island Barro Colorado is named for those cliffs," he said. The name means "red clay."

The gushing Chagres, whose channel lay 80 feet below the cliffs, had been, in pre-Canal days, a dangerous leg in the old trans-isthmian trail, a cruel, overland route which had seen many a strange and pitiful sight. From the days of Balboa's discovery of the Pacific up through the California and Alaska gold rushes, it had served as the fastest means of inter-ocean travel. Sir Henry Morgan and his band of cutthroats twice passed by the big, flaming cliffs during their march and retreat from the bloody siege of old Panama. The very name—Barro Colorado—was first recorded in connection with Morgan's advance, for in 1670 Captain Louis de Castillio, the commander of the Spanish forces sent to oppose Morgan, established a camp under these cliffs. "But," to quote Doctor Barbour, "he retreated before the boats bearing Morgan and his men arrived, leaving a record of valorous discretion."

Barro Colorado itself is a mere dot on the map of the Panama Canal Zone, lying about midway between the Caribbean and the Pacific,—an island where the wild animals are considered to be the only permanent and worthwhile residents, and where man is entirely secondary. It was set aside as a permanent base for the Institute of Research in Tropical America under the jurisdiction of the National Research Council in Washington.

The island was formed when the Chagres River was dammed by the largest earth dam in the world in order to raise the river level 85 feet. The lake thus formed was slow to fill, four years being required to inundate the 165 square miles of tropical forest now forming its basin. During the flooding, animals of all descriptions which had lived in the vast Chagres Basin had to move to dry land, and Barro Colorado, being the largest of the islands formed by the rising waters, naturally received a goodly portion.

I don't want to convey the impression that this island is either a wild circus or an island Ark, especially since Barro Colorado did not become an island until the lake had risen almost to its highest level. Furthermore, the rumor has gone around that this island is inhabited by hordes of wild animals; and when the Resident Manager, Mr. James Zetek, takes visitors out to it, they are sometimes disappointed. Naturally when a group starts noisily through the woods it is not going to see many wild animals. On the island there are, nevertheless, more than 1400 species of plants and trees, 231 species of birds. Its mammal population consists, to mention a few, of the puma, ocelot, Baird's tapir, collared and white-lipped peccaries, four species of monkeys, the white-tailed and forest deer, two species of sloths, and tamandua tayra, the coati, and agouti, etc. Essentially it has changed little from its primeval state, and probably every species of animal which in recent times had frequented it, with the possible exception of the spider monkey and perhaps the jaguar, was there when the island was set aside as a wildlife refuge. If all goes as planned, this zoologists' mecca of the tropics will remain intact, and eventually it may be the sole domain of some of the animals which now dwell in Central America.

For things have changed a great deal in Panama and in the Zone since the Army engineers first went into that fever-infested area to make it fit for the workers and engineers who came to build the Panama Canal. Today there is no fever on the island and one can sleep out at night, though elsewhere in the Zone this is not recommended. This has been made possible by Mr. James Zetek, the Resident Manager, who was one of the original biologists who fought the scourge of malaria and yellow fever before the construction of the canal. He periodically examines all the help and prohibits them from being in Frijoles after dark. Actually the "modern conveniences" in this primeval jungle are now so luxurious that one cannot help feeling paltry compared to the men who pioneered in this region and in South America. Men like Schomburk, Bates, Cherrie, Belt, André, Wallace, and even the Chief. All these men had invaded the tropics when they still were deadly—even before quinine was known except to the Dutch and to the Peruvian Indians who first discovered it.

Howling monkeys

We had hardly reached the last of the 186 steps which led up from the trim little wharf, when Doctor Chapman, panting from the climb, broke out in a hoarse exclamation, "Howling monkeys—the whole clan's over my house!" Sure enough, 40 big, black creatures were traveling high in the crown of a huge balsa tree bedecked with white, vase-like blossoms.

At sight of us they let out a series of roars, which sounded like the bellowing of a dozen lions. We watched them as they methodically crossed from tree to tree out of sight into the jungle. I was most intrigued by the way in which the females conveyed their young, who clung precariously from their backs as they scurried through the maze of quivering limbs, sometimes jumping fifteen feet and more with a grace born of complete confidence.

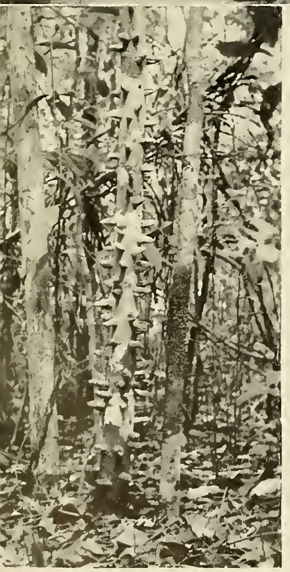
Doctor Chapman's house, his "tropical air castle," was a perfect example of simplicity in the extreme: a sixteen by eighteen foot box, with a single partition, set on nine cement piers, one open and one screened porch, and a tin roof. I'll admit I was somewhat abashed at sight of this famous castle set at the edge of the jungle and painted green so as to be hardly distinguishable.

My quarters were on the porch of the laboratory, and I had a small table, a cot, and a magnificent view. Work, if you can call it that, began immediately. Hours were from 6:30 A.M. until it was time to go to sleep. Every five or six weeks we had a holiday visit to Balboa and old Panama.

Day after day and week after week, spending never less than seven hours in the jungle, almost always alone, I gradually came to know and accept the wonders of Barro Colorado. At first, I didn't venture very far into the tunnel-like system of trails. Every 20 or 30 feet some new, unnamed creature, flower, or insect, would arouse my curiosity, and out would come the pencil and notebook. Evening after evening the Chief would identify these varied subjects of my curiosity.

I well remember my first trip into the jungle. It was a slow and methodical affair, and contrary to popular imaginings, I didn't find it teeming with birds, animals, and reptiles. About the only things that "teemed" were the trees and vines which stopped or would have greatly impeded my progress had I left the trail for so much as a few steps. It was pleasantly cool under the roof of green, which sometimes attained a height of more than 100 feet, and even 150 feet, as it reached out pleadingly into the glaring and withering rays of the equatorial sun.

My field notes describing those first impressions are as follows: "Somehow this island jungle took on the quiet majesty of an endless cathedral. Very few living things were seen, but I confess that my untrained eyes were to blame for this. I was conscious of eyes—hundreds of them, in a vast assortment of sizes and colors—focused on me, but I couldn't break through their shield of protective coloration to verify this feeling. Occasionally I was allowed a glimpse of fur or flying feathers, only after the creature which had been watching me as I tiptoed through its domain, had satisfied its curiosity. Big guans, the wild turkeys of the jungle, screamed and scolded and took wing, a grouse-like tinamou flushed from the leaves at my feet and shot off through the timber; and always I could be certain that the inhabitants for hundreds of yards in every direction had been warned of my approach. Only a parade of ants, each with a bit of fresh leaf two or three times its size hoisted over head like a green sail, seemed determined to ignore me. I was absorbed in watching them marching along a well-cleared path, half as wide as this page and apparently endless (it was at least a quarter of a mile long), when off to my left, less than 30 yards from where I was seated on a low, gnarled strangling fig of the sort that entwines about trunks and eventually squeezes the life from trees larger than most of us have ever seen, my attention was attracted by a noise like the snapping of little twigs and the rustling of crisp leaves. Small shadowy figures darted about on the dark floor of fallen debris, and suddenly a long-legged brown bird with an incredibly short tail hopped up on a log and surveyed me. The rustling became louder and more confusing, and more of these thrush-like ant birds gathered in a "wave" around me. Soon thousands, literally thousands of insects of every description—spiders in all sizes, big lumbering beetles, and even a half-grown tarantula—



DOCTOR CHAPMAN *(above left)* offering a banana to "José," a coati immortalized in his writings. (*Above right*) Native cayuca and paddle. More seaworthy than a canoe, this craft is admirably suited to noiseless observation of animal behavior along the shore

Photos by Julius Dinger

ON THESE and following pages appear some of the creatures and plant-forms whose fascinating interrelationships have made Barro Colorado a world center of zoological research. At right, a strangling fig has crushed the life out of a balsa tree. Termites quickly devoured the dead wood, leaving the curious natural "scaffolding" of the lethal fig. The tree at left has evolved a fearsome set of spikes, possibly as protection against the depredations of animals

were seen scurrying along in my direction. Caterpillars climbed to the tops of small stems, paused, and then dove back down into the leaves as if in fear of their lives; bugs and more bugs sprinted across the trail and into the dense mass behind me, and all the while the five species of Formicariidae (ant birds) gorged gleefully on this mob of insane little creatures. Following on their heels were the advance scouts of what turned out to be a mass hunting expedition of black army ants. They were scouring every niche and every tree to its topmost branches, killing all manner of insects. In less than 20 minutes the show had moved out of earshot; and as I sat quietly, a little green tree snake, which had been resting motionless on a branch a few feet in front of me, slithered down to the ground and disappeared."

The reptile population of Barro Colorado is very secretive and perhaps unusually low owing to the large numbers of peccaries, which are reputed to make short work of snakes. During my stay I saw very few—a boa, an *Oxybelis* tree snake, a palm viper, a brilliant coral snake, and the green tree snake just mentioned.

Specifically it was my job to trap and band turkey buzzards and black vultures, to run a line of flash cameras in order to get a photographic record of the large mammals, and to make a survey of the nesting habits of as many species of birds as I could discover. One of these, the beautiful rose-breasted and green iridescent Massena trogon, was the bird directly responsible for a field trip to the north side of the island.

Some days before, guided by the soft, plaintive *que-que* distress note of the Massena trogon, I had come upon a needle palm tree close to the water, which the trogons fitfully defended. Watching stealthily, I discerned that both the male and female were engaged in the excavation of a tunnel in the side of a termite nest eighteen feet above the ground. When the Chief heard of this he lost little time in packing equipment and departing for the spot. We stayed ten days while he made a life-history study with many photographs of this rare species.

At first, when Doctor Chapman had turned the two Nesbit flash cameras over to me, I had thought myself quite a trapper, but the months rolled by with mediocre success. I had taken one of these

Photos by Frank M. Chapman

THREE-TOED SLOTH *(left)*. He plays host to a unique species of moth that dwells in the green algae infesting his back. Recent scientific experiments have shown the sloth to be glandularly incapable of swift flight or sudden action. By contrast, the raucous black howler monkey (*right*) is spryness personified

(*Below*) YOUNG JACANA. Though too young to fly, this bird can make his way over lily pads with astonishing celerity. At full growth he will be little larger than a robin, yet his talon-spread will exceed the span of a horse's hoof

Photo by E. Thomas Gilliard

Photos by Frank M. Chapman

STRIKING SHOT of a Brazilian cormorant (*above*) perched on a dead tree limb in Gatun Lake. Two hundred and thirty-one species of birds have been identified on Barro Colorado

(*Right*) NESBITT FLASH camera and apparatus, with which naturalists secure trip-wire exposures of the Island's night life. This automatic camera may be left in the jungle for weeks at a time and, with luck, will catch such big game as the stalking puma (*below*), and the ocelot, tapir, and white-lipped peccary on the opposite page

...otos by Frank M. Chapman

THE IMPUDENT young marmoset (*above*) is really quite camera-shy, and what appear to be ocelot's whiskers (*below*) are actually rootlets of the stilt-palm in background

(*Above*) A NATURAL submarine who generally comes ashore only at night. South America's largest mammal, the tapir, scales as high as 500 pounds. Yet he is as elusive as a loon

Photo by E. Thomas Gilliard

(*Below*) A WHITE-LIPPED PECCARY. Right, author Gilliard forcibly takes the wingspread of one of 22 turkey buzzards he measured and banded. His data showed fifteen and a half square inches of wing area for every ounce of body weight

Photos by Frank M. Chapman

cameras on this field trip to the "Fuertes House" in the hopes that I would find a puma or ocelot on the far side of the island who hadn't already heard of me; and each day I set out to examine my "set" with renewed hope. The camera, a rather complex affair weighing about fifteen pounds, was set alongside a huge log where I had found some "cat-sign."

A set is made in the following way: the aluminum-boxed camera with fixed tripod is aimed at the spot where you suspect and hope the animal will pass, usually about eight feet from the lens and never more than 20 feet from it. The lens is focused, and the diaphragm set at f:6.3. The speed is 1/200th second. The Nesbit is designed for glass plates, which are inserted into the back of the camera in a film holder and then sealed into the aluminum case by means of a clamp and rubber gasketed lid. Two two-ounce capsules of flash powder are set in flash trays on either side of the camera, and when fired they sound like the double charge of a 12-gauge shotgun. One of these is fastened to a little piston placed under it so as to catch the recoil of the exploding powder and drive the plunger of the shutter release. Thus when the animal bumps into the delicate trip wire causing the flash powder to fire, the impulse which takes the picture is exerted precisely at the height of the flash. Almost every other day I would find that the camera had been tripped, and each time that I took the glass plate back to camp, mixed the fluids for developing it and, after going through the agony of waiting in the stifling darkroom for eight minutes while I gently bathed the plate, I would find that I had another dud. Actually I am sure that I have the largest collection of pictures of falling leaves and twigs in existence.

At length things took a turn for the better. I finally got a good photograph of an ocelot, only the third ever taken on the island; but the pumas were all too smart for me. It had been my plan to set two of the cameras over the same trigger, one close to it and the other about 20 feet back,—the idea being to hook them up in a series so that the one farther away would fire about a tenth of a second after the first. By so doing I thought I might obtain some fine action shots, but the Chief would not hear of it, because as he said, "It would only be adding injury to insult."

Treetop lookout

"Some years ago," he continued, "I started out to build a portable tree house, thinking that it would be handy to use in connection with the Nesbit flash cameras." His idea had been to rig up a light wire platform, cover it with mosquito netting, and suspend it high in the jungle roof over one of his sets. The rig he built was too heavy and cumbersome, and the idea had unfortunately come to nought. The scheme appealed to my adventuresome spirit, and shortly after we returned to the laboratory I began construction. I cut some bamboo and bound it into two rectangles, each about the size of a cot. The bottom one was covered with strong chicken wire, and the other served as the roof. Ropes served as the uprights, and the whole was covered with netting. The sum total of my efforts resulted in a light net box which was collapsible but which, when stretched by the single half-inch supporting rope, opened up into a little house. I cut a tiny trap door in the bottom and hung a 30-foot rope ladder from it.

All the time I was putting the contraption together, the Chief was offering suggestions and, in no subtle way, allowing as how it "wouldn't be safe or worth while." He didn't come right out and order me to cease my foolish antics, but I fear that he felt that the idea was a little precarious. I, however, was completely sold on it. I wanted to hang the house 50 feet up in a big almendro tree that sprayed out over a large hog wallow about three miles from the laboratory. I could tell from the splashed mud and the muddy trail leading from this wallow that a big flock of white-lipped pecarries used this trough of sand and mud to wallow in. Since I had never seen them in it by day, I suspected that they visited it in the dark of night. It was my plan, therefore, to set a flash camera in the wallow and to spend the night in the tree house where I could listen to them and to the other animals which might pass by, either below or above.

All went well. I took the house out and hung it high in the tree. I set my camera and even cut some of the lower branches away so that I could direct the rays of my five-cell light down onto the wallow. When I returned to the laboratory for supper, the Chief was already eating his portion of fried plantains, rice, and corned beef. It was dark and very quiet outside, just the weather for a storm, and I frankly wasn't in any mood to reconsider; but I could tell from Doctor Chapman's apparent nonchalance that he was rather apprehensive. I don't know whether he was aware of some lurking danger not worth chancing or whether he just felt that I might fall out of the tree house, but at length, after supper, he retired to his house with a solemn "Good night."

Later, as I passed his house on my way to the jungle, his light went on, and I heard his voice calling. Going back, I was openly amazed at his offer. "Why don't you take my pistol with you, Tom?" he asked. I had never even suspected that he had a firearm! He then told me that he had taken a photograph of a puma directly under the spot where my little house was now hanging. "Better take it," he persuaded. "You won't need it, certainly, but it may make you feel better." I turned it down. Indeed, I probably would have been in more danger with a strange gun on that dark, slippery trail than without it.

All went well until I reached the top of the first steep incline near the junction of the Snyder-Molino and Tom Barbour trails. Had I flashed the trail ahead I would have seen at least two collared peccaries standing stock-still, watching me. As it was, they did not move until I was within three feet of them; but then, with a lunge of fright, they ripped through the underbrush perilously close to my feet. I lost ten years in that second! Incidentally, there are two species of these animals on the island: the white-lipped and the collared peccaries. The last is comparatively harmless, but the former is capable of inflicting serious injuries with its long, sharp tusks.

For a long while I sat in my eyrie, chin on knees, listening, and I remember too that I prayed that the howling monkeys would keep their distance that night. Only the day before, I had been discovered by a treeful of black howlers. Being well aware of their harmlessness, I lay down on the trail and focused my eight-power glasses on a huge male directly above. The cussed old rascal barked and roared and glowered while we looked each other in the eye. His ugly face, Gargantuan in horribleness, was adorned with three open sores which he periodically scratched. I must say that the great box-throated creature had an unfair edge. Through my glasses, he seemed to be only an arm's reach away and eight times actual size. Then by means of an indecipherable signal, perhaps a change of tone, the entire group broke forth in a peal of raucous thunder which reverberated all around me. It seemed that thousands of monkeys were surrounding me—on the ground, behind me, everywhere. I leaped to my feet when the din became unbearable and, as excitement raged, stomped off a little foolishly.

Not alone

Yes indeed, I thought, as I sat in my little mosquito-proofed platform, I could do without the howlers tonight. A rapping "tap-tap," similar to the digging of a downy woodpecker, striking with irritating regularity at the trunk behind my head, kept on and on, A weevil under the bark seemed to be the only explanation. There was a rasping of something ten feet out in the dark, which was mere emptiness in the beam of my light, perhaps the result of a fickle wind and an indecisive palm leaf. A honey bear twice crossed noisily through the crown of my tree before I caught him in the ray of light and identified him as a "straw-colored raccoon with prehensile tail." The endless noises, so many of which were strange and intangible, all combined to keep my vigil tense. I sat wide-eyed, feeling somewhat as a penguin must feel on his first night in a zoo.

Heavy plodding, coming in my direction, brought me into instant action. I waited for the cameras to boom, but suddenly the animal caught my wind, stopped dead and stayed motionless for at least a minute. My beam missed fire, and with heavy crashing and thrashing the big, clumsy animal, perhaps a tapir, crazed with fear, made off into the dense underbrush.

To my chagrin, it rained twice, each time in full view of the thin moon which hove up out of the black about 3:00 A.M. Each time it rained in sheets for about ten minutes, while I sought shelter under my pants and the blanket. Ticks, hungry little devils which could crawl through the netting, advanced on me in droves. Pending the coming of daylight and revenge, I let them get a hold, only to stop their infernal crawling hither and yon.

It was impossible to steal even forty winks with all of these visitors enjoying my hospitality and with the multitudes of other unknown quantities filing away at my nerves. I wanted to greet the coming of day, the awakening of the jungle, and I wanted to be back at the laboratory in time for breakfast. This last was a "must" on my list, because if there is any one thing that could make the Chief boil, it was being late for this first meal, which was always served at 7:00 A.M., Sundays and holidays included. And the fact that he had had to roust me out several times during the preceding month hadn't made matters any better.

The sun was beating down in slender shafts. People were yelling and my bed was swaying. I awoke slowly, gazed in a vacant, uncomprehending stare, and suddenly fathomed it all.

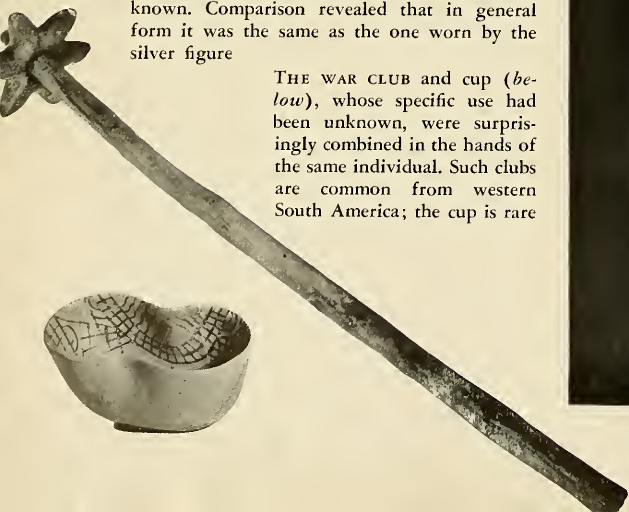
"It's eleven o'clock and the Chief is very, very mad," Chichi yelled at me.

Fernando gawked up at me and mumbled something in Spanish to the effect that they had had a "hell of a time finding me." I didn't doubt either fact as I streaked back to camp. A new day had begun at Barro Colorado, and I had already missed a good part of it. A new day in this unusual island, which is a world within itself, seemingly removed in time and space far from the world of man, yet a spot which becomes a part of everyone who has lived in it and comes back to fill your mind long after you have left it.

The Mystery of "THE TAX COLLECTOR"

(*Below*) THE SILVER STATUETTE from Peru which shed light on the feather headdress, war club, and cup

WHEN the feather headdress above was found in a mummy bundle, its use and age were unknown. Comparison revealed that in general form it was the same as the one worn by the silver figure



THE WAR CLUB and cup (*below*), whose specific use had been unknown, were surprisingly combined in the hands of the same individual. Such clubs are common from western South America; the cup is rare

Nothing is certain save Death and Taxes. If this gloomy aphorism applies to cultures other than our own it may lend color and meaning to these ancient Peruvian artifacts, recently put on exhibition in the American Museum.

In 1896, the small silver figure (*center*) found its way into the Museum. The archaeologists of that day knew only that it was Peruvian. All efforts to divine what manner of man the pre-Columbian silversmith had intended to portray were pure speculation. Accordingly it was filed away to await further data.

Thirty-seven years went by before the feather headdress shown at extreme left and right arrived. It, too, was catalogued and shelved,—purpose and period unknown. Then one day when Junius Bird, the archaeologist, was taking inventory of the 50-year-old South American collections, he noticed the similarity between the actual headdress and that worn by the silver effigy. Before long he had sifted out three other items, illustrated at the bottom of the page: the war club and the cup (*lower left*), and another portion of the headdress (*lower right*),—all of which correspond to the articles depicted in the original silver figure.

Thus was the patient method of archaeology rewarded. After more than 40 years, scientists reached a denouement whereby several individual "mysteries" mutually explained one another. The functional interrelationship of each stands revealed. But the function of the man who once wore these feathered robes of state and carried club and cup in either hand, remains unsolved. We can only guess that the cup may have been a receptacle for contributions of some sort while the stone-headed club might have been used to threaten recalcitrant "contributors." Indeed, the figure has humorously been dubbed "The Tax Collector," and—who knows? Time and future specimens may prove the jest a shrewd one.

One-half of the figure symbolizes Force, the other Begging. Together, they may well represent a "Tax Collector"

The design on the back of the cape is different, but another similar specimen, at bottom, has the same scroll

All photos AMNH by Coles

THREE ANIMALS THAT WENT TO SEA

Continued from page 99

caudal fin was formed, but this time it was horizontally placed, not vertical as in the fish and the ichthyosaurs. The limbs of the land-living mammal were transformed into balancing fins or flippers, of which only the forward pair remained useful. The typical mammal's limited, diversified teeth, which had come from the unlimited simple teeth of the earlier vertebrates, again became secondarily simplified and more numerous, to form a fish-catching mouth similar to that of the fish and of the ichthyosaur. Thus the porpoises, dolpins, and whales appeared. Once again the circle had been completed.

Once again evolution had shown a reversal in trend, yet had maintained its basic irreversibility. Again—as in the case of the ichthyosaurs—the porpoises and dolphins and whales, though fish-like, were only an approach toward the fish type, for they were warm-blooded mammals, not cold-blooded like the fish and like the reptile. And no matter how thoroughly fish-like the body might become in adjustment to a life of rapid swimming in the ocean, these were still mammals that continued to give birth to their young and to suckle them on milk, just as their land-living ancestors had done. The whales had become pseudo-fish while retaining those important inner structural and psysiological features that distinguish them as mammals. They had become fish-like in outward form, as had the ichthyosaurs, because life in the water, through the working of definite laws of physics, enforces the adoption of streamlining for the sake of efficiency.

In this story of fish, ichthyosaur, and porpoise, we have seen that strict environmental requirements can cause convergent evolution and result in a fixity of form among quite unrelated animals. The story is there as clear as a well-limned picture, traced by the long series of fossils appearing in the successive strata of the earth's surface and by the living descendants known to us in the flesh. And the methods whereby the story unfolded are being made increasingly clear by studies of the laws of inheritance and selection in modern forms of life.

Yet familiar as the tale may be, even the specialist can never get over his wonderment at the workings of nature in accord with these laws through the immensity of geological time. He can never quite reach a state of being blasé about the remarkable adaptations wrought in various animals under the physical limitations of their environment in their long struggle for survival. And the more casual student of nature, who may discover for himself other instances of convergence growing out of the basic conditions of life, will sense an unsuspected harmony and order in the life of our planet, and he can never cease to be impressed and delighted with the object-lesson in evolution which they teach.

DO NOT MISS

SEA ELEPHANT'S HOME-COMING. Unique because of a proboscis that reaches ten to twelve inches, the sea elephant is one of the most remarkable members of our native fauna. His return to former breeding places near the Pacific Coast once more tempts scientific research and observation.

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WE LIVE IN AN ICE AGE. The glacial period is still with us! These are soul-stirring times geologically, as well as politically. For a popular survey of glaciers and their significance to man, watch for this article by Weldon F. Heald, beautifully illustrated.

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Right in the center of the northern part of the Pacific, and a few minutes east of the International Date Line, lie Midway Islands, bird sanctuaries which are among the most unusual places of their kind on earth. **THOMAS M. BLACKMAN** spent nearly half a year in this bird metropolis, which supports at least two unique species. His report in story and picture will excite the interest of ornithologist and layman alike.

THE TRUTH ABOUT TERMITES — Labeled public enemies number one by exterminating racketeers, these "white ants" (which aren't ants at all) are seldom destructive in civilized communities and definitely constructive in nature. Incidentally, some species can't digest wood any better than we can

By FRANK E. LUTZ

Curator of Entomology, The American Museum of Natural History

TERMITES, popularly called "white ants," are neither ants nor even closely related to ants. In addition to a large number of structural differences between ants and termites, there is the important difference in life-history that ants hatch from the eggs as worm-like creatures and go through a pupal stage before becoming adults, while termites on hatching from the eggs look much like small adults (except that no newly hatched insect ever has wings), and they have no definite, apparently lifeless pupal stage in their life-history. In other words, ants have "complete metamorphosis" and termites have "incomplete metamorphosis." I suppose that there is no real objection to calling them "white ants," provided we remember that they are not ants and that winged ones are not white. They will be called "termites" here.

All termites belong to the order Isoptera and all Isoptera are termites. If we say that they are related to roaches, we shall be not nearly so far wrong as when we relate them to ants. In fact, we might go as far as to say that they are "social" roaches.

It was formerly a surprise to many that termites may naturally occur in a New York City suburban yard. As a whole, they are a tropical group but there is one species that ranges northward to Maine; another gets as far north as British Columbia. A large number of the Eastern one, *Reticulitermes flavipes,* first found their way to our yard in a piece of firewood; and two or three blocks down the street there was a flourishing colony in what the children and I called the Presbyterian Hole. Disregarding a Biblical hint as to the inadvisability of starting a building without having the finances to complete it, our good neighbors of that denomination dug a cellar for a new church but never put in even a foundation. The hole that they dug was a fine place for a number of ground-inhabiting insects, and its depth, combined with a fringe of vegetation, made it possible for a man and his children to watch those insects without being watched by people on the street.

Termites are ant-like in size and they live in colonies, each colony usually being made up of the descendants of one female, a "queen"; but a typical termite colony differs in several important details from a typical ant colony. A great deal of information concerning American termites is given by Banks and Snyder in *Bulletin 108* of the U. S. National Museum; and Snyder has published an authoritative book with the somewhat fearsome title, *Our Enemy, the Termite.* You might consult these if you wish more than the following.

Some species of termites live chiefly or wholly in wood; others chiefly in the ground; and others, like our *Reticulitermes flavipes,* must have both earth and wood for their dwelling. Dead wood is the favorite food of most termites and, so, those that live partly or wholly in wood quite efficiently carve out their dwellings by feeding on them—they both eat their cake and have it. Since *flavipes* must have an earthen cellar to its house, stumps or fence posts or timber lying on the ground quite suit it; but it never damages buildings in which the lowest timbers are on sufficiently high solid concrete foundations.

A curious thing is that, although termites feed on wood, some of the species cannot digest it but depend upon Protoza living in their intestinal tracts for that important step in the process of changing dead wood into living termites.

Some biologists are given to dating the occurrence of one natural phenomenon by reference to another, instead of solely to a man-made calendar, Gregorian or otherwise. This plan is at least rather pleasing, whatever its scientific advantages or disadvantages may be. Thus, Snyder, in telling about the maturing and flight of young termite queens near Washington, D. C., refers to the blooming of flowering dogwood, which has, of course, no direct connection with termite queens but occurs at the same time as their spring flight. He says that when the flower buds of the dogwood were swelling the young queen termites were about ready to undergo the molt that gives them their wings; when the first few flowers had opened, a few recently molted adults were in the termite nests, when the blossoms were half out the winged adults in most colonies had attained mature pigmentation; and "by April 30 the adults had swarmed from colonies. Dogwood was nearly in full bloom." Fine!

I have started several times to keep records in this

This article is excerpted from the chapter "Termites" in the author's forthcoming *A Lot of Insects*, which G. P. Putnam's Sons will bring out in October.

manner. It is an excellent drill in all-around natural history, and I highly recommend it to others but suggest that references to a man-made calendar be jotted down on the side.

The swarming of our real ants is a nuptial flight, hundreds, sometimes thousands, of males and virgin females darting about in a dizzy dance from which newly mated pairs drop out, the female to begin her humdrum existence in the darkness of some burrow and the male to die. Virgin honey bees have a nuptial flight but it is rarely noticed, a single female going forth without any rivals and returning entirely alone, she, too, leaving her groom to die. The bride among honey bees comes back to the home in which she was born. (What we call a "swarm" of honey bees is really a colonizing and not a mating flight. It is the mother and spinster daughters vacating in favor of a bride-to-be.)

The swarming of our termites is different from either of these. Males and many virgin females fly out together. There is more or less courtship during the flight but no actual mating then. Soon the females settle to the ground and shed their wings, the flight being over. If a female has been at all attractive, at least one male is with her and, after the wings have been shed, courtship becomes more energetic. Matters are finally arranged and the happy pair starts housekeeping, the male living to enjoy home-life. Female "sluggards," if such there be, among humans may consider the ways of real ants and be wise, but most men would doubtless prefer the ways of the so-called white ants, the blondes.

The family life of termites is extremely complicated. I shall not attempt to explain it to you in detail, largely because I do not understand it myself. Incidentally, no one else understands it fully.

The original queen of a colony of some tropical species becomes an excessively swollen egg-producing machine, her abdomen so large that she cannot drag herself about but lies in a special "royal cell," accompanied by one or more mates, the "kings," and attended by a horde of workers who feed her and carry away the eggs that she lays.

I like our *flavipes* better. Its queen goes about from one part of the nest to another. Like many other species, *flavipes* has two forms of individuals other than those whose primary function is reproduction. There are ordinary workers and also workers with, among other differences, large jaws. The ones with big jaws are called "soldiers." Snyder says: "The duty of the soldiers is apparently entirely protective, but they do not appear to be very effective, at least when the colony is opened and they are exposed to the attacks of ants, etc." So, there another good story goes bang! But, if not for protection, what are they for? Ornament? Possibly. Who knows? It costs much food to rear and maintain them but the same is true of human soldiers. Among ants, bees, and wasps the workers and soldier-workers, if any, are all females; but among termites either sex may apparently become either sort, depending on we know not what.

These things are complicated enough to suit the most energetic of puzzle-solvers but, as though to make it more difficult, there are three different sorts of reproductive individuals: "first form, second form, and third form." These are not very entrancing names but they are sufficient. Then there may be various kinds of intermediates, and so on. What are they all and why? If not "why," at least how do they come to be?

It seems that, in some species at least, if the original queen, a "first-form reproductive," dies, one or more of the "second-form reproductives" take up the work of laying eggs and, if all of the second-form reproductives die, then one or more of the third-form reproductives do the egg-laying. But, as long as there is a living first-form, neither second-forms nor third-forms function—abundantly, at least—and as long as there is a living second-form reproductive, none of the third-forms function. Furthermore, although a first-form can be the parent of all three forms, a second-form cannot produce a first-form (but can produce second-forms and third-forms, and a third-form can produce neither first-form nor second-form but can produce third-form reproductives.

Until more has been learned about this matter, it is perhaps just as well not to suggest explanations here. If things are as I have stated them, such a termite colony is, barring a major calamity such as running out of food, a perpetual affair. It may easily lose its original first-form reproductives, but the others can carry on.

I wish long life to the person who would learn all that there is to be known about the *Reticulitermes flavipes* that came to our yard in a fire log. Perhaps a study of that colony at the "Presbyterian Hole" would have revealed some of the things that were planned to be taught there when the hole was dug. But it is now too late. The property has been sold again, and the hole has been made a "sunken garden" full of things that are pretty but not particularly interesting because they are so artificial.

I have said, "It was formerly a surprise to many that termites may naturally occur in a New York City suburban yard." Popular opinion on that subject was changed by one of the most outrageous campaigns of false advertising and high-pressure salesmanship that has ever come to my attention in entomology. People who trusted newspapers, slick talkers, and writers of catchy letters for their ideas about insects were persuaded that their region had been suddenly invaded by termites; that not a house was safe from the attack of this horrible horde; that something must be done at once or the houses would come crashing down on the human inhabitants; that such-and-such a company could do this something at a cost that was high but not equal to the cost of the house, and that the company would guarantee on its "bond" that the house would then be safe for a specified term of years.

The facts are as follows:

There has been no invasion of termites. The species that is here now was here before Europeans, whatever their nationality may have been, first sighted American shores. Indeed, the same kind of termite was probably here long before there were human beings.

There has been no marked increase in the numbers of this insect except in the minds of the people who have recently been made termite-conscious by propaganda. Unless I am greatly mistaken there are fewer termites in and near New York City than there were more than 30 years ago when I first moved here. One very good reason for this is the sort of thing that happened in the "Presbyterian Hole" when it became a sunken garden. The present owner does not permit pieces of wood to lie on the ground and there are no stumps on his property. The same thing has been happening all through this region.

Any house is entirely safe from this or any other of our ground-nesting termites unless the woodwork of the house enters or comes near the ground. (Steps are often offenders.) Of course, if you make of your house an artificial stump, termites may and probably sooner or later will make use of your thoughtless kindness to them.

Even if your house is not correctly built and termites do get in, the house is not doomed. I have been told that Washington's home at Mount Vernon has had termites in its timbers as long as anyone now living knows. If that be true, they quite possibly moved in shortly after Washington did. In my boyhood days in Pennsylvania it was the usual thing for the country houses and barns to have termites in the timbers. Not knowing that the trouble was due to the wood touching the ground, the people merely from time to time replaced the affected pieces with new ones and, not being bamboozled by purposeful exaggerations of scare-mongers, they took their time about doing it.

Such being the facts, there is no need to discuss here any further the methods of prevention or cure. Some of the methods used by some "exterminators" are absolutely worthless or even worse; and some of the "exterminators" do not know termites when they see them, as is witnessed by the variety of insects that they have thought were termites when they weren't. Unfortunately, also, not even all entomologists who do know a termite when they see it are above sharp business practices. As for "guarantees," anyone who can get a sufficient number of good houses to insure against termite damage at even small premiums could get rich by doing nothing more, because the chances are that most of the houses will never become infested and that the few that do will not be seriously damaged.

In this, as in all other insect-control problems concerning which you are in doubt, write to your State Entomologist and to the Bureau of Entomology of the U. S. Department of Agriculture. Your taxes pay for their services whether you make use of them or not; presumably they know their job; and their advice is not likely to be tinged with ulterior motives. All of this is not to say that there are not many intelligent men, good entomologists, some working as "exterminators," making an honest living by controlling insect pests for those people who do not know how or who do not care to take the trouble of doing it themselves. Also, it is not to say that some day one of the dry-wood termites from some other place may not find its way to your region. If it does, the official state and federal entomologists should be told about it very quickly. Quite probably it would not become permanently established here; but, if it does, there may then be real trouble.

Darwin quite properly pointed out the service that earthworms do in turning over the ground and getting humus into it. But there are thousands of kinds of ground-burrowing insects; and, furthermore, there are thousands of kinds of wood-boring insects that are largely instrumental in clearing away dead and dying trees that would otherwise so clog the forests that there could be no new growth.

It is interesting to note that termites are among those insects that Nature uses to clear away stumps and fallen timber. In doing this they are very beneficial to the earth. If Man, in building houses, puts lumber, which is nothing but dead wood, in or on the ground, the termites quite naturally are apt to start clearing away that dead wood, too. Man's wooden houses and even Man himself are things of the last few days or so as compared with the geologic history of termites. If Man keeps the wood of his houses in this region sufficiently high above the ground, our termites will not bother him.

From the Halls of Montezuma

. . . to the buried refuse of some nameless Indian people of antiquity, George C. Vaillant has explored the Valley of Mexico to chronicle sixteen centuries of its pre-Conquest civilization

By D. R. BARTON

IN the late spring of 1919, an American army occupied the Rhineland, Germany finally signed the Versailles Treaty, and a cheerful young freshman named George Vaillant flunked out of Harvard.

George had entered college the preceding fall on the not altogether unwarranted assumption that he would be taking a crack at the Hindenburg Line before the semester was out, and his plans were rather irritatingly upset when the whistles blew on November 11th. Fate, he felt, had played a cruel trick on him, and in the full recklessness of youth, he resolved to defy her without bounds or stint. Using Standish Hall as a base of operations, he neatly avoided both Widener and the recitation buildings to gad about Cambridge with all the landless yearning of an Andover matriculate who obviously belonged in New Haven.

The Vaillant family lived in a Victorian house on Commonwealth Avenue in Boston, an address at which George found it increasingly embarrassing to call after his demise at the hands of the faculty. However, Mr. Warren K. Moorehead of the Peabody Museum at Andover, an old friend of the family's, intervened on his behalf. Mr. Moorehead was hot on the trail of Indian arrowheads in Maine and he suggested to Vaillant Senior that such a robust outdoor quest might wean George from the oriental fleshpots of postwar Boston. Vaillant Senior agreed. And with the syncopated strains of "Dardanella" and "Titina" throbbing in his ears, George embarked, somewhat unwillingly, on the Peabody Museum-Andover Expedition.

Up to this time he had entertained the notion of majoring in English literature and retiring to a country seat (which included a prep school for boys) whereat he might support himself in dignified comfort and pen occasional, familiar essays on lost Keatsian odes or new developments in the interpretation of *Rasselas*.

It would be very pleasant and most convenient to record that Maine was young Vaillant's road to Damascus, that after coming up with a prize specimen his first day out, he was immediately smitten by the true light, and blinded to any other way of life save archaeology.

GEORGE C. VAILLANT

In point of fact, he burrowed apathetically in a good many unrewarding graves, and his interesting finds were few and far between. He liked Maine, though, reveled in the out-of-doors, and came to the conclusion that desultory digging wasn't half bad once you got onto it.

This reaction was not altogether unexpected. For George had always held the Indians in high esteem and he had early begun to delve into the past as a hobby.

In spite of his laxity in regard to class attendance, George was a relatively accomplished historian and a fascinated student of military tactics. Moreover, his paramount ambition was to be a soldier, or rather, a lieutenant. Leading the A. E. F. at Belleau Wood? Afraid not. Vaillant's ambition was to be a lieutenant in the G. A. R., and he looked upon such upstart imbroglios as Chateau-Thierry and the Argonne with the frigid eye of a young Boston Brahmin reared in the shadow of Bunker Hill. For him the only worthy engagements were Antietam, Vicksburg, Cold Harbor, et al.

Apprenticeship

Early in the 'teens, George had fostered his antiquarian bent by stopping off at the Boston Athenaeum as he accompanied his father to work of a morning. Here he pored over not only the Civil War battles, but intimate correspondence dealing with the private lives of Civil War generals. This scholarly curiosity had been whetted by a widowed aunt who had survived an army officer stationed in the Indian Reservation region of the West where most of George's hero-generals served after Appomattox.

Hunting for arrowheads seemed to rekindle his boyhood admiration, and when he had finally completed his requirements for sophomore year by way of Harvard Summer School, he began to take up courses in anthropology.

From this time forth, Vaillant's academic career gave evidence of a marked change in his life. Despite the rigors of an at long last successful campaign of attrition against elementary German, he managed to be graduated and eventually to establish himself as a Winslow Scholar, from which austere vantage point he shortly became Harvard's first and, to quote him, "worst" tutor in anthropology.

Yet with increasing fervor, he had been absorbing the instruction offered on the technique and development of archaeological research, and he soon joined a select group in Harvard's Graduate School.

This was in the middle '20's, when stocks were booming and esoteric pursuits such as a sober and relatively unlucrative career in anthropology were tolerated with amused disdain. Then all at once archaeology sprouted romantic wings with the excavation of Tutankhamen's tomb, and the erstwhile gay blade of Harvard '22 found himself in Egypt with America's leading European archaeologist, George Andrew Reisner.

But there was a great deal of academic intrigue in the Egyptian air. And, repeatedly gored by the wiliness of his colleagues on the one hand and the Arabs on the other, young Vaillant decided to leave the mysterious East to the amazing fictions of his radiant contemporary, Rudolf Valentino, and to concentrate on the happier hunting grounds of the American Southwest.

It was here that he had cut his teeth, so to speak, and it was because of the excellence of his results in this region that the Carnegie Institution expressed interest in financing work to be done on the Middle Cultures of the Valley of Mexico,—a task which would throw light on the origin of the Aztecs, who are generally recognized to have reached the highest level of civilization in the pre-Columbian Americas.

At Harvard, George met Clarence Hay, Museum Trustee and a leading Mexican archaeologist in his own right. While working for Carnegie at Chichen Itza in Yucatan, Vaillant renewed this friendship. Hay was so impressed by the young man's handling of the excavations that he promptly engaged him as Assistant Curator of Mexican Archaeology for the American Museum, offering him a blank check to cover whatever digging he deemed important to the discovery of significant material on the forerunners of the Aztecs. Thus in less than the span of a decade, the scapegrace freshman flunk had expunged the unpromising start from his record and taken rank as a leading expert in his field.

Middle cultures

It is probable that a Mexican archaeologist is more certain of large renown if he devotes his efforts to the great centers of civilization which offer a better chance of spectacular finds. On the other hand, the Middle Cultures which Vaillant has made his particular province are of more importance to the science as a whole, since they formed the soil wherein the elaborate city-states came to flower.

The term, "Middle Cultures," was coined by Vaillant to signify their relativity,—"middle" referring to stage of cultural development, not geographical or historical location. He has further defined them as Lower and Upper Middle after the manner of the intermediate classes in many preparatory schools. In fact, Mexico's archaeological structure may conveniently be visualized as the student body of such a school,—the most advanced and powerful being seniors (e.g., Aztecs and classical Toltecs). Immediately beneath them in order of cultural attainment are the Upper Middlers, followed by the Lower Middlers, with the freshmen occupying the lower berth. Except for the latter—nomad hunters of the type that "forded" the Bering Straits untold centuries before—members of all these classes existed side by side as contemporaries in pre-Conquest Mexico. The original freshmen had taken up a sedentary life in Mexico's fertile valley long before they evolved the earliest pottery to be revealed by the archaeologist's spade. Nevertheless rough and tumble hunting peoples were constantly coming down from the north even as late as Aztec times.

Cannibals

Doctor Vaillant avers that he could not fashion a piece of pottery if his life depended on it. Yet he knows every step in the manufacture of most pre-Columbian Mexican varieties and he is as penetrating a student of their design as any in the world today. He can tell at a glance whether he is confronted by champ-levé or intaglio or merely simple incision. And a good thing he can, since pottery, together with figurines, comprises the sine qua non of his profession. For, whereas a study of the Aztecs, owing to the existence of various manuscripts, is inevitably part history and part archaeology, an investigation of the Middle Groups is archaeology pure and unalloyed. There is nothing to go on but the material. And the material consists largely of broken cook pots tossed into the garbage heap which was located just outside the front door of squat adobe houses. Truly, had departments of sanitation operated in those far-off times, there would be no archaeology today.

From the paltry evidence of this buried rubbish alone, Vaillant has been able to place under survey eight long centuries of Middle Culture groups. Extremely sensitive to differences in style and technique, he has separated his material into proper sequences of relative antiquity and ascertained whether it was used for household or ceremonial purposes. But how, you may ask, can a man pretend to tell anything about a people by just pawing around in their left-over junk? Well, some of the things are quite revealing.

"Once," he writes, "my wife found a great red-and-yellow bowl in such a deposit. It contained the remnants of the *pièce de résistance,* the upper legs and hips of a human being, the most succulent portions for festive consumption."

Here is an obvious case of ceremonial cannibalism. And the bones of the dead themselves, unearthed from the dump heaps, give a very clear idea of the physical appearance of the people under investigation, while their ideas of heaven are frequently suggested by the articles buried with them.

"A meager listing of objects found in the earth constitutes the historical record of the Upper Middle Cultures," writes Doctor Vaillant, "but by contrasting these pots and tools with those of the preceding era social forces may be seen at work. At Ticoman, the most carefully studied village site, the population terraced their rocky peninsula to make level places for houses which were too perishable to leave traces for later archaeological reconstruction. In the refuse beds deer bones are less in evidence than in the adjacent sites of the preceding period, indicating that game was gradually being hunted off. The Ticomanos made a greater variety of stone tools, both in shape and in purpose, and they found that the flakes of obsidian could be more easily worked than the more solid fragments used in Lower Middle times. Yet as techniques became more complex, the capabilities of the individuals differed. We found two graves of leatherworkers who were buried with the tools of their trade; one carefully fashioned his implements, while the other contented himself with chips and flakes, as if he cared more about finishing the job than taking pride in sheer workmanship."

These words indicate not only Vaillant's powers of observation but his keen appreciation of artistic integrity. His ready sympathy for the nameless artists of the long by-gone Lower Middle Group shows plainly in the following:

"In our modern world we are accustomed to sophisticated and self-conscious art forms. Seen objectively, these Early Middle Culture figurines are dumpy and gross. Short, fat bodies, blobby noses, protuberant eyes and stubby arms and legs are not attributes of a graceful form, according to our way of thinking. Yet handling one of these figurines and tracing each step in its formation, one is conscious of an intense seriousness and comprehends a whole world of thought dammed by the want of technical facility in expression. An intuitive person sometimes sees a populous world of shining fantasy behind the meager scribbling of a child. Behind these figurines must have existed an austere realization of the complex rhythms of birth, growth and death in nature, epitomized in the miracle of woman and her bearing of children."

Of time and calendars

With so reverent an interest in his work, it is not surprising that George Vaillant has been acknowledged a past master at classifying and interpreting his material. The curious thing is, he has never made a real "find." Indeed, as far as archaeological "ten-strikes" are concerned, Mrs. Vaillant easily outstrips her distinguished spouse, her most sensational accomplishment being the discovery of some hollow clay figurines at Gualupita which linked this culture to that of Vera Cruz. And together the Vaillants discovered the astonishing hoard of 200,000 specimens at a single site. Yet Mrs. Vaillant professes no personal interest in archaeology. One wonders if she practiced it simply so as not to be left behind. But Doctor Vaillant assures us that "her activities are prompted by a highly eleemosynary attitude, and I may say that she is very helpful, in fact so competent that after marriage I have not had to do any work at all."

It is a matter of record, however, that Vaillant has made ten trips into the Middle Culture digging areas and has written scores of papers about them. The achievement that has won him the loudest plaudits in scientific circles is the extremely ticklish task of bringing the archaeological study of some Middle as well as all "senior" cultures into the realm of history. That is, to establish the sequence of events and, if possible, the dates at which a given people passed from one cultural stage to another. This is a very considerable feat since the calendric systems of the Mexican Indians, while intrinsically admirable, are most difficult to translate into Christian historical terms.

Some idea of the complexity of the situation may be gained by a brief glance at Aztec dating methods. The major time unit has been estimated at 52 years. The end of this epoch was celebrated as a sort of mammoth New Year's Eve festival. An entirely new cycle was about to begin, and this festival gave rise to one particular custom which surely the gods must have ordained with archaeologists in mind. Symbolical of a new lease on life, the Aztecs set in motion a vast creative process by which all their artifacts were made anew, the community already having discarded all existing vases, urns, and general utensils whether in household or temple. In this manner future students were supplied with a made-to-order stratum denoting a specific 52-year period of artistic endeavor.

But there was a catch. Precisely because the beginning of a new cycle of 52 years was regarded as a renascence, no one cared very much about the old cycle. It was suspended in time—more or less merging with all its predecessors. For the Aztecs had no birth of Christ from which to number their major time units as we do our centuries. "In consequence there is the same sort of confusion in referring to events as would result were we to designate . . . the discovery of America . . . as 92 and the Declaration of Independence as 76."

Such are the difficulties confronting an archaeologist who has the temerity to attempt to correlate prehistoric cultures with historic time. And there were other snags. For instance, a lava flow called the Pedregal became a sort of New World Pompeii when a local Vesuvius suddenly put an end to its occupants and all their works. At what time did the eruption take place? "On the answer to that question hinges the date of these Middle Cultures, first traces of man in Mexico." Geologists estimated two to ten thousand years ago, which didn't help much. So it was up to archaeology to solve the problem if it could.

"First the materials from Copilco and Cuicuilco, the two buried sites [under the Pedregal], were compared and found to be different. Then these styles were discovered in other parts of the valley in open sites, unaffected by the local eruptions which formed the Pedregal. Next several seasons of work in these open sites disclosed that not only was Copilco older than Cuicuilco but that Copilco-Zacatenco culture was represented by rubbish heaps twice as deep as those at Cuicuilco-Ticoman. There is no way to measure the rate of accumulation of such heaps. However, on the basis of a deposit at Pecos, New Mexico, the beginning and ending dates of which are more or less known, it does not seem unreasonable to compute six or seven centuries' duration for the Lower Middle Culture of Copilco-Zacatenco and three hundred years or so for the life span of the Upper Middle Culture of Cuicuilco-Ticoman."

Oddities

In the course of reconstructing the life of these Indians of Mexico, Doctor Vaillant has come upon a variety of illuminating details, some of which may well bear repetition here.

The fate of the mighty city-state of Teotihuacan, by way of example, holds a warning for our own United States. The use of charcoal to burn lime by the builders of its massive edifices appears to have necessitated an unrelenting deforestation of the surrounding hills. Crop failures and a spreading "dust bowl" eventually resulted, all of which destroyed the economic basis of their civilization.

On the lighter side, we read that the Aztec bride, like our own, was customarily carried over the threshold of her new home—not, however, by the groom. One of the matchmakers fulfilled this ceremonial function.

The Aztecs stood very much on ceremony and it is revealing to learn that their arrow or dart points were no better examples of workmanship than the same utilitarian weapons found in the Middle Culture excavations. But the demands of their heavily ceremonialized religion brought about the fashioning of a broad-bladed flint "that could tear through human flesh at a single stroke, and this type of knife, not found in earlier horizons, was produced commonly with the extra care in chipping which is expected of a ceremonial object." It is in fact an almost ironclad archaeological rule that the cream of craftsmanship of any locality is to be found in the temple. And this rule does not apply to Mexico alone. It seems to operate in any community where the religion is conceived as absolutely essential to group survival.

The hideous brutality of the human sacrificial rites among the Aztecs is too well known to need underscoring here. And it chills us to the marrow to think of the loving artistry expended on the lavishly decorated lava boxes in which human hearts were burned and stored. But we must remember that the cult of human sacrifice is world-wide and that the Crucifixion paintings and statuary which form the bulk of our own Western religious art are all commemorative of the Savior's martyrdom, which is the highest point of development in the history of human sacrifice. The concept that the supreme sacrifice of Christ effected the salvation of countless generations as yet unborn—though it has become familiar enough to us who emphasize the priceless value of the individual—would be quite incomprehensible to the Aztec. Life seemed to him to exist from day to day only by divine sufferance. And "from boyhood on, [he] spent much of his time either in a kind of beseeching penance, to ensure his future, or in a state of grateful atonement for not having had a worst past. The Aztecs lived on intimate but uncomfortable terms with the supernatural powers." They practiced cruel mortifications of the flesh as a matter of course. And, brought up to regard the daily sight of blood and violent death as proper, they were not so much hardened as lacking in the sympathetic "imagination which is too personal and egocentric a sensation for an Indian community."

No, the Aztec was anything but an egoist. He belonged. His personality was swallowed up in the tribe. And it was tribe survival and tribe salvation that his culture stressed at the expense of all other considerations. To us this seems totalitarian and barbarous. And certainly the religion was both. In fact so tyrannous and rigid, so smothered in group-saving ceremony did it become that ultimately it destroyed the civilization itself. In the pragmatic sense, it was no match for a religion like our own which is marvelously "adjusted to meet such totally different concepts as the demands of the powerful and the needs of the weak." Doctor Vaillant points out further that our "Western civilization on the social side is nothing to boast of today, so we need not be scornful of the Aztecs [who] would have been horrified at the naked isolation of an individual's life in our world."

All the observations quoted above are from Doctor Vaillant's recently published *Aztecs of Mexico*, the second volume of Doubleday, Doran's "American Museum of Natural History Science Series." In this book he has summed up the history of the Valley of Mexico from the first spadeful of Lower Middle Culture objects to thumbnail sketches of the socially conscious peon of today. Though his sym-

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CATCH THE MAJESTY OF FALLING WATER

Photo by Charles H. Coles

Terrapin Point from the *Maid of the Mist*

By Charles H. Coles
Chief Photographer, American Museum of Natural History

A physician - photographer once remarked that water possesses a strange fascination for us because we subconsciously recognize it as the medium in which we originally lived aeons ago. Whether this is so or not, some of the most interesting and appealing subjects for the artist as well as the photographer are those in which water plays an important part. Ponds, streams, rivers, rain, ocean waves, and waterfalls are pictorial subjects that may also show phases of geology, meteorology, and aquatic wildlife.

A waterfall is, perhaps, as appealing and majestic a subject for either the still or movie photographer as may be found, but there are many waterfalls and many ways to photograph each one. Several fundamental principles remain, however, to guide the photographer in making the most of his picture opportunities whenever his travels bring him to these tumbling rivers of water.

Don't freeze water in action

Perhaps the first phase of technique to discuss is the matter of what shutter speed to use in photographing a waterfall. The first reaction of a camera fan is to treat the falling water as a moving subject whose motion must be stopped by a high shutter speed to prevent blurring. Actually, we never see each droplet of water suspended motionless in mid-air. If a photograph were to show the water sharply, its motion arrested by the shutter, an unnatural appearance of being frozen would result.

Experience has shown that a shutter speed of 1/50th of a second gives a very pleasing picture. The slightly blurred appearance of the water will convey the feeling of motion that a photograph of a waterfall should possess.

Sunshine on the water enhances the brilliance of the photograph to no small extent. If the picture is made when the sun slants on the falls at a glancing angle, the solidity of the water and the contours of the falling sheet of liquid will stand out in bold relief and give a third-dimensional aspect that is a delight to see.

Since the brightest part of a picture always captures the attention of the spectator first, it follows that the most important part of the picture should be lighter than the rest of it. A medium yellow filter will darken the sky above the waterfall without affecting the brightness of the falls; thus the water will become the brightest part of the picture and the composition of the photograph greatly improved.

Camera position important

To produce the effect of grandeur in a picture of a waterfall, you must emphasize the height of the falls. A low point of vantage will usually accomplish this end. If it is impossible to get far enough away so that the camera does not have to be tilted up sharply, a position opposite the center of the falls will permit the camera to be held level. A tilted camera should be avoided, so that the falls will not appear to lean backward.

The position of the camera should be chosen with due regard to the wind direction, because the mist thrown up at the base of the falls can completely obscure the waterfall itself if carried toward the camera. The water will also deposit upon the lens and blur the photograph besides entering the shutter and possibly ruining it. A stiff cross-wind will clear the mist away and reveal the beauty of the falling water to best advantage.

Tips on Niagara

That mecca for tourists and honeymooners, Niagara Falls, presents many intriguing problems. The Canadian side offers the best comprehensive view of the American Falls, particularly at night, when multicolored lights are projected upon the foaming water. Although it seems presumptious to improve upon nature, there are those who are not satisfied unless they gild the lily, and the great number of Kodachromes taken of this color illumination on the falls testifies that the display pleases a great many. The time exposure required to make a picture at night, however, reduces the water to a feathery, blurred mass that resembles ice much more than water.

Because of the protected area around the large electrical generating stations located on the Canadian side of the gorge, it is now impossible to obtain anything but a long-distance view of Horseshoe Falls, quite unsatisfactory for photography.

The Cave of the Winds trip on the American side, while very exciting and unusual, is decidedly not a photographic excursion unless the photographer is equipped with an undersea camera. No doubt some interesting shots could be made but they would be of the party rather than of the falls themselves. If you want pictures such as these, purchase a cheap box camera and use this rather than an expensive outfit. If the box is ruined by water entering the shutter, the loss will not be serious. A motion picture of the party passing through the spray would be very amusing, but the problem of keeping the lenses and mechanism dry is difficult indeed.

The *Maid of the Mist* offers some excellent views of the falls, when the wind direction is such as to keep the spray away from the vantage points on the trip. A good idea is to stay on the lower deck alongside the cabin entrance. When the spray becomes too dense to be good for the camera, step into the cabin until the storm blows over. An exceptionally fine picture can be made when the *Maid of the Mist* is off Terrapin Point: the falling water and cliff form an impressive scene.

Undoubtedly the most effective picture showing the height of the falls can be made from the lower station of the elevator that takes the passengers down to the *Maid of the Mist*. Although only a small portion of the American Falls can be seen from this position, the possibility of including human figures to give scale to the towering wall of water makes this view the most impressive obtainable at Niagara.

As with Niagara, the best camera view of the great falls of the Yellowstone is to be had from the bottom. Uncle Tom's Trail is taken down into the canyon to this point, where the whole majestic height of this magnificent falls towers far above the billowing spray. Morning light produces by far the most effective pictures of the Yellowstone Falls, since this is the only time of the day that the sun shines on the water.

To capture the size, the majesty, the beauty of a waterfall in an enlarged photograph is to obtain a picture that cannot be surpassed in decorative effect upon any wall.

YOUR NEW BOOKS

EARLY NORSE EXPLORERS • ANTHOLOGY OF SCIENCE
ASSAM HIMALAYAS • MUMBO JUMBO • LIFE AND LIVING
PROGRESSIVE CHILE • MODEL HUNTER • INDIAN AGENTS

THE TRUTH ABOUT LEIF ERICSSON AND THE GREENLAND VOYAGES TO NEW ENGLAND

------ by William B. Goodwin

Meador, Boston, $3.50

ACCORDING to this rather fascinating book, the post-Indian but pre-Columbian "discovery" of America, now generally accorded to the early Norse settler of Greenland, may soon have to be credited once more to the Irish! The author is one of many who during the past one hundred years have studied the old Icelandic Sagas, and the results of his 30 years of labor deserve the extended consideration of some John Fiske rather than the brief superficial comments here possible.

The chief problem involved in the elucidation of the five or six recorded Norse visits to our shores, between the years 1000 and 1020 A.D., is the identification of their so-called "Vinland" and in particular the situation of Leif Ericsson's houses at "Streamfiord," as well as the locality explored by Thorfinn Karlsefne and by him called "Hop." Earlier students of the sagas have located these places at various points, ranging all the way from the Gulf of St. Lawrence to Newfoundland, Nova Scotia, and New England down to the mouth of the Hudson River. Mr. Goodwin has himself seized upon Portsmouth Harbor, New Hampshire, as "Streamfiord" and Plymouth Bay, Massachusetts, as "Hop"; and seemingly he gives good reasons for his choices. One of his reasons for believing that the Irish preceded the Norsemen to the same general region is his discovery (as announced in the press some two or three years ago) in adjacent parts of New Hampshire and Massachusetts of a number of apparently ancient architectural stone structures which are too far inland to be regarded as the abodes of the Greenland visitors. But however these finds may turn out, the author lists and partly illustrates some twelve or more stones, as well as two steel axes, all of which bear what appear to be runic inscriptions ,and which have been found all the way from Greenland and Baffin Land down to Massachusetts.

Another important topic dealt with is the strange geographical term "Norumbega"—well known in archaeological literature—which suddenly appears on our old maps from about 1525 and onward for a whole century. Prior to and during that interval the word is spelled in many different ways and some of its forms—Noruegia, Noroega, Norbegia, Norvegia, etc.,—appear also on the Scandinavian peninsula. This phantom realm in America is placed at various points from the Hudson valley northeastward and was eagerly sought after by the early French and English explorers. Mr. Goodwin believes this proves that Columbus and others of his day had knowledge of a still-lingering tradition of the old Norse settlement in the Western world and that "Norumbega" and "Vinland" were one and the same region.

The organization of Mr. Goodwin's material leaves something to be desired, and while this phase of Norse colonization over here is of little historical importance because it didn't stick, there must be many readers who will find the book interesting.

N. C. N.

CHILE: LAND OF PROGRESS

------- by Earl Parker Hanson

Reynal & Hitchcock, $1.75

MR. HANSON knows whereof he writes. Several years' experience as a mining engineer and in other connections in Chile has given him firsthand knowledge of that country, its people, and their problems, and he handles his material in an informing and convincing manner.

In the opening chapter, "The Land," we are given a survey of Chile's geography, her resources, and climate. Though we realize the extent of his field and the limits of his space, we nevertheless wish that the author had more strongly emphasized the part that a temperate climate has played in the origin and development of Chile's population. To this climate she owes the Araucanian Indian, one of the finest indigenes of the New World. To this climate she is also indebted for the large representation of North Temperate Zone races within her boundaries, as well as for the practical absence from them of a tropical element. Chile's melting pot has barely begun to simmer, but the possibilities offered by fusion of its contents should promise the Chilean of the future a high place among the world's peoples.

Succeeding chapters are entitled "History," "People and Government," "Culture," "Agriculture — Fishing — Lumbering," "Mining and Manufacturing," "Education," "Social Legislation," and "Chile and the Visitor." To the last we would add a warning to the tourist to visit the lake region in the less wet period between late December and early February.

No one reading Mr. Hanson's impressive analysis of the factors which are now so actively shaping Chile's future will doubt that it is indeed a "land of progress"; but whither, one asks, is the nation progressing? Chile's position, her products, her population, her potentialities make the answer to this question of supreme importance to the entire Western Hemisphere.

F. M. CHAPMAN.

MUMBO JUMBO, ESQUIRE

------ by James Saxon Childers

D. Appleton-Century, $5.00

DURING a long journey through southern, eastern, and central Africa, then down the Nile and westward to Morocco, Mr. Childers was struck by two contrasting aspects. Over the old primitive Africa has been flung a network of up-to-date civilization. He gives an excellent account of the modern cities, the latest modes of travel and communication, the life of Cecil Rhodes, and the story of diamonds and gold.

A Hindu religious ceremony in Natal, the changing life of the Zulus, and a visit to the Kruger Park are splendidly treated. The ways of natives in the equatorial regions are not so well appreciated. The Ituri pygmies are dismissed as filthy little people living mainly from the tourist trade, but he must have seen them only along some main road.

Mumbo Jumbo, for whom the book is titled, was a tribal disciplinarian in Senegal who kept the pagan women in subjection. No one like him appears in this book. Mr. Childers paints a lurid picture of tropical diseases, and fears the sun overmuch.

Photographing big game he preferred to slaying it. His own stories of the creatures are thrilling, but those he borrowed from others are less reliable. Certainly more than three African elephants have been brought alive to the United States. The eating of prisoners by Congo soldiers is just another of the wild stories to be heard in East Africa about the Belgian Colony.

We are continually reminded that the author is an American, and was recognized as such. Sometimes it exasperates him, sometimes he is charmed, as on the American steamer bound for Zanzibar. On the trip down the Nile, the old and the new Africa are again at odds. The trials of a tourist in Egypt are told with brutal frankness, though ancient glories are not forgotten. The illustrations of the whole book are beautiful and well-chosen.

JAMES P. CHAPIN.

ASSAM ADVENTURE

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

Jonathan Cape, London, 12/6

THIS is the ninth book on plant hunting by a man who has had great experience in this field. The basis for the present volume is a trip made across the Assam Himalayas in 1935, and supplemented by a later visit to these mountains in 1938. Part of the travel was in regions perhaps never before visited by a white man, certainly never studied by a botanist. The author's interest is primarily in plants, but he makes extended observations on topography and on the natives.

The book will make its greatest appeal, among the lay public, to those who love plants. The temperate to alpine zones of Tibet produce a flora of great significance to Americans. Many important groups of plants are common to both places, and some of the fine ornamentals, brought from Asia to the United States, have become so familiar that we can consider them naturalized citizens.

But what a privilege it is to see these plants growing in their native environment often, as in the case of primroses, in great breath-taking masses! To one who has struggled to rear a few rhododendrons through the vicissitudes of our eastern climate, the forests of the tree forms of that plant in Assam and Tibet or the thickets of the shrubby or dwarf species seem well-nigh unbelievable. But the climate encountered by the author in Assam has its vicissitudes as well, and his travels there prove him to be a hardy explorer.

One must read *Assam Adventure* slowly, because it requires time for digestion. The place names do not memorize easily, and it is difficult to keep oriented.

The illustrations, taken by the author, are very good and are helpful in visualizing ideas expressed in the text. The map is also an aid, and should be well studied in advance.

H. E. ANTHONY.

THE FLOWER FAMILY ALBUM

- - - - by Helen F. Fischer and Gretchen Harshbarger

The University of Minnesota Press, $2.50

TWO novel features make this outstanding among recent flower books. The plants are drawn to scale as seen in the garden, and both wild and cultivated members of each family are represented. Some 450 plants are illustrated in the line drawings which are arranged according to plant families. Opposite each page of illustration is an interesting discussion of the family and its representatives, combining folklore with gardening recommendations and unusual facts.

In many cases, drawing the plants to scale has required the addition of larger drawings of the blossoms above the plants. More of these detailed sketches and a more complete statement of the botanical characters which aid in the identification of each family would have made this book more useful to the advanced flower lover. The amateur gardener and the nature study teacher, however, will find this book a fascinating and attractive introduction to the plant families and their more familiar members in woods, fields, and our flower and vegetable gardens.

J. W. THOMSON, JR.

THE BLOOD OF THE ARAB

- - - - - - - by Albert W. Harris

The Arabian Horse Club of America, $5.00

IN this most entertaining book, charmingly written, the author shows the result of much diligent research regarding the early history, and origin so far as can be stated, of the finest of horses, the Arabs. He gives many proofs of the superior intelligence and courage and the remarkable endurance of this breed, or rather distinct species as he rightly considers it.

The author gives detailed accounts of long-distance endurance tests of several hundred miles in which horses of many types competed under the saddle. In these grilling contests the Arabs proved themselves to be unquestionably superior.

It is with much satisfaction that the writer notes the increase in America of this splendid type of horse. In 1913 there were 27 owners of 127 horses while a recent report shows 402 owners of 1335 horses.

He tells of his experience on a cattle ranch in Minnesota, when only a boy. Here he made the acquaintance of a beautiful little black stallion, "Jim," which he rode about the ranch. A real friendship developed between "Jim" and his rider. While at the time the boy did not realize it, "Jim" carried in his veins a high percentage of Arabian blood. It may well be that this chance incident was largely responsible for the later development of an absorbing interest in Arabian horses and finally the appearance of the book under consideration. The writer speaks interestingly not only of Arabian horses but of those interested in the subject, many of whom I have had the pleasure of knowing. One of the charms of the book is the fact that the author, quite unwittingly, reveals much of his pleasing and generous spirit.

An anatomical detail might be criticized. On page 118 the author seems to have slightly dislocated his horse's kneecap, or patella as the anatomist terms it, which like our own is on the hind leg. But possibly this point should not even be referred to as nearly every horseman will speak, though quite incorrectly, of the carpus, or wrist joint in the horse's fore limb, as the "knee."

The book, well illustrated with more than 70 beautiful pictures, is a valuable contribution to equine literature, and is also interesting to the layman.

S. HARMSTED CHUBB.

LUCK IN ALL WEATHERS

- - - by Donal Hamilton Haines

Farrar and Rinehart, $2.50

THE character of this book is well expressed by its subtitle, "Personal Adventures in Hunting and Fishing." To the reviewer the most interesting and informing of these adventures is not the author's account of his pursuit of birds and fish (chiefly ducks, trout, and bass) but his introspective revelation of himself as a sportsman. To us he represents the best, most highly developed type of modern hunter. His ethical standards are high, he would not permit himself to take unfair advantage of his game. He shows generous consideration for the rights of his fellows in the field as well as those of the owner of the land on which he hunts. He supports the game laws both in preaching and in practice. His equipment and technique are the outcome of prolonged, constant observation. Indeed the major part of his pleasure afield is found in the employment of methods that he has originated, and in the success to which applied experience enables him to outwit his prey. He shows little or no interest in the gustatorial end of his pursuit, and is obviously not dependent for food on the contents of his bag or creel.

In short, he has apparently reached the height of modern man's evolution from the primitive hunter. But sweep aside Mr. Haines' acquired characteristics, material, technical, mental and we find that the bond between him and his Stone Age ancestor is as strong as though their birthdays were separated only by hours instead of countless generations. Nowhere do we find in his very readable volume any evidence that from his life as a hunter has grown a love of the homes of the hunted.

F. M. CHAPMAN.

NEW WORLDS IN SCIENCE

- - - - - - Edited by Harold Ward

Robert M. McBride and Co.

THIS large, well-made book is an anthology of recent nontechnical articles on science by 33 contemporary American and British scientists. The advantages of anthology are successfully exemplified: each subject is treated by a writer who has special and thorough knowledge of it; different points of view are persuasively presented; varying personalities and styles give color and maintain interest. There are also disadvantages: chapters removed from context may lack background; quality is likely to be uneven; continuity may be lacking. Here the editor has skillfully performed his difficult task.

The taste of his selections is impeccable, they do give a well-rounded picture, and the Introductory Notes make good reading in themselves, whether they evoke the conditions from which the following paper emerged or whether they gently warn the reader of an author's prejudices.

The point of view is primarily social. Human biology is stressed almost to the exclusion of any other aspect of life-science, and among the physical sciences preference is given to work that is a basis for present or future technological advances. Thus a theme is maintained among all the variety of the separate passages: the design of human life, the conquest of energy for social use.

The anthology will be profitably read for its information, but it has another, more subtle value. It reveals not only what scientists are doing, but what they are thinking and the direction of their personal orientation in society and in the universe. No objective review of a field of science by one author can do this. It is possible only in a purposeful anthology and, to this reviewer, it is the unique virtue of this particular compilation.

This book is fascinating and exciting. It is itself a fine social contribution and it should be owned and read by scientist and layman alike.

G. G. SIMPSON.

AMOS EATON: SCIENTIST AND EDUCATOR

- - - - - - by Ethel M. McAllister

University of Pennsylvania Press, $5.00

AMOS EATON, who has been called the "greatest popularizer of natural science that America has ever known," was much more than that. Teacher, founder of Rensselaer Polytechnic Institute, and an authority in numerous fields of science, he was a leader in that group of naturalists who laid the foundations for all that has been accomplished in American natural history in the past century.

Author of textbooks, manuals, and "dictionaries" in botany, mineralogy, geology, zoology, chemistry, physics, and mathematics, Eaton considered himself above all a geologist. And it is in this science that he had his greatest influence on the scientific thought of this country. He has been called "the founder of the American system of geology," and the decade 1820-1829 has been designated as the Eatonian Era by Merrill. As a teacher at the Rensselaer School Eaton was able to say, about one month before his death in 1842, that "more than half the State Geologists of the Union" had been his students. Without doubt the most famous of these was James Hall; but the names of Ebenezer Emmons, George H. Cook, Douglas Houghton, and Benjamin F. Greene, to mention only a few, are fitting monuments to his influence as a teacher and scientist in the progress of geology in this country.

When one considers that, in addition to great accomplishments as a scientist and teacher, Eaton led a full family and early business life, and spent four years in prison on a charge of forgery, it becomes obvious that Miss McAllister has had a copious amount of material upon which to base this work. The fact that much of the information here contained has been derived from the correspondence of Amos Eaton and his close friend, John Torrey, should add to the appeal that this great biography has for those who are primarily interested in botany.

H. E. VOKES.

INDIAN AGENTS OF THE OLD FRONTIER

- - - - - by Flora Warren Seymour

Appleton-Century, $3.50

ALL readers of nonfiction books on Indians will be interested in this new volume. It begins with brief sketches of such original Indian agents as Sir William Johnson of Iroquois fame, William Clark who had initial charge of all the Indians in the territory known as the Louisiana Purchase, the learned and capable Henry Schoolcraft, and, not to overlook one of the most picturesque agents, Kit Carson. A number of forgotten names will be found duly annotated in this preliminary list. Among later famous agents are the 22-year-old John P. Clum, who controlled the fierce Apaches without support of the army, the fearless James H. Wilbur of the Oregon country, known among Indians as Father Wilbur, the conscientious patient Quaker agents, Laurie Tatum and John Miles, the rugged individualists, James McLaughlin and T. V. McGillicuddy, the wonderful Colonel Pratt, and the distinguished General Scott.

Many of the agents mentioned had real adventures, the reciting of which will increase your respect for the inherent bravery of mankind. The sketches of these agents are arranged in chronological order and so give an historical outline of Indian policy. As the author sees these events in perspective, the hopes of Colonel Pratt and others that the Indians would vanish in the American melting pot are not to be realized for centuries because the laws of the nation require that the lands and capital of the Indians be forever held in trust for the support of persons of Indian descent. So long as this policy endures we shall have books about Indian agents and their works.

CLARK WISSLER.

HOW MIRACLES ABOUND

- - - - - - - by Bertha Stevens

John Day, $2.50

HERE is an excellent book for teachers and parents, planned to aid in stimulating interest in nature. Miss Stevens has also written other books of high merit along somewhat the same line, namely, *Child and Universe*, *Nature: the Child Goes Forth*, and *Thoreau, Reporter of the Universe*. The last mentioned was reviewed in the November, 1939, issue of NATURAL HISTORY Magazine. The author is a practical teacher, and she has actually used the materials discussed in these books with her pupils. Her suggestions are so convincing that one cannot doubt that she has used them with marked success. With the great teacher, Pestalozzi, she does not believe in telling a child that which he can discover for himself.

It is evident that the author is unusually well-equipped as an all-round naturalist, and it is encouraging to the student of nature to have a book of this kind written by one who has so high regard for scientific accuracy. There is, however, a typographical error as to the number of constellations. The astronomers recognize and use more than twice 42 constellations.

For each of the ten chapters of this book Miss Stevens has selected a "miracle,"—a star, a magnet, a salt crystal, a dewdrop, a lima bean, a petunia, a tree, a snail shell, a goldfish, and the hand. This is a varied list and well-chosen, but as every naturalist knows, and as suggested by the title of the book, the author might have prepared ten chapters on selections from myriads of other objects. The illustrations from line drawings and photographs add much to the interest and attractiveness of the volume.

CLYDE FISHER.

THE MARVELS AND MYSTERIES OF SCIENCE

- - by Clyde Fisher, John Gerould, James P. Poole, John A. Timm, Terrence T. Quirke, Clark Wissler

Wise, $2.95

THE Marvels and Mysteries of Science, is a popular survey of five important fields of science, written in everyday language for Mr. John Q. Public. It is a one-volume encyclopedia designed to aid the man on the street in the mysteries of astronomy, geology, physics, biology and anthropology. Each of its five sections is either written or approved by recognized scientists in these various fields. While the story of science is simply told, it is accurate and surprisingly comprehensive.

Readers of NATURAL HISTORY Magazine should be particularly interested in this volume, since it contains the work of two of the leading Museum curators. Dr. Clyde Fisher, Curator-in-Chief of the Hayden Planetarium, wrote the Introduction and was responsible for the chapter on astronomy. Doctor Fisher's Introduction, while brief, is an excellent review of the development of science from the earliest days to the present.

The section on anthropology is the work of Dr. Clark Wissler, who is Curator of Anthropology at the American Museum. This section of the book contains four chapters which include "Human Paleontology," "Modern Peoples," "Ethnology and Archaeology," and "Cultural Anthropology." Those who are familiar with Doctor Wissler's numerous writings on these subjects know how eminently well qualified he is to handle them and we can vouch for the fact that he has done an excellent piece of work in these chapters.

The book is copiously illustrated and well indexed. We feel that it will make a valuable addition to any library where a one-volume work on science is desired.

ROBERT R. COLES.

The last million years

------- by A. P. Coleman

University of Toronto Press, $3.50

THE death of Dr. Coleman, two years ago, removed the Dean of North American glacial geologists. Within this relatively small volume, which was almost completed at the time of his death, and has been subsequently edited by Professor Kay of the University of Iowa, he had summed up the results of his lifelong study of the history and effects of the glaciation of the Pleistocene period.

The last million years of the earth's history is dominated by the spread of glaciers over the continents of the northern hemisphere. Dr. Coleman confines his discussion and description of this glaciation and its effects on the land and its life to the continent of North America. In his introduction he sums up the importance of this glaciation:

"The most populous parts of the United States and Canada were ice-covered in the Pleistocene and the work of glaciers has profoundly influenced the present life of the region. The soils, the scenery, the routes of roads, railroads and canals, the sites of cities, the Great Lakes and their connecting rivers, and even the international boundary between the two countries, were closely bound up with the advance and retreat of ice sheets in the geological period immediately before the present.

"No one can really understand the geography and the human history of the northern United States and southern Canada without a knowledge of the strange events that shaped things as they are and prepared the way for our present civilization."

It is not a popular book, as that term is generally used, but it is essentially a nontechnical account designed to interest the intelligent general reader as well as to summarize for the geologist the present status of our knowledge of Pleistocene events. Above all, it is a significant summary of the lifework of a great scientist.

H. E. Vokes.

Life and living

------ by Frederic Wood Jones

Kegan Paul, Trench, Trubner
London, 10/6

THESE brilliantly written essays were originally delivered as lectures before academic audiences in Australia and Tasmania.

Professor Wood Jones, an experienced debater, immediately enters upon a discussion of the two opposite and controversial methods of approach to life and living, "Mechanism and Vitalism," and declares vigorously for vitalism: "There would seem to be good cause for believing that materialistic doctrines of pure mechanism have had their day in the interpretation of life and that we have witnessed their passing. It is likely that we are all on the threshold of a new phase of thought in everything relating to life and the essential nature of the living." As always, he makes his case good.

In a discussion of the biological implications of the mammalian toilet the author reveals the great wealth of his own observations made upon living animal subjects and especially the results of his long and close study of the primate hand.

In "The Changing Point of View" the author most clearly proclaims his faith as philosopher-anatomist: "Both the extremely little and the extremely large are so far beyond our comprehension that no human mind may see wholeness in it all; but an approach to wholeness may lie in an appreciation of the apparent underlying similarity of design that seems to stretch from the atom to the universe..." Here he quotes Francis Thompson: ". . thou canst not stir a flower Without troubling of a star." He continues: "No new physicist, no biologist, has so far given us a concept of organism so completely satisfying as this. . ."

The book is interesting throughout, showing the author's full grasp of the literature relating to biology and especially his own subject—anatomy. His original observations on the structures and habits of animals are almost innumerable and make a convincing background for his philosophical interpretations. I have only favorable comments to make on this work.

H. C. R.

A field guide to western birds

------ by Roger Tory Peterson

Houghton Mifflin, $2.75

MR. PETERSON'S *Field Guide to the Birds* has become indispensable to all field bird students in the eastern United States. In the present volume he places western bird students equally in his debt. The two combined cover the bird life of the Union and its coasts.

The "Peterson method," first introduced in 1934, is now too well known to require description. To say that it evidently has been made to work as well in the West as in the East is a tribute to its author's skill in meeting the requirements presented by a successful treatment of the somewhat more complicated problems presented by western bird life.

The author has supplemented his own experience by liberal use of pertinent published works, and has secured the cooperation of many other bird students both in the East and in the West, the sources of this assistance being fully acknowledged. In its surprisingly successful achievement of its main purpose Mr. Peterson's book deserves unqualified praise, but we continue cordially to disagree with his estimate of the value of the work his book is so well designed to promote. Admitting that a bird list in itself is not the highest type of scientific literature, bird lists in the aggregate form the foundation of faunal and seasonal ornithology and they thus become indispensable contributions to this phase of bird study. A bird census is not a profound document, but the combined Bird-Lore Christmas censuses of the past 40 years form a unique record of the midwinter bird life of the area covered, and as such this unequalled mass of data has exceptional scientific value in its special field.

There is, therefore, no reason for the "bird lister" to apologize for his occupation. True, it represents the kindergarten stage of the bird student's training, but it is an essential part of his education if he hopes to become a graduate ornithologist.

F. M. Chapman.

FROM THE HALLS OF MONTEZUMA— *Continued from page 119*

pathies are avowedly on the side of the Indians, he is too much of a scientist to attempt to whitewash them. He rests his case squarely upon the shortcomings of our own culture and the magnificent artistic and architectural achievements of a Stone Age people to whom the wheel, metal tools, and most of the fundamental principles of engineering were completely unknown. In speaking of the greatest Toltec goddess, he says, "Her statue was never finished. It still lies anchored to its matrix of living rock and cannot fail to impress the modern visitor. Its concept is grandiose, but the engineering skill was lacking to cut the sculpture free of its base. Prometheus in his chains may symbolize the tragedy of European thought, but to me this goddess, still an integral part of the land that made her, represents the paralysis of Indian civilization."

We are fortunate indeed to have so sensitive a view of Indian history enclosed within the covers of a book. Even as the master playwright or novelist must identify himself with the thoughts and feelings of his characters, so must the anthropologist be capable of assuming the bias of the people under his investigation, of feeling himself a part of their ethos. Not only has Doctor Vaillant attained this special insight, but, perhaps more important, his own admirable prose evokes the attitude in the reader. "Today," he writes, "there are grubby railroad yards and slums where the Aztecs made their last sacrifice and bled to death. The ghosts of its heroic defenders still haunt the place."

Yet he bears a heartfelt affection for the living Mexico which is, as it were, his alma patria. And Mexico is not insensible of his scholarly devotion to its interests. Recently the National Museum of Anthropology appointed him as Honorary Professor—a select title shared with only four or five other scholars, and one for which he is deeply grateful.

L'envoi

There is another consideration which makes us doubly grateful for Doctor Vaillant's book, and one which we must confront with mixed emotions. For, this very month, he leaves the American Museum to undertake the Directorship of Pennsylvania's University Museum at Philadelphia—and for him a new and exalted life must begin at 40. One institution's gain is, in truth, the other's loss. But there will be none to begrudge him the honor of such an impressive advancement at so young an age.

Meanwhile he has left us a summary of his fourteen years of scholarly devotion to the Mexican Indian while on the Staff of this Museum. And there could be no leave-taking more appropriate to the times than the final paragraphs of that work which are hereby appended:

"The civilization of the Indian may not offer a direct inspiration to us modern individualists, yet we have profited from their labor in our food plants and the wealth produced by our neighbor republics to the south. In this world, torn with hate and war, adrift without an anchor or a compass with which to chart our course, we may well consider their example. The Indians worked together for their common good, and no sacrifice was too great for their corporate well-being. Man's strength lay in the physical and spiritual welfare of the tribe, and the individual was honored only inasmuch as he contributed to that communal good. The Indian civilization may have been powerless to resist the culture of the Western world, but it did not consume itself, as we are doing, in the expression of military power.

"The American countries today share the ideal of the republic and individual freedom. We share also an older tradition left us by our Indian forebears, that of mutual service for the benefit of man. With our continents spread before us, we have boundless opportunity to create on earth a wider life for everyone, an American civilization where old and new contributions to human welfare may be fused and amalgamated for the benefit of all."

DO NOT MISS

MONUMENT VALLEY in southeastern Utah and northeastern Arizona is one of the very few natural wonders still isolated from the main stream of tourist traffic. A magnificent story in photographs by Josef Muench will shortly bring its scenic grandeur into every NATURAL HISTORY reader's home. Mighty structures of stone rise 800 to 1200 feet from the valley floor, all miraculously carved by Nature into shapes of fantastic beauty.

•

The next time you aim your gun at a hawk or a coyote, a mountain lion or any other predacious animal, just remember that intelligent people consider predators occasionally harmful but usually beneficial. Don't miss **SHERMAN BAKER'S** answer to the question, "Why Pick on the Predators?" Learn about the dynamic relationship between the predators and the resources of any given area, how predators protect man from bubonic plague, and other startling points in a compelling defense of our native carnivores.

Continued from page 66

game fish, such as the large-mouthed bass, display the unquestioned ability to discriminate between colors.

Numerous species of tropical fish assume brilliant body colors at the time of spawning. Experiments conducted in the Laboratory of Experimental Biology at the American Museum of Natural History revealed that a female selects as her mate the most brilliantly colored male available. Baby jewel fish, whose parents are brilliant red, will swim toward any moving red object and avoid other colors.

The fact that fish will strike at spoons and spinners is, of course, no indication of color blindness. Mr. Hough's story of trout that ignored artificial flies and attempted to seize the fisherman's reel is a case in point. The small flies may not have been noticed by the trout; whereas a large metallic, shining reel would be more likely to compel the fish's attention. A whirling spinner drawn rapidly through the water displays more motion and reflects a greater amount of light than does a dry or wet fly. It is not surprising, therefore, that fish swimming several feet below the surface of the water are attracted by the metallic lure although they may fail to notice the flies. It is inaccurate to conclude that the fish is color-blind merely because it can be caught with devices that are not colored.

Mr. Hough's belief that the fish "has just sufficient brain power to open his mouth when he sees something to eat" does the fish an injustice. Students of animal behavior know that fish can learn to swim through complicated mazes without entering any blind alleys. Furthermore, they can learn to come to the surface for food in response to a number of visual stimuli. We must not overestimate the intelligence of fish, but they are not nearly as stupid as Mr. Hough would have us think, and the consistently successful angler can take credit for a working knowledge of one field of natural history.

* * *

SIRS:

. . . The binder I am ordering will preserve my seventh year of NATURAL HISTORY Magazine, which I trust will continue to be the same magnificent and highly instructive share of the American Museum which those of us far from New York City are privileged to enjoy.

ROBERT E. BALL.

Canton, Ohio.

* * *

SIRS:

Your museum probably does not have much upon the "nerve of a brass monkey," but we are afraid, by the time you have read this letter, you will know more of it.

Is there anyone who belongs to your association who would be glad to pass along his old copies of NATURAL HISTORY to our library?

We can't afford to take it, but it would be a useful reference tool for us, since it is indexed in the *Reader's Guide*.

We have just had a few copies given us, and are delighted with it. So, even though you may not find us "an angel" to give us his back numbers, we still sit here in Pottsville and sign ourselves,

Admiringly yours,

EDITH PATTERSON,
Librarian.

Pottsville Free Public Library,
Pottsville, Pa.

* * *

SIRS:

For a long time I have been wanting to tell you how much I enjoy your magazine, and now after reading the June number I can resist the temptation no longer.

First I read "Big for His Day." It was fine. Then came "Canyons under the Sea," with heightened joy. "Scylla Was a Squid" really got my blood flowing. Next I pursued "Old Juan" with throbbing enthusiasm. But the height or climax of the crescendo came when I took the High Road to Nature with David Lavender. That brought me right back home. I was born and have lived all my life within a few hours' ride of the Salmon River—The River of No Return—with its mighty canyon and its rushing flood of water and detritus. . . .

RALPH TELCHER.

Granville, Idaho.

★ ★ ★ ★ ★ ★ ★

HONORS

Dr. George Gaylord Simpson has received the distinction of election as "Honorary Advisor" to Venezuela's modern and progressive Museo de Ciencias Naturales, in Caracas.

* * *

Dr. Margaret Mead, Assistant Curator of Ethnology at the American Museum, was honored by the degree of Doctor of Laws from the New Jersey College for Women, Rutgers University, on June 1.

* * *

The honorary degree of Doctor of Science was conferred by Brown University on Dr. Robert Cushman Murphy, naturalist, explorer, and Curator of Oceanic Birds at the American Museum of Natural History.

* * *

The national Museum of Anthropology of Mexico has bestowed on George C. Vaillant the title of Honorary Professor, "an honor which the Museum has reserved not only for people who have advanced archaeological science in Mexico in an extraordinary way, but also for those who have manifested in their work their friendship and understanding of the country. . . ." Doctor Vaillant has served the American Museum of Natural History as Associate Curator of Mexican Archaeology since 1927, but early in September he will take office as Director of the University Museum of the University of Pennsylvania, in Philadelphia.

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.

October NATURAL HISTORY 1941

Desert Skyscrapers · Grandfather Fish · Bear Quads

Midway's Feathered Airmen · Eskimos · Sea Elephant

VOLUME XLVIII. No. 3

FIFTY CENTS

LETTERS

SIRS:

. . . I enjoy the Magazine so much and hope it can always continue. It is lovely in every way and so free from the turmoil of the day—I am beginning to think of it as an escape magazine. I will make an effort to send you some new subscribers.

(MRS. J. B.) PARALLEE HAVRE.

Berkeley, Calif.

* * *

SIRS:

I have certainly enjoyed your NATURAL HISTORY Magazine. It is both instructive and beautiful. I am greatly interested . . .

JESSIE MERCIER.

New York, N. Y.

* * *

SIRS:

I am a very happy member and enjoy the Magazine beyond words.

MRS. GEORGE B. LEE.

New London, Conn.

SIRS:

I must thank you very much for your most kind letter dated July 8th saying that one of your American members has graciously sustained my membership during the coming year because of our assets being frozen under the international emergency.

I find it very difficult indeed to express what I feel about such a generous and charming thought and action, and I hope you will let him or her know how very, very much I appreciate this kindness and with what added pleasure I shall now read your delightful magazine. The people of your country are indeed the most generous of givers in small as well as big ways and so often make life gayer and happier by their many kindnesses. I work in a munition factory and your magazine in wartime is a source of real joy and rest. I cannot tell you how much I look forward to its arrival.

Again my best and grateful thanks.

V. MACEWEN.

Somewhere in Scotland.

SIRS:

I am not aware whether you use single pictures in NATURAL HISTORY Magazine but believe that the accompanying photograph possesses unique interest.

This is of a series of strange natural dams dividing a lake in Balls Cave into fourteen sections. The cave is near Schenectady, New York, on the edge of the Helderberg escarpment. Dr. Paul A. Zahl, research associate in biophysics at the Haskins Laboratories in New York, and myself, have been investigating these dams for the past few months, and as far as we are aware they are the only ones of the kind. The underground water is frequently so high as to make careful exploration and examination impossible.

The dams are of limestone origin and are probably the result of a chemical precipitation. They range from eight feet high at the deep end of the lake to about six inches at the shallow end. The dam shown is the largest of the thirteen, and the water it impounds is about ten feet deep.

DUANE FEATHERSTONHAUGH.

Schenectady, N. Y.

* * *

SIRS:

. . . Our entire family take such pride and joy in keeping your magazine and having the binders for each year. They not only enhance the bookcase but keep people from borrowing the single issues. I don't object to lending books on principle but everyone really should have his own NATURAL HISTORY Magazine because it's so fascinating and interesting. It just tells you

Continued on page 190

1941 looks at 1916

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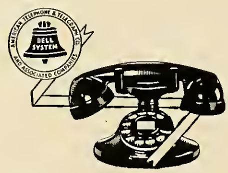

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NATURAL HISTORY

The Magazine of the American Museum of Natural History

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

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TOTEM POLE: a slender spire which towers nearly a fifth of a mile into a sapphire sky. Nature's cutting makes it resemble a gigantic totem pole carved by the Indians. Fewer travelers have seen this than most of the other monuments, for it stands well out from the center of the valley

SKYSCRAPERS OF THE DESERT

By JOYCE ROCKWOOD MUENCH   *Photographs by* JOSEF MUENCH

WHEN the sun comes up over Monument Valley's unique skyline it shines on Goulding's Trading Post, the most remote spot in the United States,—over 130 miles from any railroad.

Far and wide in every direction spreads a landscape whose fantastic beauty ranks high among the foremost spectacles of Nature. Monument Valley has not been set aside as a National Park or a National Monument, and its age-old sculptures look down upon a scene unsullied by surfaced roads or other works of man. When you set out from Kayenta in northern Arizona over the road shown in the photograph below, you may drive all day through this weird scenery, up past the Goosenecks of the San Juan to the nearest paved road in Utah, without, perchance, passing a single car. And at times even the sociable traveler may be glad of this, for there are stretches where it would be quite impossible to pass another automobile.

Ages ago a great plateau existed over what is now southeastern Utah and northeastern Arizona. It was made up of layers of rock of varying degrees of hardness. Rivers carved their courses down into this plateau, then widened them, and left a multitude of towering tablelands. As time went on, these yielded further to the elements without losing their tremendous height; and as wind-driven sand added its share to the work of rain and frost, an assortment of columns and spires was formed which has no rival. In height they range from 800 to 1200 feet above the valley floor.

Before the water was gone, antelope were hunted here by the Indians, who drew crude pictures of them on the soft sandstone walls in some of the canyons. Water is scarce now, and there are no antelope. Descendants of the early Indians still live here with small flocks of sheep and goats that enable them to eke out what seems to many a miserable existence in a desert country. The men of the family tan hides and make shoes or beat jewelry from native silver and set it with turquoise. The women weave the wool of the sheep into the beautiful, durable Navaho rug and saddle blanket that is sold all over the world. To the family who produce it, it represents trading power to secure flour, sugar, coffee, and tobacco.

To the modern Indian, as it must have been with his ancestor, home is any spot under the shade of a tree where the family puts its jumble of household goods and builds a fire.

(*Below*) GATEWAY TO A STRANGE WORLD. The twin sentinels of Owl Butte and Algothla guard the road on either side as the motorist enters Monument Valley from the south. He has already left the traveled highway far behind and is over 100 miles from the nearest railway. Once through the gate, he looks out upon a scene of unearthly beauty, with breath-taking vistas of at least 50 miles in either direction

To enter Monument Valley from Kayenta, Arizona, the traveler is beckoned on by two buttes, Algothla and the Owl Butte, which stand like guardians at opposite sides of the road. Algothla is of volcanic origin and looms up with a conical shape reminiscent of Old-World castles. The Owl is of red sandstone like the rest of the valley's monuments. Together they make a gateway to a strange world.

It is a gateway to a valley unique in a country of wonders, spectacular in the West where spectacles are the common run in scenery. The clear air is deceptive, and these great mesas look close even when they are miles away. Vistas of at least 50 miles in either direction are open to the eager eye. Carved on a scale greater than that used in most of Nature's works, the Mittens for example, need a pair of hands about 800 feet from wrist to finger tip. Brigham's Tomb dwarfs the Pyramids of Giza. The Totem Pole rises a sheer and slender 1006 feet above the valley, carved as delicately as the Alaskan Indian's hand-made pole in front of his lodge.

Here is an enchanting land which is being "discovered" by more people every year. Its horizons are matchless, and the Indian, part and parcel of the land, is always fascinating. Today this place is still primitive, untouched. Tomorrow the hand of commerce may brush the bright bloom from it; then those who have seen it while it was still "unknown" will remember it as one of the most spectacular sections of our western frontier.

(Left) DESERT SKYSCRAPERS, over which brilliant clouds chase a constantly shifting procession of shadows. Here Merritt Butte sulks in the gloom while some of the more distant monuments gleam like a city of gold. Their flat tops mark the level of the plateau that stood here eons ago, before the forces of wind and water carved it away and left these lonesome, majestic reminders

(Left, below) THE MITTENS. A pair of hands 800 feet from finger tip to wrist would be necessary to wear them. The left-hand mitten is three miles from the camera, the right-hand six. Merritt Butte, on the right, is named for a prospector who was killed by Indians for robbing their silver mine

(Right) ONE OF THE MITTENS as seen through the gap. A close-up of one of the formations shows the layers of rock over which the débris has tumbled as the pedestal was shaped and the upper portions of the monument carved by sand, wind, and water

(Right) Desert housewife. Among the many hundreds of Navahos that live in this natural wonderland, home is where you rest your head for the night. The household goods are strewn on the ground, and woman's work is never done. Here a squaw is preparing bread for baking, while her younger sister watches the process with interest. The simplicity of the velveteen blouse lends itself to the effective display of the ornate silver and turquoise jewelry

(Above) AMID THE FLAMING CLIFFS and turrets of Monument Valley, man feels the insignificance of man. Heat and cold, moisture and drought, have aided Nature here in her timeless art

NOW AN ALMOST WATERLESS DESERT, Monument Valley once supported antelope, probably several hundred years ago. The game that then survived in a damper climate can still be seen from the hand of some Indian artist who stood upon the sand and with some rough tool scratched the surface of the soft sandstone *(right)*

(Above) THE THREE SISTERS. The procession makes its way, into the cathedral at right, where the tiny novice in her veil may take her vows. The prioress who takes up the rear carries her hands neatly folded, and even her features can be seen on closer scrutiny. The figures rise over 800 feet from the floor of the valley. In winter you may see them wearing veils of snow

(Right) DESERT NOMADS: two Navahos who have stopped for a bite to eat on a ride home from the trading post. The desert road leads toward the monolith Algothla, which unlike the others is volcanic rock

Brilliant colors suffuse the skyline as the desert sun paints the massive sandstone blocks like Pop's Mesa *(above)* a richer red. This mass at times looks like a great red elephant charging down upon the road

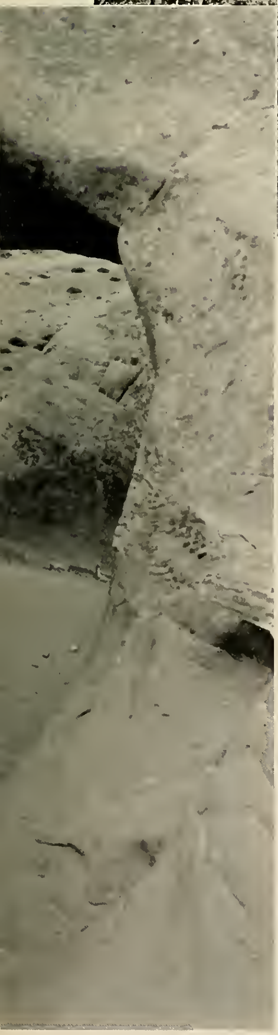
(Right) Against a background of red rock, these Navaho women and their children rest in the hot noonday. The young goat has the run of the "house." A blanket loom is propped against the tree, and jerked meat can be seen hanging from a rope at right

(Above) WORKSHOP IN THE DESERT. The Navaho weaver always finds a place to hang up her loom and continue work on her rug. The patterns, we are told, no longer have symbolic meaning. Even the small girls are interested in the weaving and seem eager for the time when they can practice on their own loom

(Right) WOOL raised on the family flock is used in weaving the beautiful rugs. With the proceeds from sale of them the Navaho buys flour, sugar, and other supplies. The usual Navaho dress is here varied by sleeve band and buttons—signs of Piute influence

(Left) AN ENDLESS VARIETY of such vistas offer their beauty against an ornately clouded sky in Monument Valley

(Below) AN EYE in the rock. Sand, wind, and water have here cut a large hole in the top of an open cavern in the cliff. Note the figure on the sand of the valley floor



(Above) The distinctive beauty of Monument Valley comes from the great sweeps of barren ground surmounted by curious shapes of brilliantly colored sandstone, rising into cloud-strewn skies like this

Water is scarce in this land, but the Navaho usually knows where to find it for himself and his inseparable companion, the horse

(Above) LIKE A GEM of great size in the most unusual setting, Merritt Butte is here seen through the branches of a scrub juniper tree—a symbol of Nature's majesty, which will doubtless stand long after man's works have been disfigured by time

(Right) OUTLINED against a desert sky, this Navaho represents all Indians who still cling to the freedom that their horse gives them and the strength that the desert demands

(Above) THE LOW LIGHTS give Monument Valley some of its most sublime pastel shades, as when the sun, struggling through gathering clouds, casts a soft mist over the landscape and touches the thin carpet of desert growth with light. A winding road can be seen approaching the lonely hut and coral, over which moonlit night will later cast a matchless spell of solitude, amid scenery unsurpassed for sheer grandeur perhaps anywhere on earth

After a period of slaughter which threatened to exterminate this picturesque mammoth of the sea, rigid protection may enable layman and scientist alike to observe its interesting habits on the islands off the California coast

JUST ahead, off the port bow, a bulky brown mass projected vertically two or three feet above the blue water; it suggested an ill-painted buoy, or the butt of a large tree, upright in the sea. As the ship approached closer, several observers almost simultaneously cried, "Sea elephant!" Some had never seen such a creature, but all guessed its identity almost on first glance. Unmistakable were its huge body and characteristic proboscis, flopped over in front of its mouth. The animal remained motionless regarding the trim *Velero III* for a few moments, finally sinking from sight of the approaching ship.

In 1884 Dr. Charles H. Townsend, former director of the New York Aquarium, made an extensive cruise along the Pacific coast of Lower California, searching for specimens of the Northern Elephant Seal, or Sea Elephant. During the trip he was able to obtain only sixteen specimens at San Cristobal Bay, which were prepared for the United States National Museum. Numerous bleached bones of the elephant seal were found along the coast and on the offshore islands, attesting to the former abundance of the species, whose range once extended from Cape San Lazaro near Magdalena Bay, Baja California,

QUIET: please go away and let us sleep. A congregation of sea elephants in a rocky cove on East Bonito Island off the coast of Mexico's Lower California, indulging in their favorite pastime. The herd consists principally of adult females who lack the ten to twelve-inch trunk. A pup nestles between two hulks in the foreground and a young awakened bull rises in protest, lending action for the cameraman

Photos, Courtesy of Allan Hancock Foundation

THE TRUNK contains inflatable air chambers and flap-like valves which close for diving. A rumble is sometimes emitted which gains resonance in its fleshy interior

JUMBO *of* THE DEEP

· *By* WOODBRIDGE WILLIAMS

to Point Reyes just north of San Francisco, California. The decline of the elephant seal was due to the extended activities of sealing and whaling ships which sought this peculiar animal for its bountiful supply of valuable oil.

Again in 1911 Doctor Townsend investigated the realm of the sea elephant on board the United States Bureau of Fisheries' ship *Albatross*. To his surprise he found on the then uninhabited Guadalupe Island, lying off the northern coast of Lower California, a herd of approximately 125 northern elephant seals hauled out on Elephant Beach on the northwest side of the island. Since the rediscovery of the species, there has been a substantial increase in the number of seals on Guadalupe Island. A good deal of the credit for the come-back of these animals is due the Mexican Government, which has afforded them protection for the last eighteen years through the maintenance of a garrison of soldiers on the island for this purpose.

For many years Guadalupe Island was considered to be the only locality where the northern elephant seal landed, or in the sealer's terminology, "hauled out" on the beach. But Doctor Townsend, enthusiastic over the increase of these seals, which he formerly believed approaching extinction, optimistically wrote in NATURAL HISTORY Magazine (February, 1924), "The casual reappearance of the Elephant Seal at other islands from Cedros northward to the Santa Barbara Islands may reasonably be expected."

It was in October, 1940, that the *Velero III*, belonging to the University of Southern California and used for marine exploration under the auspices of the Allan Hancock Foundation, had sighted an elephant seal far to the north of Guadalupe Island, off Point Vicente, just west of the busy port of San Pedro, California. During the last few years, one and sometimes a few more elephant seals have been seen swimming in the sea or hauled out on the islands, off the coast of southern California. These islands are collectively known as the Channel Islands, or the Santa Barbara Islands, as referred to by Doctor Townsend. The Allan Hancock Foundation feels that at present it is not wise to publicize the definite localities where elephant seals have recently been observed on the Channel Islands. Rigorous protection of these animals from molestation by yachtsmen and fishermen is absolutely necessary to insure the continued increase of sea elephants on the islands off the coast of southern California. Despite the still few numbers of elephant seals in this region, the fact remains that Doctor Townsend's prediction of seventeen years ago has been borne out, and in its entirety: for the sea elephants, as well as coming north to California, are going south to breed on islands long vacated by their kind.

In 1933, while searching for elephant seals in preparation of a group for the Field Museum of Natural History, the *Velero III* chanced to visit

East Bonito Island, about 150 miles southeast of Guadalupe Island. To their suprise and delight they discovered a breeding herd of elephant seals inhabiting the rocky coves that indent the rugged island coastline. The situation was quite in contrast to the observations made by the California Academy of Natural Science's expedition in 1922, when they reported finding many bleached bones as the only indication that the northern elephant seal was once abundant on the island.

This year the island again teemed with sea mammals. In late February, 1941, the skiff from the *Velero III* met with a noisy reception as it headed into a cove surrounded by crags except at the farther end where small waves broke on a boulder-strewn beach. Pods of pup sea lions dotted the kelp-streaked water with their shiny dark heads, accompanied here and there by a larger cow. In contrast to the actively moving sea lions, most of which rapidly floundered into the water upon our arrival and swam gracefully about the skiff, barking like so many frightened dogs —great, dirty brown forms, ten to fifteen feet in length, lay high on the strand, almost completely unconcerned over the hesitantly approaching skiff. One lumbering elephant did make a half-hearted attempt to leave the beach but was carried by its ambition only as far as the water's edge, where it bogged down, lying half submerged and greatly suggesting a floating hippopotamus in an African river. One elephant seal swam leisurely about in the cove, making the landing party a bit apprehensive over the animal's potential ability to upset the skiff. But it soon seemed evident that the creature was incapable of planning such an attack.

With the scraping of the skiff on the beach, the party scrambled and waded ashore, then leisurely photographed and observed the sleeping hulks, as if they were prepared specimens behind plate glass in some museum. All that was missing was a tag reading: "Northern Elephant Seal, *Mirounga angustirostris.*" Only occasionally would one of the listless forms rear on his foreflippers and bend his neck far back to emit rumbles which seemed to start deep in his throat and gain resonance in his fleshy proboscis. The sound was one which a seasick person certainly would not care to hear. The sea elephant would hold this position for a moment, then flop back onto the beach, or more often onto the body of a sleeping companion. With a few sweeps of his foreflippers he would blanket his back with sand as protection from the rays of a semitropical sun. Soon pits would form in the sand beneath his nostrils from silently exhaled breath. The creature was happy again, for he was fast asleep.

Only after much provocation by means of rocks was one of the bulls convinced that we wished him to perform by moving toward the water. He accomplished the feat by using the foreflippers as vertical levers. The forward motion was initiated by the lifting of the body just in front of the hind flippers, forming a contraction which traveled toward the head. These movements suggested the muscular waves in the fleshy foot of a moving snail, though the sea elephant was far less graceful. He accomplished progress by much grunting and scraping of cobblestones on the beach. The hind flippers were not directly used but simply dragged along on the sand and over the rocks.

The cove of landing sheltered a group of bulls; but in other indentations to the west there were a number of cows, smaller, about ten feet in length, and lacking the short trunk of the adult male. Accompanying a good many of these cows were plump pups, so round and fat that they could hardly move. Sleek and shiny these infants were, quite in contrast to the bedraggled, almost emaciated appearance of their elders, who at that time of year were shedding their skins in much the same manner as do humans who have acted like seals on a beach for too long a period of time. The adults seemed to feed little during shedding, as they appeared to have lost a great deal of weight.

Exactly how old the young pups were, or where they were born, was somewhat of a mystery. Little is known concerning the life histories of these animals, although Mr. Lawrence M. Huey of the San Diego Society of Natural History reported in 1926 that the remains of four small elephant seals (about 30 inches in length) on the beach at Guadalupe Island would seem to support the assumption that their cycle had begun on that island.

One could walk right up to the youngsters on East Bonito and stroke their smooth gray backs. They only occasionally objected by lifting back their heads, opening their pink mouths, and hissing in lazy protest. Besides these newly-born pups, numbers of yearlings were distributed among the ill-sorted piles of unconscious adults. The sex of these youngsters was very difficult to determine from superficial observation.

East Bonito appears to have become once again a breeding ground for the elephant seal. It is interesting to note in comparison that in 1933, when the *Velero III* visited Guadalupe Island, only large bulls were seen. At that time a seventeen-foot specimen was taken for the Field Museum of Natural History; its estimated weight was 5,000 pounds. Some observers have commented on the absence of young and females on Guadalupe Island, while others have reported their presence. There is yet much to be learned concerning the yearly meanderings of this interesting animal.

The feeding habits of the northern elephant seal have long been a source of much conjecture. Only scanty information has been obtained from examining the stomach contents of the animals taken on the beach. Usually no food was found, only "ballast," as sealers term it, consisting of rocks and sand. But Dr. A. W. Anthony of the California Academy of Natural Sciences reported finding in the stomach of a Guadalupe sea elephant one whole fish, which had been bolted, a squid and some seaweed. The stomach contents of a specimen taken by the *Velero III* in 1933 yielded squid and seaweed. Because of the usual empty condition of the stomachs and the fact that the animals have large lustrous eyes resembling the so-called "night eyes" of nocturnal mammals, most zoologists believe that the animals are more active at night, doing their feeding at that time. The two specimens in the San Diego Zoo, on the contrary, are fed twice daily, consuming about 60 pounds of sardines. Mrs. Belle Benchley, Director, reports that she has not been able to observe any differences in the animals' activity, day or night. Of course, the artificial environment may account for such a discrepancy.

The most complete report that has been made concerning the feeding habits of the northern elephant seal was made in 1930 by Mr. Huey, who examined the stomach contents of a specimen harpooned by a fisherman 40 miles off San Diego, California. The harpooning itself was quite significant at the time, as no elephant seals had been reported so far north for many years. But what this animal had consumed for lunch was even more surprising. The meal consisted of seven ratfish *(Hydorlagus colliei)*, one California dogfish shark, one puffer shark, three skates, and four squid. The study brought out several significant facts. The ratfish was the most abundant form represented, and as it lives in water from 50 to 120 fathoms deep, its presence seemed to indicate that the elephant seal had dived a comparable distance for its meal. From the evidence given by the fisherman, the sea elephant was feeding some distance offshore, and during the day. The intact vertebrae of the dogfish shark indicated the food was bolted, probably alive, as the elephant seal has poor dentition for mastication, its teeth being set quite far apart. Mr. Huey attributes the success of the elephant seal in deep-water feeding to its large eyes, which are probably quite effective when swimming far beneath the surface of the sea.

From the evidence the questions arise: does the sea elephant feed in two distinct areas—one while near the breeding or hauling grounds on the islands, where it would feed on marine vegetation and shallow water fish and invertebrates, and another in deep water, far offshore where it must descend many feet to obtain a meal? Or does the adult sea elephant, for the most part, fast while on the islands and do most of its heavy feeding in deep water? Since we found some evidence of food in the stomachs of seals taken on the beach and the cows with pups might be expected to require nourishment, it seems likely that the animals do feed, as least to some extent, along the shores of the islands. This probably occurs at night, as most of the animals remain quite inactive during the day. When migrating at sea, it would seem from the evidence presented by Mr. Huey that the real banquet tables of this animal are in the deeper offshore waters.

Taming of the elephant seals has presented extensive problems to the San Diego Zoo. One specimen took 157 days to make up its mind that the zoo menu was acceptable. All that time force feeding was in order and required somewhat elaborate equipment. A large canvas with an aperture for the seal's head was constructed and used like a poncho to protect the animal from the handling necessary with force feeding. The animal was induced to place its head through the hole in the canvas by holding food on the opposite side. After he had been shrouded in canvas, a padded iron bit was thrust into his mouth to hold it open for the ensuing procession of fish. When the stubborn animal finally did condescend to eat on his own accord, he at first required the stimulus of the canvas before he would take the proffered meal, despite the fact that the canvas was no longer used in the actual process of feeding. The specimen lived for seven years in the San Diego Zoo —which is the longest period that institution has been able to maintain an elephant seal. The animal's career was terminated by the introduction of a large bull, which continually forced the smaller animal against the cement sides of the tank, finally killing it.

Despite the artificial surroundings and environment, zoo animals do shed some light on their habits in the wild. An interesting faculty of the northern elephant seal easily observed in the pool is the length of time the creature can remain underwater. One specimen seemed to enjoy relaxing under the shade of an overhanging shrub where he periodically submerged his head just beneath the water. Occasionally his head would break the surface and the animal would blow, making a sound like a person very much out of breath. Only for a short spell would he remain at the surface, then down he would go again. The submersion lasted on an average around three minutes, although his companion disappeared beneath the pool for a period of five minutes. Mr.

Huey reports a specimen in the zoo remaining underwater for seven minutes. These observations tie in very nicely with other evidence that these animals can dive to great depths—requiring a comparable time in breath-holding.

Many diving mammals close the nostrils so as to prevent the entrance of water. Young specimens of the northern elephant seal do this; but older ones, at least the adult males, do not contract the nostrils—they have a different modification for the purpose of diving. Mr. Huey reports that in both nasal passages there are flap-like valves that can be closed or opened at will. Also there are air chambers in the proboscis which the animals can inflate, causing many of the strange expressions so characteristic of elephant seals. Perhaps these air chambers and valves also facilitate longer submergence, although, of course, the female lacks the proboscis with its air chambers.

The swimming methods of elephant seals can readily be observed in the zoo. When one of these seals is fully under way beneath the water, the powerful hind flippers, so useless on land, operate very much like the tail of a shark, propelling the animal along with a thrashing movement. Only when the seal is slowly cruising along the surface do the fore-flippers come into play, acting as balancers and perhaps aiding somewhat in propulsion like the pectoral fins of a fish. At this time the hind flippers, held rather far apart, propel the creature with a vertical flapping or sometimes a scissors action.

The larger specimen of the two young males now in the San Diego Zoo enjoyed swimming beneath the water along the visitors' side of the pool.

In battle, the proboscis is a major objective, as shown by the gashes on the trunk of this large male. The heavily calloused chest serves as a sort of shield, portions of which can be seen here. The warring opponents seem not to care whether this portion of their ponderous anatomy is injured or not. The fighting of these seals is not so serious as that of the fur seals, which is often to the death. "Sunburn lotion" in the form of sand thrown over their backs is visible in this photograph

Courtesy of Allan Hancock Foundation

Then, slowly emerging on the opposite side, he cruised along with just the head and proboscis above the water, blowing small jets of water in front of him with his breath. His head would be constantly turned to one side, pointing toward the edge of the pool closest to him, and one might wonder at first why he persisted in this. But the secret was soon revealed by a clatter up the road.

A truck appeared above the pool. The two Steller sea lions living with the elephant seals already had their foreparts up on the concrete walk. For a change the usually listless sea elephants showed surprising energy, hauling completely out of the pool to take their breakfast of sardines directly from the keepers' hands. Gulp—headfirst down the fish would go. No chewing was observable. What a wonderful conservation of energy and time! The zoo was no place for impractical human manners. After feeding, the larger of the two elephant seals stretched out on the concrete for an after-breakfast snooze, while his companion returned to his corner beneath the shrub and continued the incessant bobbing up and down.

The elephant seal is not a graceful creature, nor one with a pleasing "vocabulary," but he is the largest of the seals with the possible exception of his southern relative of antarctic regions. He is unique because of his proboscis, which attains a length of ten to twelve inches, and he is a tempting subject for scientific research and observation.

The home-coming of this animal to haunts long deserted stands out as a notable exception to those numerous species which have not come back. Even as Doctor Townsend predicted the return of the elephant seal to the Californian islands, so may it now be foretold that the layman and scientist alike in the near future will perhaps need not resort to the zoo or expend large sums in traveling to distant islands to see this strange creature, but will observe it "at home," in large herds on our near-by Santa Barbara Islands.

Photos, Courtesy of Allon Hancock Foundotion

(Above) An attempt to herd a large bull on Guadalupe Island with the sides from a cage floated ashore. Herding was difficult and apparently useless. When the animal made up his mind, he went into the cage of his own accord

(Below) Handsome by sea elephant standards: the head of a large bull on East Bonito Island. Notice the scanty dentition and peeling skin about the mouth

Elephant seals are easy prey for the hunter, and their come-back from threatened extinction is largely to the credit of the Mexican Government. Above is the garrison house on Guadalupe Island for their protection

The trim *Velero III*, research vessel belonging to the University of Southern California and used on the expedition as recounted, under the auspices of the Allan Hancock Foundation

Courtesy of Allan Hancock Foundation

Photo by the author

Sixteen years ago Dr. Paul B. Kinney began studying and photographing bears in Sequoia National Park. As one of their most conscientious followers, he witnessed many strange and amusing sights but nothing comparable to the previously unrecorded spectacle of a mother black bear nursing and educating a family of four. The black bear's average litter is two cubs, with one or three occurring occasionally. Mother Goofy, with a litter of four, goes on record as the most exceptional mother in beardom, and her family deserves eminence comparable in their own sphere to that of the Dionne's.

Doctor Kinney had known Goofy since 1931, when she herself was a cub. The name was fitting, for she was a clown among clowns. Perhaps it was well that these unusual burdens fell upon a bear with so sporting a disposition, though the world will, of course, never know how she took her first trials. For bears are born in winter while the mother is hibernating under deep snow. The cubs are blind, helpless, and almost hairless—mites that weigh only about half a pound and are about the size of a small chipmunk. The mother often has to nurse the ravenous cubs for three or even four months without a mouthful of food or water for herself.

About 40 days after birth, the four cubs first opened their eyes. They were about three months old before Mother Goofy introduced her unusual family to the forest and began their education.

(*Right*) Mile after leg-weary mile the quads trudged after Mother Goofy, learning the ways of the forest. The "wee bear" of this family is the runt. An adverse position at the lunch counter (he had to stand on his mother's arm) might seem a handicap, but by December he had become almost as fat and large as the others

QUADS ON PARADE

An unheard-of event in beardom presented this buffoon of the forest with troubles few mother bears have ever faced and provided a seasoned student of bears with the thrills of a lifetime

By PAUL B. KINNEY
All photographs by the author

(Left) SAFE RETREAT from danger could be found only in the lofty branches of trees, and one of the cubs' first lessons was in climbing. Experience is the road to skill in this well-known feat of bears, and Mother Goofy was not content until the quads were as much at home in a tree as on the ground. They must learn which trees not to climb, for dead trees are not safe. Nor can a bear climb a sequoia. The author has seen this fact dawn on cubs as a rude awakening, when their claws tore loose from the soft bark and they fell in a bewildered heap

(Right) BEARS DO NOT HUG a tree but climb with their claws like a cat. The sharp, curved claws dig into the bark going up and act as brakes on the descent, which is tailfirst.

Once out of the den, bears no longer use it as living quarters but make their home in the forest at large. When the melting snow exposes the den, they would be at a distinct disadvantage in its confining quarters if attacked by a larger bear

THE PHOTOGRAPHS shown here were all taken without a telephoto lens and required a very close approach to the bears. "Here the inordinate curiosity of the bear is of very great assistance," writes Doctor Kinney. "Cautious, unhurried movements and a calm voice—I constantly talk to the animal—often make it possible to get within range. More often than not a bear will snort and puff, chop his jaws and even make an incomplete lunge toward the intruder. At such times only experience will tell when the bear is bluffing or when he means business. If he is bluffing and you stand your ground, the bear will do one of two things: he will lumber off, or he will tolerate the intrusion and calmly resume his activity. Only then is it safe to bury one's face in the hood of a Graflex camera, for on the ground glass distances are deceiving, and it is extremely disconcerting to raise your eyes suddenly and glare into the face of a large bear."

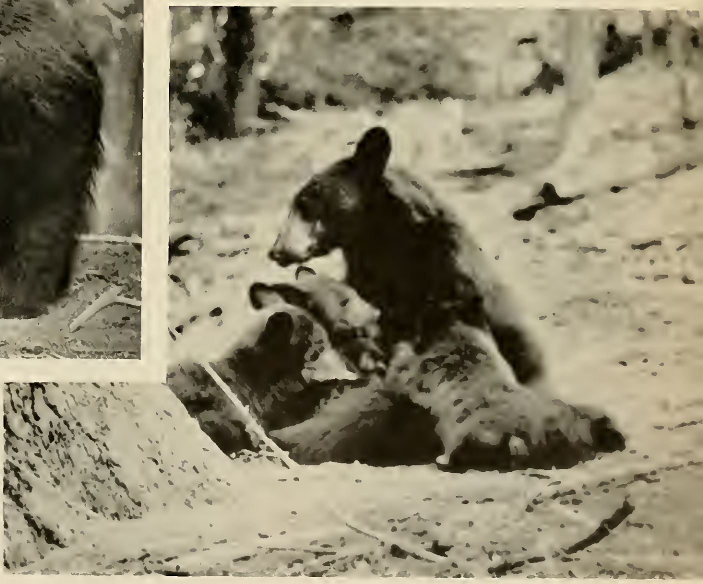
(Below) LEARNING TO FORAGE. **In August the cubs were old enough to eat solid food, although they still depended largely upon mother for regular nursing. From their independent and often arrogant manners it was evident that they felt quite grown-up. In search of grubs, they tore rotten logs apart with their strong claws, and in the meadows they dug bulbs and sweet roots. They seemed to revel in the sport of tearing open the sticky, pithy cones of evergreens. Berries ripened, and the cubs ate great quantities. Bees and wasps were to the quads what ice cream is to a boy**

(Above) Mother always stands between cub and intruder. A wise man respects this unwritten law of the forest, for a mother bear is easily annoyed. In spite of her clownish temperament, Goofy with four cubs instead of two was no exception.

Each week the quads grew larger and stronger, and their knowledge increased. When they became weary, they climbed into a tree and slept

(Below) Sparring in a forest clearing: two lightweights with heavyweight possibilities. A moment later the cubs were locked in each other's arms, rolling in the duff

An anxious mother waits for her family to catch up



(Right) Conventional nursing posture: Mother bear with three hungry cubs. With head erect, the mother can spy approaching foes

Obliged to accommodate four cubs instead of the usual two, Mother Goofy was faced with a problem. But Nature had provided amply, and a meal could be served to all the quads at one "sitting." Goofy was forced to recline as shown. Each cub had its own feeding station. The runt stood on her arm.

While feeding, black bear cubs hum and sing a contented song, which starts softly and gains volume as stomachs fill. The song, like the buzzing of a swarm of bees, has more than once led the author to the scene of photographic possibilities.

When Goofy tired of the camera, she rolled over and stood on her feet without so much as a warning grunt. Cubs fell like leaves in autumn, and Goofy marched toward the photographer, clearly showing that she meant business. Doctor Kinney withdrew, but he had secured the only pictures ever taken of a mother bear nursing four cubs

(Below) With stomachs full, the quads drop off to sleep. But Mother stays on guard as long as they are on the ground

GEM FOR OCTOBER

October's child may treasure an imprisoned rainbow, or choose from many harmonious colors offered by the sturdy tourmaline

By Frederick H. Pough
Acting Curator, Geology and Mineralogy, The American Museum of Natural History

The strongest, most harmful, and least sensible of all gem traditions is probably the most modern in origin. When Sir Walter Scott dressed his mystic Lady Hermione with an opal in her hair, in *Anne of Geierstein,* he did that most beautiful and individual of gems a disservice from which it has never recovered. Because Lady Hermione came to what appeared to be an unhappy end, the superstition has arisen, and seems to be believed by many otherwise normal people, that opals bring bad luck. Probably nothing could have been further from Scott's mind, but apparently there is no other explanation for the modern superstition.

In the Middle Ages opals were believed to be valuable in treatment of the eyes. Opals were associated with thieves, because they were thought to have the power of making their wearers invisible. Blond girls wore them to preserve the coloring of their hair. Fairly abundant in the Middle Ages, these delicately tinted stones were known to many since they had a European origin. Unlike most of the early gems they came, not from the far away Orient, but from near by, in Czernowitz, Hungary. They are fragile, however, and it is possible that the modern superstition arose in part from their susceptibility to fracture.

Opals have the most brilliant and wonderful coloring of all the gems,—the fire of the ruby, the cool greens of the emerald, and the rich blues of the sapphire. Yet this gem owes its color to no impurity; no trace of another element adds to its charm. Opal is composed of pure silica and water; chemically it is much like quartz, except for additional water and the fact that it is not crystallized. Its beauty can be attributed to that very fact, for in place of the regularly distributed and fixed proportions of silicon and oxygen of the quartz, we have a sort of solidified gel, composed of layer after layer of slightly varying proportions of water and silica.

No certain explanation of the color play of opal has been given. Once it was thought that the layers were separated by microscopic cracks which broke up the reflected light rays. For we know that the color does not lie in the stone itself, but arises from a separation of the infinite number of differently colored rays that make white light. Light transmitted *through* an opal shows its true color to be gray or orange, or it may be colorless. Other theories of this interesting color play agree that the microscopic cracks developed but suggest that more opal material, which bent light slightly differently, later filled in the spaces. Some scientists think that the superimposed layers simply break up the light, without requiring filled or unfilled fractures in the stone. Still another suggestion holds that precious opal formed as a replacement of some other mineral and that some of the crystal direction lines of the original mineral are preserved in the opal, producing its fire. But no one knows. Science is still baffled by this unique gem.

All opal—a common mineral—does not have the fire of the precious opal. Sometimes it is drab yellow, white, brown, or colorless. Often it replaces wood or shells, forming fossils of precious opal, which are found in Nevada and in Australia. Another variety of opal, known as fire opal, has little or no internal color play, but it does have a rich orange color. Because opal is a gel containing water, it may dry out, contract, and crack in the dry air of our heated homes. Since it also is not hard, opal jewelry should be treated with care.

Pliny tells a story of a Roman senator, Nonius, who had an opal which Antony desired. Because he would not give it up, he was banished from Rome and his possessions forfeited—but he kept his ring. Modern mineralogists do not think it was the same stone as that which we today call opal. What it may have been has not been guessed. Though adversity came to Nonius, he could not have thought the opal unlucky to have sacrificed so much to retain it.

Photo by B. M. Shaub

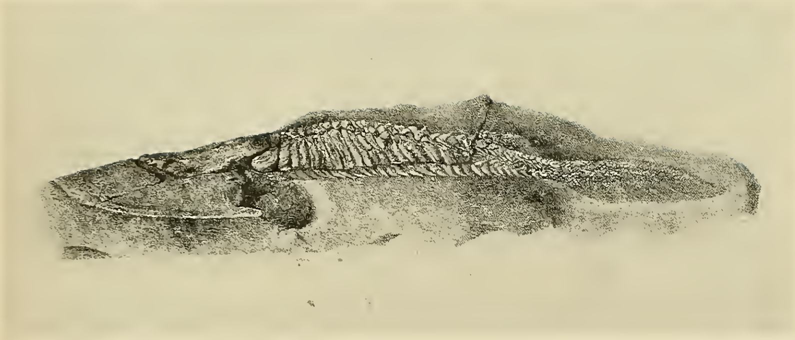
A tourmaline crystal, with quartz, from Pala, California

A realistically carved turtle, in opal from Australia

AMNH photo

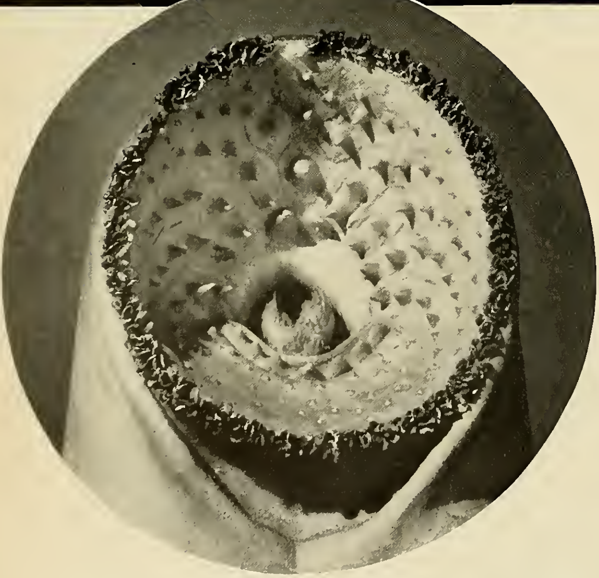
An alternative and sturdier stone, the tourmaline, has been accepted by jewelers for this month as well. This is an attractive mineral which comes in many colors, and a single crystal often shows more than one hue. A variety with a green skin and a pink center is known appropriately as watermelon tourmaline; but other tourmaline crystals change color along their length instead of outwards from the center. The gem is a complex silicate of boron. Found in many places where the rocks are old—in once deeply buried formations that now reach the light—tourmaline, like beryl and topaz, forms in rocks which once were molten, deep below the surface. The best stones today come from Brazil, where most of the crystals are green; others are found in Madagascar, South Africa, Maine, and California, in almost every color and shade.

Those born in October who want some particular color in a birthstone can often find it in the tourmaline; but should they desire every color at once, a tangible rainbow, then only opal can please them.



(*Left*) "GRANDFATHER" of 50,000 species of living animals and countless extinct ones: the 400 million-year-old "shell-skinned" fish, Cephalaspis. Its ground plan is seen to develop through successive evolutionary stages to provide the complex bodily features of all the modern fishes, amphibians, reptiles, birds, and mammals

After Lankester



(*Above*) ANOTHER LIVING FOSSIL descended from Grandfather Fish: the lamprey, front and side. Its efficient suction disk has permitted the lamprey to survive down to the present day in spite of its refusal to adopt a modern body design. Lampreys are sometimes popularly called eels, but in the tree of life they are farther from eels than eels are from man

Twenty-four centuries ago, the Greek philosopher Anaximander said that men were first produced in fishes and when able to help themselves were thrown up to live upon

GRANDFA

By WILLIAM K. GREGORY

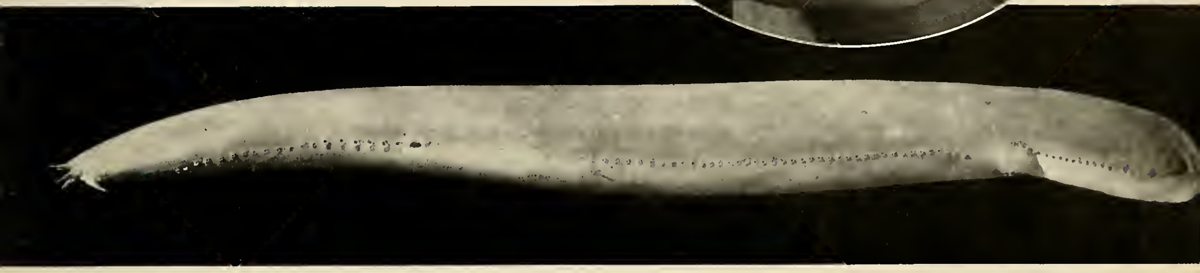
Curator, Departments of Fishes and Comparative Anatomy, The American Museum of Natural History

GRANDFATHER FISH lived so long ago that his personal history might seem to be of small importance to his remote descendants. Very few of them have ever heard of him anyway, and if they did they would promptly disown him. The very idea that man has been derived from a fish might seem to them even more fantastic than that man's ancestor was a monkey.

In this article we are not attempting to set forth the evidence for the reality of Grandfather Fish, for that evidence is scattered among thousands of facts and recorded in hundreds of books and papers. Neither are we assuming momentarily an improbability merely to lead to something better. We are only trying to sketch the introduction to a factual history covering several hundred million years in the transformation "from fish to man."

(Right) A VAMPIRE of the sea with an illustrious lineage. The modern hagfish is a "die-hard" that retained many of Grandfather Fish's basic features and survives today as a veritable living fossil. It lacks the true jaws of modern fishes and uses outmoded pouch-like gills. In place of a backbone, it has an elastic notochord. But it has developed a full kit of burglar tools for rasping a hole in the body of a fish and sucking out its blood. The portrait shown is from a model on display in the American Museum of Natural History. Directly below is a side view of the same creature

All photos by AMNH



the land. Modern science, piecing together the factual story, finds that this ancient theory was surprisingly farsighted. Here the celebrated author of *Our Face from Fish to Man* tells the first chapter in the evolution of backboned animals. Other chapters on the history of animal life in North America by various authors will appear in future issues

THER FISH and his descendants

Before we begin that history we must glance for a moment at its sources and documents. Broadly speaking these are: (1) paleontology, or the science of ancient life; (2) living animals, their zoology, embryology, and comparative anatomy, and (3) such newer sciences as experimental biology.

As to the documents of evolution, confusion has sometimes come from the very wealth of the evidence. There are estimated to be over 50,000 known species of backboned animals still existing, and if the known fossils are added, the number becomes even more bewildering. But there are easily available clues to this labyrinth.

Every beginning student in zoology is taught the rudiments of the classification of animals. He is expected to know that the smaller divisions, such as varieties, subspecies, and species, are combined in an ascending scale into larger groups called genera, and that these in turn are built up into progressively wider and more comprehensive assemblages called families, orders, classes, superclasses, and phyla. But what the student may not realize is that any individual cat, for example, besides being a sample of the species, also has the physical characteristics common to all members of the cat *family*, and, in decreasing numbers, those of the *order* of carnivores, of the *class* of mammals, and of the *phylum* of vertebrates. As a rule the popular mind as recorded in common speech thinks of one thing at a time and has a special name for it: cat, dog, bear, skunk, etc. And among specialists the idea has gained credence that the most important kind of knowledge is that which expresses the finer differences between different varieties of the same general kind. But when we study individual animals as representatives of larger groups, we find that the characteristics common to a broad division of animals, such as a class, are mostly older in the evolutionary story than those of the smaller division known as the family, and that the latter are in turn older than those of the genus, and so on down to individual peculiarities. This is like saying that the human race as a whole has had two arms and two legs for a long time, but that the peculiar chin of the Jones family or the red hair of the Smiths is not an ancient or fundamental feature of the human race. The remains of ancient animals dug up by fossil-hunters show that the same principle holds true in the tremendously long story of animal evolution.

Thus the classification of living animals into broad and narrow divisions gives a fairly clear indication as to which characteristics are older and which are younger, and provides a helpful key to the history of animals, especially when used in connection with the fossil remains of the animals themselves.

The chart occupying the center spread of this issue of NATURAL HISTORY shows the important position that Grandfather Fish holds in the history of evolution. This chart will be found useful in connection with other articles that will appear in NATURAL HISTORY dealing with other chapters in the story of the origin of our animal life in North America. Here only 81 animals have been selected from the thousands that have made their appearance along the stream of time, but these few samples represent most of the main divisions of animals concerned.

The broader lines of descent and relationship are shown on the chart by the main branches and by the larger lettering. How have we discovered these lines? They are gradually coming to light as almost unexpected by-products of the exploration of hundreds of localities yielding fossils in many parts of the world. Nobody, for example, dug fossils anywhere with the purpose of proving that the most ancient and primitive fishes were the ones known as the ostracoderms, or "shell skins." Indeed, these shell-skinned forerunners of the true fishes were long thought to be "specialized and extinct side branches" of the supposedly unknown ancestral stock of the vertebrates. But, thanks chiefly to the later explorations of the Danish East Greenland Expedition and to the intensive work of Doctor Stensiö of Stockholm, it is coming to be realized that the ostracoderms as a whole have the basic requirements for this key position in evolution. This means that we may properly search among them for Grandfather Fish,—the type of fish that is responsible for all the hosts of backboned animals that today inhabit the land and waters. With regard to the many intervening types of vertebrates, whether or not we know their *exact* ancestors and descendants in each case, we are getting better and better evidence of what led up to them and where they belong in the general sequence of events.

Finally, we have certain animals on earth today that are conservative "die-hards,"—"living fossils" which have lagged behind their progressive relatives and retained for our inspection much of the internal ground plan of their remote ancestors. Among living creatures, the lampreys (often wrongly called eels) preserve the basic features of the ostracoderms. For example, they have no true jaws of the complex type presently to be described, and their gills are pouch-like. Also they have a large elastic rod along the back, known as the notochord, which all backboned animals possess before birth but discard for the more rigid and serviceable backbone. Therefore, though the lampreys are millions of years removed from Grandfather Fish, they are classed with him and the ostracoderms, under the superclass Agnatha (jawless).

Grandfather Fish seems to have fed on small living things, probably by sucking them into the mouth slit by a pumping action of the throat. But his descendants, the lampreys and hagfishes, attack other fishes, hanging on by a horny sucker that is armed with sharp thorns, and rasping the flesh of their victims with their thorn-studded tongue.

While the earlier ostracoderms fed on small creatures or floating organic particles, all their principal descendants later attained a predatory or robber stage. Some never got further, others pushed on to become quiet vegetarians. Jaws, it may be noted, were primarily organs for seizing and biting living prey, and all the backboned animals above the ostracoderms and lampreys are frequently grouped together into a superclass called "gnathostomes," or jaw-bearing vertebrates. In spite of this classification, at least some ostracoderms (for example, Pteraspis) had a jaw-like bone in the lower margin of the mouth and a firm palate against which it could work.

In these shell-skinned ostracoderms the head and forward part of the body were usually covered with a shelly case. How did this condition come about? The physiologist Homer Smith has put forward an ingenious and highly plausible theory, as follows. When the still more remote and as yet undiscovered vertebrates came up out of the sea into the rivers and lakes, their blood, or body fluid, which was nearly as salty as the ocean itself, would tend to absorb the fresh water through the then naked or porous skin. Since fresh water tends to pass through a permeable membrane at a greater pressure than that of the saline blood, the fresh water would continue to be absorbed until a state of dropsical swelling would result. The proper balance for the animal was restored when its kidney tubules began to secrete an excess of calcium salts. These, being carried by the blood stream and deposited in the skin, eventually formed a waterproof armor of surface plates. Hence the building up of bumps and spikes on the surface plates, formerly regarded as a fatal specialization, seems to have been merely a stage in the evolution

Continued on page 163

The Chart

GRANDFATHER FISH AND HIS DESCENDANTS

The following is a detailed explanation of the most important groups of animals shown on the chart on the next spread. This chart outlines the evolutionary road from fish to man, as developed by Dr. William K. Gregory.

Since the period covered is about 400 million years, only the most significant steps can obviously be shown. During this long period, whole groups of animals died out without leaving any descendants to carry on their line. Other large divisions, on the other hand, continued in greater or less abundance to give us the estimated 50,000 different species of backboned animals that we have on earth today.

The chart will be found useful also in connection with succeeding chapters on the history of animal life in North America that are to appear in NATURAL HISTORY Magazine.

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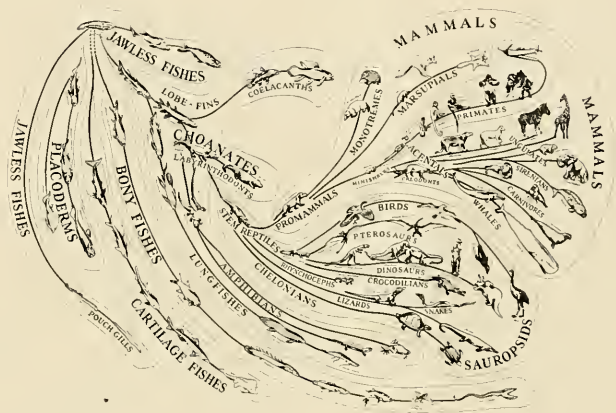

JAWLESS FISHES (Agnatha). These are the oldest and most primitive known chordates, or animals with a notochord or core of the backbone. The group includes the ostracoderms (shell skins) of the Silurian and Devonian ages and their pouch-gilled modern descendants, the lampreys and hagfishes. The casts of the internal structure of the head of ostracoderms reveal paired organs for smelling, seeing, and balancing. These collectively are included in the "basic patents" for the control system of all higher vertebrates, including man. The ostracoderms, although diversified in body, also show the beginnings of median and paired fins, and their motor units, as in higher vertebrates, are the red muscle fibers.

PLACODERMS. This large group was basally intermediate between the "jawless" and the "jawed" vertebrates. It showed an early stage in the formation of complex "gill-arch jaws" plus tooth-bearing jaw plates. The higher placoderms included the curious "joint-necks," an extinct group, mainly gigantic predators.

CARTILAGE FISHES. Sharks, rays, and their fossil relatives and ancestors are included in this group. Its members are generally primitive in their jaws, teeth, and internal organs, but the gristly state of their skeleton is now believed to be due to the retention in the adult of an embryonic condition. The sharks possess greatly developed smelling organs, while in the bony fishes *(see below)* the sense of vision is predominant.

BONY FISHES. These in the broader sense include the vast majority of still existing fishes. In the earlier forms, called ganoids, the massive scales had a thick bony base and were covered with a shiny layer of ganoin. In the modernized bony fishes, or teleosts, the scales have lost the bony plate and the ganoin, and have become thin and horny. The teleosts display the utmost diversity in body form, fins, jaws, teeth, food, and breeding habits. They are very far removed in structure and in time from the stock which gave rise to the land-living vertebrates.

CHOANATES. These include the air-breathing fishes with internal nostrils, including the lungfishes, the lobe-fins, and the ancestors of all the four-footed land-living animals, scientifically known as tetrapods. The chief divisions are:

Lungfishes. These form a side branch appearing in the Devonian and continuing up through all the ages into the existing Australian, African, and South American lungfishes. On the roof of the mouth they have a pair of dental grinding plates like two fans arranged back to back, which work against similar plates on the inner sides of the lower jaw. Their paired paddles are elongate, leaf-shaped to thread-like.

Lobe-fins (Crossopts, Rhipidists). These are the central stock of the air-breathing fishes. They have strong dagger-like cutting teeth fixed to the jaws with greatly infolded (labyrinthine) bases. The group is characterized by paired paddles which are strong and fan-like but have a tapering jointed axis.

Labyrinthodonts. These are the first of the four-footed land animals (tetrapods). Their teeth are infolded at the base as in the lobe-fins, and the skull also is similar, though it lacks the opercular bones covering the gill chamber. The paired appendages, however, have become typically five-rayed, essentially as in all higher vertebrates. The shoulder girdle is not tied to the skull. The pelvis is subdivided into three bones on each side.

Amphibians (modern). In this group are the salamanders, newts, sirens, frogs, toads, and the worm-like caecilians. Their young are hatched from eggs spawned in the water or developed in a watery medium enclosed in a leafy covering. The "tadpoles" usually have fish-like gill arches and external gills. During metamorphosis, legs sprout from within the body, and the adult animal may become either fully land-living or secondarily water-living.

SAUROPSIDS. This vast assemblage includes all the diverse reptilian hosts, together with the birds. The extinct stem reptiles (cotylosaurs) grade back almost

GRANDFATHER FISH and his descendants

By WILLIAM K. GREGORY
Curator, Departments of Fishes and Comparative Anatomy.
The American Museum of Natural History

This chart shows 81 of the most im
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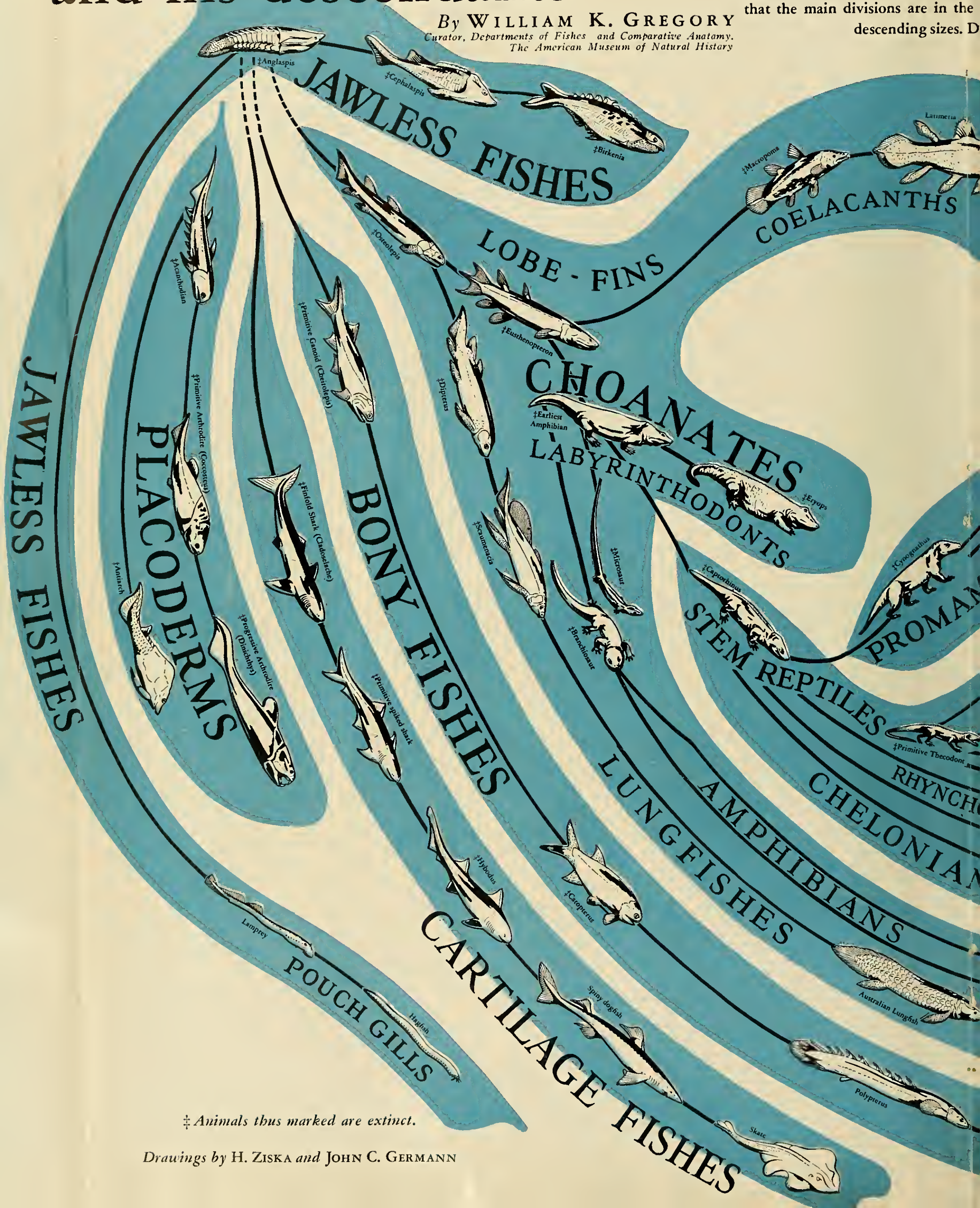


‡ *Animals thus marked are extinct.*

Drawings by H. ZISKA *and* JOHN C. GERMANN

tant animals along the 400-
differs from any other chart
thor's latest information and
rn stressing the evolutionary
ıssification of animals. Note
;est type and lesser ones in
ls on page 159

into the labyrinthodonts and forward toward the more typical saurians. In general the reptiles represent a further advance beyond the labyrinthodonts. They have succeeded in reducing or eliminating the fishlike or tadpole stage, and the eggs may be buried in the sand or hatched within the body of the parent. Devices for maintaining a more stable body temperature to resist severe changes are at best but poorly developed in the lower reptiles.

The main divisions of this group are as follows:

Chelonians. These are the turtles and their allies. They are the oldest branch of the stem reptiles. They have performed the amazing anatomical feat of developing a rigid dermal outer skeleton and at the same time drawing the top of their shoulder girdle well beneath the projecting rim of the first ribs. In the sea turtles the large forefeet have been changed into wing-like paddles.

Lizards. Though not far removed from the stem reptiles, the lizards have developed a skull in which the surface bones, especially those that originally covered the jaw muscles, have dwindled into narrow strips and bars.

Snakes. These are essentially lizards that have lost their limbs and acquired huge, loosely attached jaws for swallowing large prey. The extinct marine lizards (mosasaurs) were closely related to the existing monitors.

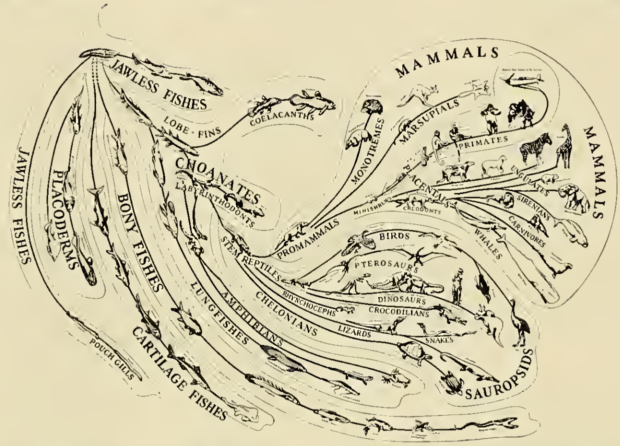
Rhynchocephs. These are represented today only by the tuatara of New Zealand. They were an early side branch equipped with somewhat rat-like front teeth, and are related to the lizards on one hand and to the stem of the dinosaurs on the other.

Thecodonts. These were slender fast-running, lizard-like reptiles of the Age of Reptiles, with many skeletal features that foreshadowed the ancestors of the crocodilians, dinosaurs, and other extinct groups.

Crocodilians. Now reduced to a few survivors (crocodiles, alligators, gavials), these were once a highly diversified group. They were an aquatic side branch from the ancient forebears of the dinosaurs. Many features of the skeleton are like those of dinosaurs, but others are highly peculiar. Their skull and jaws form an exceedingly efficient springtrap for capturing fish and even large mammals.

Pterosaurs, or flying reptiles. In these animals the enormously enlarged fourth finger of each hand served as a movable framework for a wing membrane. These reptiles, although excessively specialized, were a side branch of the thecodont group mentioned earlier.

Birds. These are truly "glorified reptiles." The strong, greatly improved four-chambered heart and the presence of feathers and air sacs enables a high body temperature to be developed and maintained within wide limits.



PROMAMMALS, or mammal-like reptiles. The earliest of this series were small, lizard-like offshoots of the stem reptiles; but as we follow the history of the group, many of them became swift-running creatures, and some gradually approached the earlier mammals in the details of their skeleton. For example, the teeth in *Cynognathus* and related forms became differentiated into incisors, canines, premolars, and molars—all adapted for a flesh-eating diet and thus foreshadowing the central group of mammals. At the rear end of the skull the joint with the first or atlas vertebra of the neck was formed by a double ball-and-socket, as in the mammals. A bony palate of mammalian type was being formed, and the limb bones were becoming fitted for swift running.

MAMMALS. In general the mammals are characterized not so much by the fact that they "bring forth their young alive" (because certain sharks, lizards, snakes, and ichthyosaurs also follow this method), but because the newborn are fed with milk from the mother's breast. Among the mammals are the following:

Monotremes. These interesting animals (including the duckbill platypus and the spiny anteater) differ from other mammals in that their eggs are not developed into young inside the body of the parent but are laid, like those of reptiles. Also the breasts are represented only by milk-secreting depressions on the ventral surface of the body. But the skin is well provided with hair, as in mammals. The popular statement that the duckbill is a link between birds and mammals is entirely in error.

Although the oldest known mammals date from the upper Triassic period (about 165 million years ago), fossil remains of this group are for the most part exceedingly rare during the greater part of the Age of Reptiles. The most conspicuous examples are the numerous and diverse fossil jaws of very small mammals, ranging from the size of those of a mouse to those of a kitten, which have been found in rocks of the Jurassic period, near Oxford, England and in Wyoming, United States.

Marsupials. Near the close of the Reign of the Dinosaurs, another glimpse of early mammalian history is afforded by discovery of a lower jaw and parts of a skull associated with the bones of a dinosaur. These represent a primitive opossum, the forerunner of the great marsupial division of the mammals, in which the young are born in a very immature condition and are subsequently nursed in the mother's pouch.

Placentals. All the higher mammals, including carnivores, herbivores, primates, and whales, belong to this division, in which the unborn young float in the interior of a membranous bag. A part of the bag, called the placenta, is in contact with the inner wall of the mother's womb. Although the blood of the mother does not pass directly through the placenta, this absorbent organ is able both to select from the mother's blood nutritive material for the growing fetus and to excrete waste products from the latter into the maternal blood stream. Partly by means of this improved method of producing high-grade young, the placentals have become the dominant group of mammals in the present epoch of earth history.

The oldest known placentals are represented by a few very small fossil skulls and jaws found in the Upper Cretaceous rocks of Mongolia. Among these are some whose teeth, jaws, and skull appear to embody the fundamental features for the rise of all the diversified insectivores, carnivores, and derived groups of the Age of Mammals.

of the outer or dermal skeleton. And, especially among the later or true fishes, there is much evidence that teeth arose from little swellings or spikes on the surface plates of the mouth and gill region.

To make effective use of its jaws and teeth, an animal must usually be able to pursue its prey. Hence all predators, at least of the vertebrate type, have a complicated system of locomotor organs, the power of which is furnished by the red muscle fibers. The beginning of contractile tissue is suggested in the jellyfishes, in which the mouth and body wall already exhibit sensitivity and contractility, which are the basis of the nerve-muscle complex. But by the time of the ostracoderms the vertebrate stock had already reached the stage in which the muscle fibers were strung in parallel series along the sides of the body. These were separated by partitions into more or less **W**- or **V**-shaped strips, called myomeres. A long series of these muscular segments was arranged on each side of the elastic notochord. But the real secret of vertebrate locomotion is found in the crossing over of certain nerve fibers from one side of the spinal cord to the other. This arrangement starts a wave of contraction that runs down along one side of the body, while almost immediately afterward another wave is started on the opposite side. In this way, the primitive vertebrate, although by no means flag-like in shape, could "wave" its way along the bottom or weave through mud, and was eventually able to swim freely in pursuit or flight.

The ostracoderms when we first find them had already attained a considerable diversity of body form, as shown in the accompanying illustrations. Broadly speaking, the most primitive form was shaped somewhat like a flattened raindrop, while one or more specialized side branches were much flattened, like a skate, and another was narrow and tending to be ribbon-like *(Pterolepis)*. In the typical cephalaspid ostracoderms the head shield was almost semicircular in outline, domed toward the center. The eyes were on top and looked like a pair of spectacles. Presumably these creatures clung to the surface of rocks or moved slowly along on the bottom. In *Birkenia*, which appears to be related to the cephalaspid stock, the body was becoming quite fish-like with the small head streamlined into it.

The interior of the head of the more primitive ostracoderms was comparatively simple in plan. There were three right and left pairs of organs for smell, sight, and the balancing sense, arranged one behind another on each side of the middle. Between them was the brain, doubtless showing corresponding subdivisions, and behind them the medulla and spinal cord. Below the brain and main sense organs was the roof of the chamber into which the mouth and gills opened. Thus we see that this lowly ostracoderm had already achieved the general pattern and arrangement of a number of important organs that have been retained in all later backboned animals, including man.

When some of the ostracoderms died, the mud seeped into the blood vessels of the head shield and followed the tunnels in the skeletal tissue left by the cranial nerves. Thus when the entire mass was turned into rock, there was a permanent record of the blood vessels and nerve tunnels. Stensiö found that he could safely identify most of these vessels and nerves by careful comparisons with the similar parts in the existing lampreys.

As already mentioned, the initial step toward the development of complex jaws had been taken by Grandfather Fish, himself, who was already using some of the upper and lower plates around the mouth as tweezers or pincers. The next great advance is seen in the Devonian period (about 300 million years ago), when certain fishes (placoderms) began to enlarge the first of the internal skeletal hoops supporting their gills, as bases for the surface jaw plates.

From the placoderm stock the foregoing "basic patent" for complex jaws was transmitted with increasing modification in detail to the cartilage fishes, bony fishes, lungfishes, stem amphibians, and higher vertebrates. Unmistakable remnants of this arrangement may be seen in the jaws and throat of the embryos of existing fishes and higher vertebrates, including man.

The ostracoderms and placoderms also show very significant experiments in the formation of paired locomotor appendages. Even in some of the ostracoderms the sides of the body just behind the head shield were prolonged into rounded lobes or projections of the body wall, which presumably were more or less movable and served somewhat like the lateral stabilizers of an airplane. When, as noted above, the kidneys secreted an excess of mineral matter, it often accumulated on the surface in the form of spikes located along the back or on the sides of the body. Behind the spikes the skin was pulled up into a sort of fin or web. These backwardly curved spikes, like the other projections, served as stabilizers in keeping the fish on its course.

Later the **W**- or **V**-shaped muscle segments of the body began to attach themselves to the underside of the spikes and fin webs. From this it was but a short step to a stage in which the spikes could be raised or lowered, thus greatly improving the fish's ability to make quick turns. This took place in a group of placoderm fishes known as the acanthodians. The earliest ones retained widely based spikes, but in later acanthodians the spikes became more and more slender, and the body elongated.

As we follow these early fishes along their predatory career, we see improvement in their machinery for attack. Thus we come to the Devonian "joint-necks," scientifically known as arthrodires. They receive their name from a useful horizontal peg-and-socket joint on either side between the head shield and the shoulder plates. When they were about to attack their prey, they raised the head and opened the mouth very wide. The front "teeth" on the larger arthrodires were somewhat like a parrot's beak. Behind the beak were shearing plates, like butcher's knives. Dr. Bashford Dean, the American Museum's first Curator of Ichthyology, with a humorous touch of understatement, said that the arthrodires were "doubtless unpleasant neighbors," especially to the fin-fold sharks (Cladoselache), which he himself made famous in zoology textbooks.

Thus most of Grandfather Fish's early relatives had the advantage of some sort of armor. As they became more formidably equipped with offensive weapons, however, and developed the ability to move rapidly, this armor was for the most part reduced or eliminated.

The story of the rise and diversification of the swarming lines of bony fishes (ganoids and teleosts) is demonstrated by thousands of fossil and recent forms. But here we must be content to say that the earliest bony fishes had bodies completely encased in an armor of thick scales with a bony under layer and a shiny surface of enamel (whence our name ganoid for these fishes, from the Greek *ganos,* shiny). The horny scales of modernized fishes are a later development.

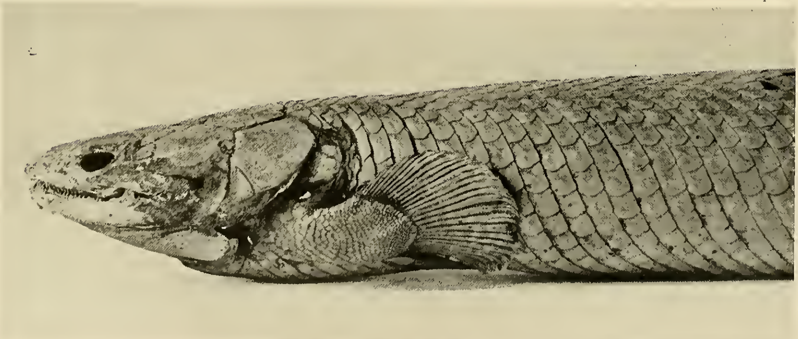
Grandfather Fish might envy the jaws and feeding habits of the bony fishes that descended from him, because they became exceedingly diversified. From a primitive stage in which the upper jaw was fixed, one can trace the changes into highly protrusile sucking jaws, jaws armed with sharp-edged sabers, massive jaws with crushing teeth, tube-like jaws with little nippers at the tip, etc. It is hardly necessary to state that the modern fishes as a whole have become very far removed from the earlier lines that gave rise to those backboned animals which established themselves on land.

The modern sharks used to be regarded as paragons of primitiveness, but it is now coming to be realized that the gristly or cartilaginous base of their skeletons may instead be only a hold-over of a normally embryonic feature into the adult stages of life. In the cartilage fishes the pectoral fins range from slightly movable, wide-based keel fins acting as elevators and depressors in swimming, to flexible paddles with a narrow wrist-like base. As the muscles in the fin bud grew upward and subdivided into a fan-like cluster, so did the bony rods that supported them. Thus were produced large fan-like fins as in the skates, in which the individual rods could be moved in sequence like the keys of a piano.

As long as fish remained fish, their opportunities for invading the land were quite limited; and only a few forms of present-day fishes venture to risk the traditional fate of a "fish out of water." This undertaking was successfully achieved some 300 million years ago, however, in one of the most dramatic and far-reaching events in the whole history of life. The modern fishes which temporarily manage to live on land include the famous mudskipper, the tree-climb-

PROTECTION is afforded our surviving ganoid fishes, like those of the past, by their hard, enamel scales *(below)*. Most modern fishes, on developing offensive weapons and rapid movement, adopted more delicate ones. This is the famous *Polypterus* of Africa

AMNH photo



ing fish *(Anabas)*, and certain eels and eel-like fishes. Suffocation in air has been avoided either by developing an accessory enclosed gill chamber with a supply of oxygenated water, as in the labyrinth fishes, or by the further development of the lungs. These were the birthright alike of the lungfishes and the lobe-fins.

The early lungfishes were well equipped to burrow in mud and thus survive seasonal droughts, as their descendants still do in central Africa. But they never developed strong limb-like paddles, and in the later lungfishes the paddles have been reduced to long threads. In our search for the forerunner of the first land animals, the evidence leads up to the air-breathing lobe-fins; for they alone have the right combination of characteristics to give rise to the severally distinctive patterns of skull and skeleton found in the earliest amphibians.

We are speaking of very remote time, but even so, we of today have a link with that distant era before the backboned animals came out onto the land. A very specialized side branch from the lobe-fins were the coelacanths. The last of the coelacanths, it was formerly thought, perished with the dinosaurs at the close of the Cretaceous period. But in 1938 some fishermen who were trawling off East London, South Africa, hauled in a strange-looking five-foot fish. After careful study by Dr. J. L. B. Smith, this was proved to be the only known living descendant of the coelacanths.*

The oldest lobe-fins of the mid-Devonian had pectoral fins of the fringe-finned (crossopt) type with a jointed axis and delicate side rods; but the more advanced Upper Devonian fish known as *Eusthenopteron* had broad, spreading pectoral fins, supported by a strong skeleton *(see drawing)*.

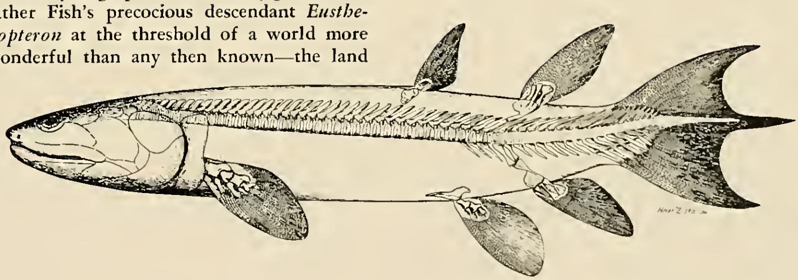
But exactly *how,* the reader may well ask, were the flexible paddles of the air-breathing lobe-fins able to bear the weight of the body on land, which eventually became perhaps their foremost duty? After several years' study of the fossil and anatomical evidence, my colleague, Henry C. Raven and I have ventured to put forward the following partly new theory. As the paddle became bent at the future elbow and wrist joints, its bones gave rise directly to the three arm bones—humerus, radius, and ulna—and to the central carpal bones of the hand. The bones corresponding to the ones farther out on our hands, on the contrary, seem to have come from new buds from the rear border of the original paddle bones, as indicated in the individual development of the living newts and salamanders. The horny rays of the fin must have diminished and finally disappeared, as they did in the lungfishes. Meanwhile the muscular lobe of the paddle grew outward and subdivided into the muscles of the hand. The rear paddle became modified in much the same way.

Thus *Eusthenopteron* stood almost at the threshold of a far greater and more diverse world than any that he or any other water creature had ever known. For when his descendants began to push their frog-like snouts up on to the river banks, our ancestors were taking the initial step toward the conquest of all the lands.

[*The epic story of the rise and evolution of our four-footed, land-living animals will be told in successive issues of* NATURAL HISTORY.—ED.]

*See Edwin H. Colbert, *"A Fossil Comes to Life,"* NATURAL HISTORY, *May, 1939, p. 280.*

PADDLE-LIKE FINS for "walking" on mud and the ability to gulp air occasionally put Grandfather Fish's precocious descendant *Eusthenopteron* at the threshold of a world more wonderful than any then known—the land



NO WONDER THEY

By Margaret Lantis*

All photographs by the author

From Alaska to Greenland and Labrador, over a range longer than from Oregon to Maine and Florida, the Arctic coast is inhabited by "the eaters of raw meat"—the Eskimos. They might reasonably be referred to as the eaters of raw seal, for without this animal, most of the Eskimos would have to leave their homeland or die. Not only do they depend on the seal to a vital degree for food but for important items of clothing and innumerable implements—indeed, for almost every imaginable necessity from boats to "windowpanes."

Some Eskimos rely more upon the seal than those of Nunivak Island, some less. This community is portrayed here because it shows many of the characteristic ways in which the natives of the North weave their lives inseparably with the seal.

Where there are more seals you are likely to find more people, and here you have the town of "More People," Mekogoyuk in the native tongue, where the author lived for eleven months in 1939-1940. The dwellings are not snow igloos, for the Alaskan Eskimos have never seen them in their region. They are the half-underground log and sod houses, to which the isolated Nunivak Islanders

Kangalik carefully noses his one-man boat onto the beach of fine sand after two months of seal hunting at a spring camp with three other men. He pulls himself up and out of the circular hole in his decked-over kayak and steps out into the water. Then he fairly stands on his head as he reaches back into the stern to pull out what looks like a baby blimp but which proves to be much heavier than any air-filled sack. It is the whole skin of a seal—a "poke"—, filled to bursting with seal blubber, the fuel for many a cold day or warm meal.

A man runs down to give him a hand, and a swarm of children gather around to ask questions and hear the newsy answers. "No, Kusauyak and his wife are coming in tomorrow. Get that kayak-sled over there. We will put the poke on it. Ayagaktok killed five full-grown bearded seals. Fine! He is Best Hunter this year."

With this scene you have witnessed a crucial chapter in the strange chain of events that links the Nunivak Islander to the seal and thus to life.

The outsider wonders why Kangalik mentions only the five bearded seals and not the total of 22 seals of all kinds that Ayagaktok brought in. But that is the way on Nunivak. Each hunter is rated according to his catch of full-grown bearded seals, and the scores are known to all, like the goals of a polo player.

Carrying it like a stretcher, the two men lift the little sled with its big burden of seal oil and carry it to a storeroom, a log house half underground and covered with sod.

It takes Kangalik more than an hour to dispose of two more pokes and a surprising assortment of goods. No wonder the kayak almost had its sealskin decks awash: cooking and eating utensils, extra water boots made of sealskin, rain parkas made of intestine casing, fancy bag for personal belongings, made of whole sealskin, fur outside, and on the deck of the kayak an array of spears, harpoons, and other gear for hunting the seal.

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*When Margaret Lantis undertook to live for eleven months with the unspoiled Eskimos of Nunivak Island, she went as an anthropologist to a region which is scarcely known even to the professional scientist, not to mention the general public. Her background includes a previous visit to the Aleutian Islands and teaching experience at the University of California, where she received her training.

Of her experiences among the Nunivak Islanders, who have not been degraded by contact with "civilization," she writes: "My life there was so delightful that I want to tell all those people who have winced at the bestiality of the Eskimos in de Poncin's *Kabloona* about the charm of my Eskimos. When the Eskimos have security in the form of plenty of seals, and when their games and ceremonials have not been torn from them by encroaching civilization, they preserve an altogether admirable dignity and self-reliance. They have the interest and patience to carry on the old-time activities of their distinctive life even when these are laborious. Especially on Nunivak has the fullness of the old culture survived. Most of the population is still unable to speak even a pidgin Eskimo-English. The people are still using a wealth of ancient tools and doing beautiful carving; and the men's ceremonial house is daily in use as of old."—Ed.

WORSHIP THE SEAL

in Bering Sea still cling despite the introduction of civilized huts in many other Alaskan villages

(Above) A PORTION of near-by Nash Harbor Village, where the Eskimos likewise still live underground where they can keep warm. The log huts are all storehouses

(Above) A LIVE BABY HAIR SEAL delights the hunter's little sister when he brings it home from his spring hunting trip

The greatest activity in the hunting cycle is shown in the spring, when the break-up of ice calls every able-bodied man on the island to match his skill, strength, and supernatural power with his honored adversaries, the seal and walrus. For many weeks the hunter and his wife have been preparing for this heavily ritualized and emotionalized hunting season.

Finally the weather is right. Fasting and bathing ceremonially, the hunter puts on all his amulets and charms to give him power, dons a new waterproof parka and a large sacred wooden hat painted white and blue, with ivory decorations. He takes down from its rack his sealskin-covered kayak, which bears the painted blue figure of his protective animal, possibly a cormorant, sea gull, or mink.

Carefully he loads the slender one-man boat with all his gear. Even the narrow deck is piled with equipment: six-foot ice cutters and ice hooks to manipulate the kayak among the broken ice, meat hooks, harpoons, and spears, and a little board for throwing them, a great coil of harpoon line made of seal rawhide, and inflated floats made of whole sealskins. Finally he puts the sled on the kayak and is ready for either water or ice. In the water, the kayak carries the sled; on the ice, the sled carries the kayak.

After still more ceremony, including a food offering to the sea, the hunter shoves off, and his wife and children watch the white and blue thing disappear into the white of the ice and the blue of the sea.

The few weeks of feverish hunting before the ice entirely disappears yield the great store of niceties and necessities without which life would be impossible on Nunivak. With luck there will be quantities of meat, raw materials to clothe the family and fashion into new hunting equipment, and sea oil that can be burned in pottery lamps.

The Nunivakers utilize all of the seal except the grunt and—strangely enough—the bladder and bones. With natural reverence for anything so important in their lives, they fear the souls of the animals they kill, honoring the bones and the bladders (the seat of the soul) with sacred rites.

THE STAPLE FOOD of the Nunivakers is a little silver gray variety of hair seal *(above)* and a larger spotted hair seal *(right)*. Here the skin has been cleaned and stretched, ready to be softened by scraping and rubbing and made into clothing. Through the cold season the seals can be frozen solid like the one at upper left, to be used when the need arises

One village of 135 catches 600 or more seals each year, while a maximum of only about 35 walruses will be obtained by the whole island. The seal alone gives a dependable food supply, though there will occasionally be a sperm whale, killer whale, sea lion, dogfish, polar bear, or at rare intervals a bowhead whale

AS FAST AS the seals are caught, work proceeds rapidly at home. All the flesh of the little gray seal is dried in one piece as shown at left. The Nunivakers eat every morsel of meat, brains, eyes, heart, and liver

(Right) THE SKIN, still whole, is turned inside out, cleaned, and inflated. These seal pokes will serve as containers for that important commodity, seal oil, or as floats on the harpoon lines, to keep the captured animal from diving

(Above) A FAMILIAR SIGHT on Nunivak. Suggesting an elaborate sort of bagpipe and giving forth musical tones like a marimba when knocked together by the wind, these objects are in reality seal stomachs and esophagi, inflated. Like sealskin exposed similarly, they bleach to a beautiful snowy white when frozen in very cold weather. They will be used for trimming clothing and fancy bags

(Above) A SEAL INTESTINE inflated in the sun. The intestinal membrane of the seal or preferably the walrus is used to make waterproof clothing. Stretched above the intestine are sealskin harpoon lines, strung out to dry, with which to catch other seals. The lines are cut in a continuous spiral from a whole sealskin

(Above) RAIN, WIND, AND THE WAVES will be thwarted by this jacket made of intestine casing. The back of the parka is shown by a young lady who was too curious to stay hidden. It is decorated with red dyed dog hair and white tabs of seal esophagus

THE RAIN PARKA, tied tightly around wrists and waist, gives good protection also from the icy water when the fisher sets out his salmon trap—and sits on it

BLEACHED WHITE by frost, long strips of sealskin form a pleasing pattern against a darker background above a border of fringed seal fur. Beyond can be seen kayaks and on one of them the kayak-sled mentioned earlier

(Above) A WHOLE SEALSKIN is needed for each pair of women's boots, but the Eskimo boots above are dolls' miniatures. The woman's pair on the left, shorter than usual, is of gray seal, with reindeer trimming. The man's pair, waterproof, is of scraped sealskin, with bleached seal-throat borders. The black object is a large woman's-knife with rubbed slate blade, one of the main tools used in the manufacture of boots

(Above) LATEST STYLES in gentlemen's boots: models recently copied from the Norton Sound Eskimos of the mainland. A former seal poke, thoroughly saturated with oil and therefore highly waterproof, forms the uppers of the long ones. The soles of this pair are of bearded sealskin. The smaller ones have uppers of reindeer and beaver

(Below) YOUNG HARRY'S sealskin parka and boots are the worse for wear, for his stepfather is poor, but he can smile, for he is the best swimmer among the boys and one of the most promising ivory carvers

LITTLE FELLOWS playing outdoors all day in the snow need high sealskin boots. The mittens here are made with the fur on the inside

(Left) Rare is the garment that contains no product of the seal. Even these reindeer parkas have gray seal cuffs. Note that women's parkas are always curved up the side, whereas men's are straight around the bottom

To capture the seal the Eskimo must become something of a seal himself. He invades the seal's domain in a remarkable boat made of the skins of seals previously caught, stretched over a frame of driftwood. At right is seen one of the skins, scraped and being bleached as a future kayak cover

(Below) The decks and hull of the completed boat glisten in the sun, for new kayak covers are beautifully white and clean, which incidentally pleases and attracts the seals. Seated snugly in the circular opening, the paddler becomes part of the boat, a fit adversary for the animal he hunts. In some sections, kayakers turn themselves completely upside down in their sealskin boats and right themselves without mishap

(Below) Another important use for the intestinal membrane is as a "windowpane," as shown in the skylight of the typical underground hut. Much light shines through the translucent material to the underground dwelling, yet it is wind and waterproof

With these and a multitude of other things in daily use, the resourceful Eskimo converts the seal to his comfort and need. Is it any wonder then that the Nunivaker has a reverential respect for the animal and gives its bones a decent burial as for a man. Religious emotion reaches a peak in a great festival held each year in honor of the seal souls.

In late December after nine or ten days of solemn preparations, including the composition of new songs, carving of new feast dishes, and completion of new clothing, the ceremony begins. The bladders of absolutely all the seals caught during the year are brought into the men's ceremonial house and hung from the roof. The soul of the seal, still in its bladder, is entertained. There are five days of singing and feasting. Ancient masks made of real animal and bird heads are worn, and the actors impersonate the spirits of the bearded seal, which come to frighten the little children.

On this last evening, when the spirits are called up, the year ends, and the bladders (that is, the souls) are put down under the ice to return to the seals' villages under the sea.

The seasonal circle is completed, and there will be hope for good hunting next year.

FEATHERED AIRMEN *of* MIDWAY ISLANDS

By THOMAS M. BLACKMAN

All photos from Three Lions

THE TRAVELER who sees the albatross at Midway Islands has progressed far beyond the Ancient Mariner in mode of travel, for these tiny specks in the Pacific are a stopping place on the clipper route from Hawaii to the Orient. The black-footed albatross or "black gooney" itself resembles an airplane in landing or taking off. The bird glides slowly down with tail spread and feet wide apart to insure good balance. Even so, an unsteady wind may topple the bird over before it safely comes to rest

Utilizing the same tiny dots of land as the clippers which fly across the vast Pacific, a multitude of beautiful birds add interest to the wayfarer's visit on these lonely airway outposts

RIGHT in the center of the northern part of the Pacific, and a few minutes east of the International Date Line, lie Midway Islands. The two islands, each approximately two miles in greatest diameter, rise a few feet above sea level and are composed entirely of coral deposits.

Sand Island, the more westerly, is densely covered almost throughout with a bush known to the residents as beach magnolia *(Scaevola frutescens)*. This is the only plant of much size, except for some groves of ironwood trees *(Casuarina equisetifolia)*. Inland on Eastern Island the ground is generally much harder, and wherever the scaevola bushes are not too dense, it is covered with a variety of low plants and grasses.

Midway has received protection for birds during the past few years which has made it a veritable paradise for its feathered inhabitants as well as for the bird student. Cats and dogs are entirely absent, as are rats or other destructive vermin.

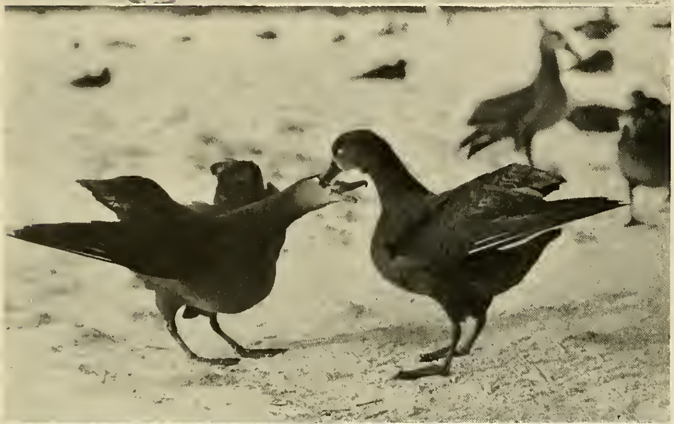
This protection has meant the survival of two land birds which were introduced in recent years from Laysan Island, 400 miles to the east, and have since become extinct there. These are the so-called Laysan finch and the Laysan rail. They are the only true land birds of Midway, except the introduced yellow canary, and they are found nowhere else in the entire world.

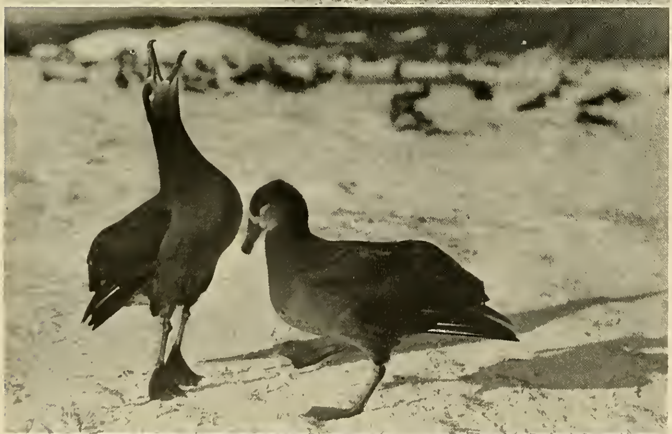
On visiting for the first time these remote islands, inhabited for many thousands of years by birds that until recently did not know man, one finds their tameness or unconcern most striking, a situation that might be expected in a fairy tale or imagined in a dream. You have the novel experience of seeing birds as large as the albatross remain still until you approach within a pace or two. And then, apparently even more inquisitive than yourself, the bird advances nearer and looks up at you without any show of alarm.

I was fortunate to remain in this metropolis of bird life from December 7, 1939, to May 14th of the following year, a period which included the nesting season of the majority of the birds. These tiny islands are, of course, the resting place of the giant clippers of the Pan American Airways on their way from Honolulu to the Orient, and the birds of Midway are certainly one of the interesting features to be observed by anyone pausing here on this transoceanic flight.

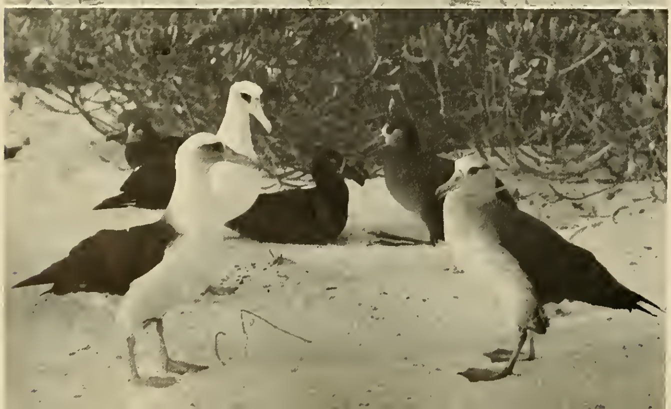
WHEN TAKING OFF, the black-footed albatross must first find a clear space and, after spreading its seven-foot wings, run for 60 to 90 feet over the ground before rising. After a few slight strokes, the wings are set for the glide upward. These birds travel great distances with scarcely a perceptible movement of the wings, taking their rest as they travel

A BLACK GOONEY comes home to her chick. The nest is a mere scratching in the sand, which when damp may be banked up to a height of several inches





CEREMONIAL "DANCE." Usually in the center of a small group of onlookers, the participants begin by bowing, crossing bills, and shaking their heads from side to side while rapidly chattering their bills. At intervals and in turn each gooney raises one wing while nibbling beneath it; and at the conclusion both birds raise their bills to extreme height and utter a loud and deep "ah." The bird often shows such enthusiasm that it raises itself up on the extreme tips of its toes. Normally the finale comes when both birds adopt the erect attitude together, each reaching as high as it can. Generally supposed to have originated as a part of courtship, this exercise seems to resemble a competitive game and occurs at all seasons ashore. Having some of the elements of fencing or boxing, the game frequently terminates in a violent squabble, with sometimes a final derisive cry from the victor as the worsted participant walks dejectedly away



TWO KINDS OF ALBATROSS and a possible hybrid. Though the two species are not known to interbreed, the coloration of the right-hand bird is approximately midway between that of the black-footed albatross in the background and the Laysan Island albatross at left. On the other hand, it may be a yearling Laysan albatross. The habits of the two species are similar. Both return to their breeding grounds about the beginning of November after an absence of about two months at sea, and both indulge in the ceremonial "dance," though the Laysan albatross does so less enthusiastically

A FALL OF SAND at the entrance to their burrows frequently traps both Salvin's white-breasted petrel *(above)* and the wedge-tailed shearwater. Both are abundant at Midway and are mainly nocturnal in habit. In the loose ground on Sand Island the burrows are often six feet or more long and sunk to a depth of two feet or more, elsewhere considerably shorter. Over much of Sand Island the ground was so tunneled with these burrows that the author found walking extremely difficult, not to say dangerous. Even when exercising great care, one would repeatedly sink knee-deep

AN ASTONISHING scarlet throat pouch *(upper left)* distinguishes the male frigate bird in the breeding season. When distended, this brilliant adornment gives the bird a very grotesque appearance and is probably instrumental in producing the varied warbling heard when the males sit around the nests in company with the females. At such times the head is repeatedly thrown back, and a rather pleasant sound reminiscent of water bubbling mingles with other notes resembling the cooing of a male pigeon

THOUGH the frigate bird is said to be lighter for its size than any other known bird and is one of the most expert flyers, it is virtually unable to rise from the water or from level ground. The nests on Eastern Island are built on the tops of bushes from five to eight feet high. Even from this point of vantage, it was noted that the birds spread their wings carefully a few seconds before taking off, apparently waiting for a favorable air current to assist them in their rising

A BOLD THIEF is the frigate bird. Whenever it finds a nest unguarded, this pirate among birds deliberately breaks the egg and then proceeds to pull the nest to pieces, carrying the material away for its own use, until none remains

THE FRIGATE BIRD obtains most of its food by chasing and robbing other sea birds. Waylaying the returning boobies and others it gives chase and forces its victims to disgorge their hard-earned meal and shows much skill in catching a fish in its fall before reaching the water

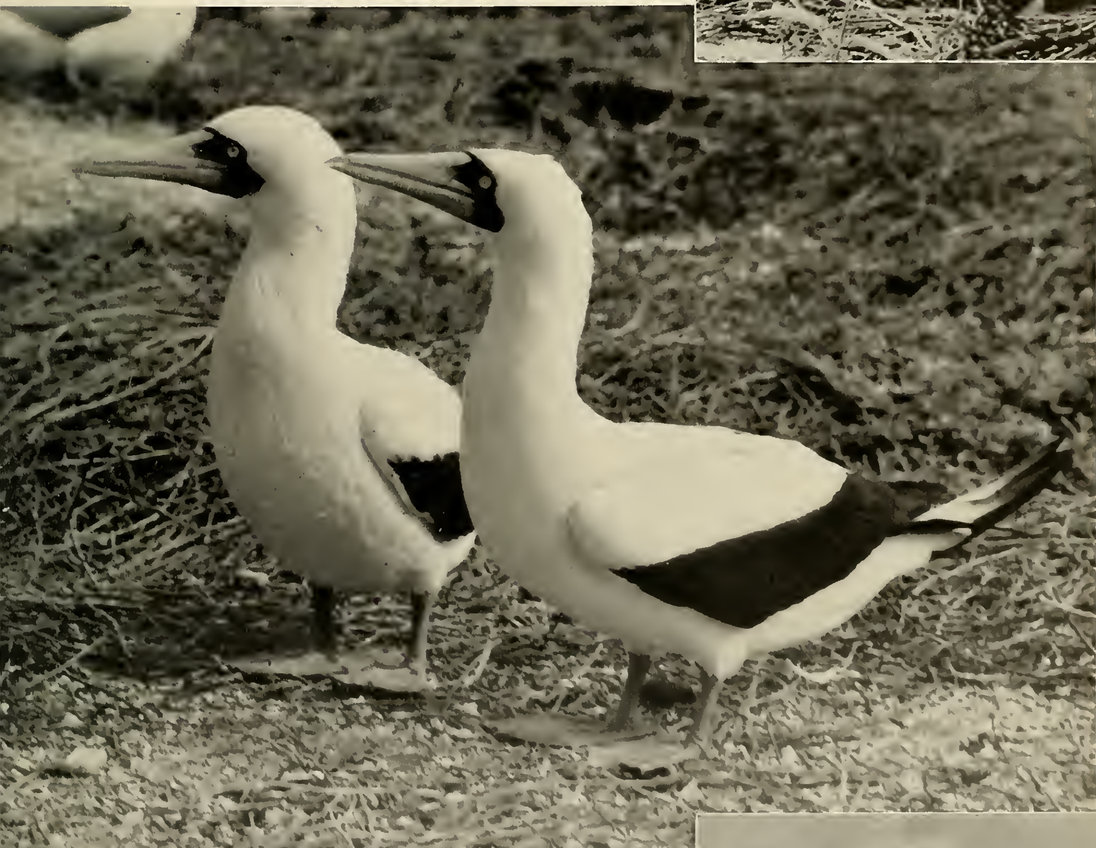
ACROBAT OF THE AIR. Especially on hot sunny afternoons, the red-tailed tropic bird, or "bo'sun bird," displays aerial maneuvers in small groups. Circling around together, one bird after another hovers with tail spread forward beneath the body and travels *backwards* three or more feet in perhaps as many seconds with vigorous beatings of the wings, then shoots ahead again.

This bird is slow and awkward on the ground, but is one of the most exquisitely colored of all birds, having satiny-white plumage, scarlet and black bill, and long crimson and black tail shafts *(below)*. The supreme touch is added by a soft rosy pink tint of the body plumage which is variable in the species and fades rapidly in museum specimens. The bird lays one egg on the bare ground beneath the shelter of bushes

VICTIMS of the frigate bird's piracy: two species of boobies. The common or white-bellied booby *(at right)*, of which this is the Pacific form, has a wide distribution in the tropical seas. This bird makes a rough nest of sticks and dead leaves on the ground beneath or just outside the bushes. It lays two eggs of a slight greenish-buff tint, incrusted with a white limy deposit. So serious are the depredations on the young, however, that no instance was observed of more than one young bird surviving beyond mid-growth.

The blue-faced booby *(below)* is a stouter bird about the size of a goose, pure white in plumage with black wing patches. Like all the boobies, it is an expert diver. It hatches its two eggs on the bare ground, with little or no attempt at nest making. Both chicks seldom reach adulthood.

A third booby, the red-footed booby, also nests at Midway. This bird is marked much like the blue-faced booby, with a broad patch of slaty gray on each wing, and red feet. It nests on bushes and gets along with one egg



(Right) FOUND NOWHERE ELSE in the world, the Laysan rail, like the Laysan finch, has survived exclusively on Midway Islands after its extinction a few years ago on Laysan Island. This bird is completely flightless and may frequently be seen to enter the burrows of petrels and shearwaters, sometimes remaining two or three minutes. This bird is inquisitive and fearless. It enjoyed drinking and bathing when a pan of fresh water was put out and refilled each day, though fresh water was never found on the island except in rainy weather

(Above) The Laysan Island finch is now abundant over the entire area of both islands and helps man by restricting the growth of an objectionable trailing plant, *Tribulus cistoides,* whose seeds are its favorite food. The bird spends much of its time searching the ground for these seeds and shelling them, for which its broad bill is well adapted. Strictly speaking it is not a finch but a member of the Drepanididae, or Hawaiian honey creeper family

The Hawaiian sooty tern, or wide-awake tern, nests in large colonies on Sand Island. The season's first were seen to arrive on February 18th, and by March 9th their numbers had increased to many thousands. Egg-laying began around May 10th. The bird lays a single large egg on the sandy ground with little or nothing in the way of a nest. Many of the birds left their eggs quickly when approached closely, but others were more fearless, and some few even advanced to attack the camera.

The male birds were often seen walking about their mates, their necks stretched forward and wings drooping almost to the ground. Frequently they would chase away other male birds that ventured too near

(Below) This is the Pacific form of the noddy tern, which has wide distribution in tropical seas. When the author visited their nesting grounds on January 7th, at which time many were found with eggs and some with young already half grown, the old birds proved very aggressive. Flying up from their eggs or young, they quickly returned to make savage swoops at his head, and more than one inflicted a cutting stab with its strong, sharply pointed bill.

The bird is fourteen to seventeen inches long and sooty brown in color, with the neck grayish and forehead light gray in the adult

WINGED GRACE. The Hawaiian tern is like a small and blacker edition of the noddy tern. Unlike the latter it makes a substantial nest in bushes or trees

(Below) WINTER VISITORS at Midway: three of the five species of shore birds which regularly pass the season in these remote islands but breed elsewhere. The bird on the left, the bristle-thighed curlew, is now known to breed in western Alaska. It is much less plentiful at Midway than the golden plover, at upper right. The golden plover comes each winter from its breeding grounds in Alaska and northern Siberia, and is distributed over the entire area of both Midway Islands. Each bird has its own hunting grounds where it searches for the insects on which it chiefly feeds. Fights of a more or less severe nature sometimes result when others of its kind encroach upon its domain

The wandering tattler *(lower right)* is slightly more slender than the golden plover, and more somber. It is seen frequenting the Midway shore line singly or with plovers and turnstones

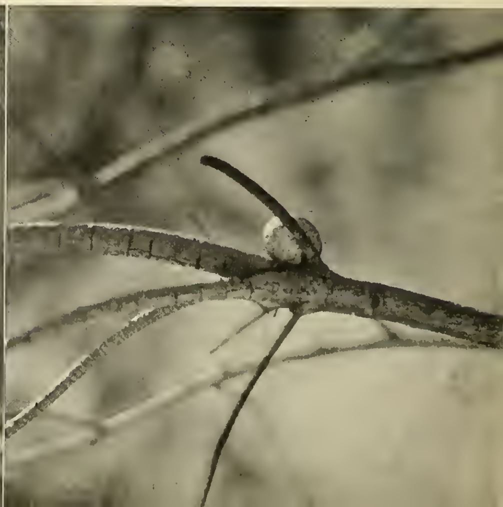
Midway's other two winter "vacationists" are the ruddy turnstone and the sanderling. All five species breed in the far north. The sanderling apparently leads the spring departure from Midway about May 3rd; the turnstones follow perhaps a week later; and the plovers and curlews hold on longer

One of the most charming birds is the white tern, or love tern, whose elegant appearance and gentle ways endear it to everyone. It has plumage of pure white, with a ring of black feathers around the eye. Although frail and delicate in appearance, the white tern is an expert flyer and travels great distances over the ocean to obtain the small fishes upon which it lives. Bringing its catch home to feed the young, it loads its bill from base to tip with two-inch silvery fishes, leaving the spectator to marvel how the last one could have been caught with the bill already full

(Below) The most astonishing thing about the white tern is its fantastic choice of a nesting site. The bird below is sitting on its egg

(Right, below) So precarious is the resting place of the egg that the parent bird sometimes dislodges it in flying away. Almost any imaginable place may be chosen, even a slight depression in a branch or a spot where the roughness of the bark will prevent its rolling. The young chick must of course be an acrobat from the moment it hatches out. It clings to the bark in the same position as the egg until nearly fledged.

The foregoing are the most important birds of Midway. Numerous yellow canaries (all said to be descended from a pair imported in 1909 and two males brought from Honolulu in 1910) and occasional accidental visitors complete the list of winged creatures which utilize tiny Midway Islands, as man has recently begun to do, as a resting place in the broad expanse of the Pacific



ATTORNEY FOR THE INSECTS

Frank E. Lutz has devoted much of his career to reminding his fellow men that they owe their very existence to that ancient and honorable form of life, the insects. As Curator of Entomology he has contributed greatly to our knowledge of their behavior by his studies in field and laboratory

By D. R. Barton

We know not what other characteristics may reasonably be expected from a blend of Connecticut Yankee and Pennsylvania Dutch, but a fusion of these hard-headed strains is apt to produce more than a match for ordinary men at the shrewd art of bargaining. A good case in point occurred in a small Pennsylvania town just before the turn of the century when Frank E. Lutz, then a student on vacation from Haverford College, was informed by his father that some sort of bug was devouring a sizable section of woodland several miles from home. Lutz, senior, who was merely Dutch, attached no special importance to this news beyond its general interest to the neighborhood. Nor did his wife, who was merely Yankee. But the double dose of shrewdness instantly became manifest in their son. He suspected "walking sticks" (phasmids) of being the flies in this particular ointment and, though he did not then know how rarely these insects gather in numbers sufficient to do such extensive damage, he had heard of a firm in New York which made a business of mounting them. Young Frank wrote at once, inquiring prices. A penny apiece was the big city's answer; the writer of the letter doubtless estimated that this country lad might conceivably earn a quarter if he worked really hard.

Frank E. Lutz

Frank worked hard all right. He had several large flour sacks and set about cramming them with the teeming multitude of six-legged pennies which abounded on every side. In fact, so great was the embarrassment of riches that he was soon knocking off a dime's worth at a clip by flailing at the surrounding branches with a stick. When the sacks were filled, he boxed and shipped them to the writer of the letter, expressing the respectful hope that the firm liked its specimens not only fresh but alive. He added that though he was sure of at least 2000, he had been unable to take an accurate count and would settle for $15.00. When the package was opened, the recipient had to clear his front office of a swarm of disgruntled phasmids anxious to stretch their 12,000 limbs after a most crowded journey. Needless to say, the man was glad to settle. He had had all he wanted of "innocent country lads." And it would certainly seem that this Lutz boy was another Abner Slick of Punkin Crick—a sharp dealer to whom everything in the world, including bugs, was a plain matter of dollars and cents.

This was, it is true, the first money Frank Lutz ever made out of entomology. Yet when he became a museum curator and acknowledged master of that science, he wrote:

"I call the insects that are living in the lot on which we have a home 'our six-footed guests.' I am supposed to have purchased the land by giving a piece of paper that entitled the bearer to a number of shiny, metallic disks; but no six-footed creature signed the transfer, and the ancestors of many of them had squatter rights here long before any man lived anywhere. Furthermore, some of them assert their rights when I plant things that suit their tastes. . . . Insects are a benefit to me because I like to watch them. If I am a benefit to them by making a nice flower bed in which they can live, so much the better." And again, "Do not think too harshly of all mosquitoes. . . . No mosquito is vicious. If she bites she bites not in anger but in hunger. I rather like mosquitoes."

Surely these are not the words of a tightfisted materialist. Rather is there a touch of saintliness, and one might even recall the Christian ascetic who willingly suffered worms to mortify his flesh, replacing them on his person if they chanced to fall off. At the very least such talk introduces a paradoxical note that seems to pervade the whole story of Doctor Lutz's career. For example, his studies have taken him to Europe, and his Museum expeditions not only to all the principal sections of the United States but to the West Indies and South and Central America as well. He has investigated the faunal relations between Florida and Cuba and shed light on the geological history of the whole Caribbean area. Yet what he himself considers his most important work was done almost entirely in the back yard and cellar of a prosaic suburban house a few miles outside of New York City. Equally arresting is the fact that he came to the Museum as an entomologist without formal training in that subject beyond an elementary undergraduate course. Moreover, one learns with a measure of wonder that his first two papers, as a museum entomologist were "A Brief History of Antarctic Exploration," and "String Figures from the Patomana Indians of South America." Yet a bare half dozen years later he was able to write his *Field Book of Insects* which has been a "steady seller" ever since.

Doctor Lutz's own education was largely made possible by winning scholarships and waiting on table. Nor did it ever veer close to insects or any other particular fauna. Lutz, senior, sold insurance, and his envy of the large salaries drawn by actuaries caused Frank to start out on a mathematics major. However, midway through Haverford he decided on medicine and switched to biology, which department offered a course in entomology. No one ever seemed to take this course, although it bobbed up in the catalogue year after year. But Frank had an open elective and signed up. He was the only student. The professor, no whit dismayed, strode the rostrum and flourished his pointer at blackboard outlines and diagrams quite as if a hundred young men were scratching busily at their notebooks. As a matter of fact, not even his solitary pupil was so engaged. The "class" met just after lunch, and during the third lecture Frank quietly dropped off to sleep. Being practical even though a pedagogue, the professor changed the plan of the course. He assigned a series of textbooks and a little collecting work, adding that an examination would be given at the end of the year.

That was the sum and substance of Lutz's entomological schooling. He passed the exam with flying colors, but on graduation he needed a job and tried to work "back" into the actuarial game, drawing a complete blank. Then, "canvassing the teaching situation turned up only an offer of '$200 a year and a good home' in a private school. It involved teaching Latin and playing the chapel organ. I hated Latin, having nearly flunked it in college, and my entire musical education consisted of a few lessons on a reed organ when I was a small boy. The 'professor' owed father some money, I guess, and that was the only way father had to collect it.

"College practically over; no job; and no money to go on with medicine. Then my professor of biology, H. S. Pratt, had an idea. Biometry, a combination of mathematics and biology, had reached America and its chief exponent on this side of the Atlantic was C. B. Davenport of the University of Chicago. I had specialized in both mathematics and biology. Biometry, a thing I had never heard of before, seemed to be my kismet. Why not apply for a scholarship at Chicago in biometry?"*

Lutz throve on the subject and subsequently became the first American student of the revered London biometrician, Karl Pearson.

But it was the home-grown Professor Davenport who, indirectly, piloted Lutz into the American Museum. In the early nineteen hundreds the Chicago biometrician moved to the then newly organized Station of Experimental Evolution at Cold Spring Harbor, Long Island, whither Lutz followed to apply biometry to a study of heredity. Insects, because of their profusion, are excellent material for this as for almost any other work involving large figures. Lutz's major opus at Cold Spring Harbor was a paper on the heredity of fruit flies. This contribution asserted results that seemed to run counter to Mendelian laws. The latter still stand, but Doctor Lutz sticks to his own guns after 30-odd years, demonstrating a pronounced tendency toward scientific heterodoxy, of which more anon. Incidentally, both crickets, which were the subject of his doctor's thesis, and fruit flies have figured prominently in Lutz's leading experiments, which may possibly indicate that the general direction of his course was fixed relatively early in life.

Museum appointment

Doctor Bumpus, who directed the affairs of the American Museum in the early part of the century, met Lutz at Cold Spring Harbor and was sufficiently impressed by his skill at general biology to sign him up for this institution. Today Doctor Lutz is a gray-bearded savant, but this fact does not deter Bumpus from addressing him as "Bugs" and signing his letters, "Dad," which should give some idea of the closeness of their relationship.

The Field Book of Insects amply demonstrates Doctor Lutz's taxonomic interests. For more than 30 years the Museum's large entomological collection has been his primary concern. Nevertheless, his vocation for experiments on insect behavior has persistently beckoned him away from the "regular" work, so that taxonomic research is left largely in the hands of his departmental assistants. And theirs are capable hands, indeed. For, about 180 new insect species are described every year by the Museum's Entomology Department—a record which averages a new species every other day. On the other hand, the name of Frank E. Lutz will perhaps be longest remembered in the specialty of experimental biology.

The house of Lutz

Had Doctor Lutz come of age in the early colonial period of our history, his household activities might easily have roused the neighbors to the point of burning him at the stake. As it is, he has from time to time managed to clutter up his property with the most bizarre assortment of pets and gadgets and to behave in the most extraordinary manner, without straining the patience of an unusually indulgent wife and a remarkably tolerant neighborhood. Imagine glancing out the window to find the man next door crawling along his lawn, listening to a clump of shrubbery with a stethoscope. Such a sight scarcely elicits more than an amused smile on Doctor Lutz's street. People know he's just listening to some bug or other (crickets* in this case) and dismiss the matter without pause. Nor did they raise objections when he and his fellow communicant of the devil, Dr. E. N. Grisewood, of the City College Physics Department, rigged up a "peanut whistle" in the back yard that blew one shrill, piercing note all day long. The object was to discover whether certain bees are sensitive to certain sound waves. And are they? Doctor Lutz doesn't know. But the experiment was not a complete failure. It furnished an acid test of the good will of all those within earshot.

The lavish hand with which Grisewood and other physicists can conjure up an elaborate testing apparatus replete with dials, gauges, and glowing bulbs is a source of wondrous joy to their entomological confrere. He and Professor Richtmyer, a Cornell physicist, working as members of a National Research Council committee demonstrated that insects can see ultraviolet beyond the range of human vision, and that flowers, both wild and cultivated, have ultraviolet patterns, a fact not previously recognized and one that reveals a new factor affecting the pollen-carrying practices of insects. What is even more amazing, Doctor Lutz and Professor Grisewood, working in the former's cellar, showed that fruit flies are markedly responsive to an extremely short wave-length, one that is so short in fact that it is practically absent from the sunlight that reaches

*This quotation like all others used below is from Doctor Lutz's *A Lot of Insects*, published this month by G. P. Putnam's Sons.

*Readers of NATURAL HISTORY will recall Doctor Lutz's experiments with the song of crickets on sound film. *See* F. E. Lutz, "The Insect Glee Club at the Microphone," NATURAL HISTORY, December, 1938, p. 338.

the earth and therefore *could not possibly have been previously encountered by the insect or any of its ancestors as far back as science can determine.* This astonishing disclosure left the investigators wondering how the fruit fly had come by such unique powers of vision. And of what use could they possibly be? "None, so far as I know," writes Doctor Lutz, "and that is one of the things that make me quite willing to believe that also other things in Nature 'just are.'"

"Anti-utilitarian"

Though he has failed to draw upon himself the unreasoning wrath of his neighbors, such statements have prompted certain scientific sects to burn Lutz as a heretic. And if he does not watch his step their actions may become stronger than this mere figure of speech. For Doctor Lutz has long been an extreme sceptic and a confirmed "anti-utilitarian."

Ever since his days at Cold Spring Harbor, he has been probing the private lives and potentialities of fruit flies. "Just at present we have at home pure-blooded normal flies and pure-blooded wingless ones. . . . You may wonder why we keep a strain of wingless Drosophila in our home. It is partly because they are just as interesting as goldfish and partly because they are handy food for pet mantids, spiders, and the like."

While these "handy" creatures were undergoing the ordeal of artificially selective breeding, Lutz became interested in their "courtship dance" (they actually perform one) and decided to experiment with their so-called secondary sex characters. What he singled out for study were the "tibial combs" which had glibly been labeled as "adornments" useful in attracting the opposite sex. But when Lutz removed these appendages there seemed to be little noticeable difference in courtship behavior, and he felt that he had scored another point against the "selectionists" who regard all individual characters as having been selected and preserved by Nature because of a specific utilitarian purpose that increases the organism's power of survival.

Lutz disagrees. Like others, he trained bees to associate food with a particular color. And that, he maintains, is all there is to this business of flowers "advertising their wares" to bees. The bees may associate a particular color with food. But it is the food and not the color that attracts them. Moreover, Lutz's garden experiments disclosed that the black-eyed Susan, to take a familiar example, has brilliant ultra-violet tips to the "petals" which are clearly visible to the bees even though they look uniformly yellow to us. All of which thickens the plot. To quote:

"It seems to me reasonable to conclude, or at least to suspect, that floral colors have developed simply as by-products of the plant's metabolism; that they are at most of only incidental and minor service to insects in finding flowers; and that they have not been developed by any action of natural selection. These colors may be of no more value to the plants than are the colors of the purely pathological galls on the leaves and stems. It is certainly not going too far to change the old expression 'whatever is is good' to a more moderate 'whatever is is not bad.' If we can bring ourselves to do this, we can think of even the colors of flowers in terms of plant physiology instead of solely in the more attractive and exciting terms of advertising and the struggle for existence.

"There are other subjects in which some well-conceived and satisfying theory seems to have so quelled our curiosity that we stop thinking about it and repeat the approved formula like a litany. For example, it is said that a yellow spider in a yellow Evening Primrose is yellow so that insects coming to the flower will not see the spider and will be caught. The spider's color matches the color of the flower *as we see it* and the explanation formula is conveniently at hand. Why worry? Insects might be presumed to have a keen—in fact, a vital—interest in this matching of colors, but they can see ultraviolet and it happened that the only spider of this sort that we tested was only very slightly ultraviolet, although the Evening Primrose on which it sat was strongly ultraviolet. The colors did not match at all in the eyes of the insects. If insects 'explained' the color of that spider they would use a different formula.

"Evolution there certainly has been, and without doubt natural selection places limits beyond which variation may not go; but these facts give us no license to place the burden of the universe upon Selection's houlders until we have a better knowledge of that burden's weight."

The hardy insects

At one time, the Lutz cellar housed a colony of crickets who were being subjected to artificial "nights" and "days" in order to check their response to changed daily rhythms of light. Lutz set an alarm clock to wake him every two hours so he could go down and watch. But he soon found himself sleeping through the alarm and had to invent a machine:

"A delicately balanced treadle was put in the middle of each passage-way. When a cricket stepped on this treadle, as it must in going from one end of the cage to the other, its weight depressed the treadle, completing an electric circuit that included an electromagnet. When the circuit was completed this magnet pulled aside a recording pen that was otherwise tracing a straight line on adding-machine paper. The paper used was wide enough to accommodate six of these pens and was kept moving at a constant rate by, according to circumstances, either an eight-day spring clock-work or a motor such as is used in electric clocks. The movement of the paper was regulated to be about three inches per hour and one of the pens was used to mark the hours, being electrically controlled from an accurate clock. The ink reservoir of each pen (also homemade) was of such a size that the supply of ink was sufficient for several days of recording.

"An incidental advantage of this machine was that it greatly impressed those of our friends who came to the house. They saw an array of ten or eleven cages with electric wires going from them to one or the other of two contraptions made up of what looked something like a battery of telegraph instruments, each contraption rolling out a strip of paper bearing jiggled red lines. A cricket would walk across one of the cages; there would be a click, and a new jiggle would be made in one of the lines. A much greater advantage was that, without disturbing my sleep or greatly taxing my daytime attention, I had an accurate, detailed record for each insect every minute of day and night."

Sometimes Lutz deserts his cellar for a genuine physics lab, and when he does, things begin to pop. Perhaps his most sensational experiment involved duplicating the atmospheric pressures existing at high altitudes in order to find out how high above the earth's surface insects could travel and still survive. Supposedly "frail" fruit flies did not even stop walking around when Lutz set the atmospheric pressure equivalent to an altitude a third higher than Everest—a height fatal to Man. Then he "rocketed" ten fruit flies 17 miles "up" *in less than two minutes.* And did it eight times in rapid succession before one of the flies finally collapsed under the strain. A score of terrific, one-to-three minute swings from normal air pressure to "none" and back again were needed to eliminate all but two fruit flies. Lutz then bred these two survivors and found their children, grandchildren, and great grandchildren absolutely normal. The next move was to test the capacity of three bees, two ants, a beetle, and an immature grasshopper to withstand the most *complete vacuum* man could devise—conditions so drastic that moisture was literally sucked out of the insects and frozen into snow. One of the physicists who watched the experiment about to begin remarked drily that one hardly needed so much apparatus—one could simply step on the bugs and get the same results. But except for a single ant all of the assorted bugs survived in excellent shape, even though they were plunged instantly back to normal conditions by smashing the vacuum tube with a hammer.

Under such duress you and I would have been simply torn to pieces. "All we can say," Doctor Lutz concludes, "is that insects seem to be better made than we are. They have invaded almost every bit of livable world, including hot springs and the highest mountains, the Arctic and the Tropics, in water and on water, under ground and above ground, in plants and animals and on them. Only the ocean is largely avoided by them (although some water-striders actually exist in the middle of it). Their structure and modes of living have stood the test of time practically unchanged since the Carboniferous. Possibly Maeterlinck was right when he called them 'beings so incomparably better armed and endowed than ourselves, concentrations of energy and activity in which we divine our most mysterious foes, the rivals of our last hours and perhaps our successors.' On the other hand, as has been pointed out, relatively few kinds of insects seriously injure us and we owe much to many kinds. Possibly, with increased knowledge of insect habits, we may be able to swing the balance still more in our favor.

"What good are such experiments as these? Possibly collecting interesting information about the masterpieces of Creation is of no greater value than collecting human masterpieces of art; but, until someone is wise enough to be able to predict the worth of any bit of pure (as contrasted with 'applied') science, we can at least say that it is interesting."

"Useful" insects

Here we see what appears to be the keynote of Lutz's thinking. He objects to the taking of Man (and his pocketbook) as the measure of all things. And his case is strong. "Unthinkable millions of bees and other flower-visiting insects have given the world fragrant, conspicuous flowers and luscious fruits instead of nothing except such things as pines and grasses. Then, thanks to the activities of insects, and only then, was the world ready for man. Except for corn there is not a vegetable in our garden that did not come from an insect-pollinated plant. Think how largely cotton—its fiber and its seeds—enters into our 'civilization,' whether there be peace or war. Has it occurred to you that without insects we would have no cotton? We owe the shirts on our backs to insects, even though those shirts be linen, for flax flowers are insect-pollinated. Silk is, of course, an insect product. Wool? Well, sheep might be raised on timothy (wind-pollinated) hay but they are not. Clover and legumes (insect-pollinated) are sought. The sheep-growers of New Zealand found that, although they could grow clover from seed, they could not grow seed on clover because there were no bumble-bees in New Zealand. So, they imported the insects that were needed there to make sheep-growing profitable.

"Do you smoke tobacco? You wouldn't if it were not for insects.

"And so on to an extent that no one has, as yet, fully noted.

"Yes. A relatively few kinds (not 1%) of insects—chiefly kinds that have been introduced by Man—*seriously* injure our crops, but, considering insects as a group, they take no more than a moderate commission for the work done. Furthermore, there are thousands of kinds of parasitic and predacious insects that, far more effectively than we can do it, keep most of their native relatives in check."

No, Doctor Lutz's pulse does not quicken at the word "man," which to him signifies merely a belligerent mammalian biped with its own peculiar and not altogether winsome behavior pattern. One gathers that if the forces of man were drawn up in martial array on one side, and those of the insects on the other, he would be hard put to restrain himself from taking his stand with the bugs. Probably so harrowing a dilemma would send him off to some barren hermit's cave in the wilderness wherein he might renounce the world and all its inhabitants.

The "lot"

Although he makes his living as custodian of one of the greatest, constantly growing collections of pinned specimens on earth, he definitely prefers his insects alive and usually will not even use poisons in his suburban garden. Fellow horticulturists are aghast at his calm toleration of various "pests." And nearly everyone squirms when he remarks that he has counted 1402 different species of assorted bugs in his back yard. "What an awful place it must be," they exclaim. Upon which Doctor Lutz may dangle the first place silver medal, the two second place bronze medals, and the certificate of achievement which the New York *Herald Tribune's* garden contest judges have awarded this yard within the brief period of four years.

How Lutz came to count those 1402 species takes us back to his early days as a curator when he was trying to persuade the Museum's Director to increase the number of entomologists. With half a million species known and fully as many more awaiting discovery, his staff was carrying (and still is) an insect load of 100,000 species per man. To drive home his point, he offered the Director the following sporting proposition. "I bet there are more than 500 species of insects on my own 250 x 75 foot lot. You reduce my salary by $10 for every one *under* that number and increase it for every one *over* 500 that I honestly find." Had that bet been taken, Lutz's income would have been increased by almost $10,000 a year. And though it hasn't been, this adventure into bug census-taking has now borne fruit. Under the waggish title of *A Lot of Insects,* Doctor Lutz has given us the cream of his vast experience with the foremost members of the insect legion which he welcomes as guests in his home. Partly memoirs with touches of autobiography and not a little philosophy, and partly popular science most engagingly written, this work should reach a far wider audience than *The Field Book.* At bottom it is a splendid brief defense and praise of insects and one that deserves and will command an attentive hearing. Even the most hardened insect-baiters will melt before its persuasive charm, and one need have no predisposition toward entomology to enjoy and profit by this summing up of an outstanding scientific career.

YOUR NEW BOOKS

THE HISTORY OF NATURAL HISTORY IN AMERICA • ART
LIFE HISTORY OF A SALMON • YUCATAN FOLK CULTURE
GREAT LAKES FISHES • INDIAN AGENT • BUTTERFLIES

RETURN TO THE RIVER
- - by Roderick L. Haig-Brown

Morrow, $3.00

As is well known, the several species of Pacific salmon after getting their growth in the sea, return to fresh water, spawn once, and die. How large a proportion return to the identical stream where they were spawned, and how this is accomplished, are problems that have been much studied and argued.

The narrative of this book follows in detail the supposed life and adventures of a single female Chinook salmon from its hatching in a stream tributary to the Columbia River, to its return and spawning in the identical pool where it was hatched. Thus the much that is known of the life history of this interesting and noble fish is presented in the form of fiction, which also permits rounding out the story with accepted theories concerning what has not yet been proved. Methods of salmon investigation, and various problems faced by the important Pacific coast salmon fisheries are touched on incidentally. In short we have here a picture of a great fish, and of an important natural resource with unobtrusive side lights on its conservation.

It would be a mistake to use details of the story, especially those not directly concerned with salmon, as a source book of scientific fact, and even features of the general picture might some day have to be altered. But as a picture it is true to our present knowledge of the subject, reads easily, and can be recommended to any layman with an interest in Pacific salmon, or in fisheries research.

J. T. N.

BY THEIR WORKS
- - - - - by H. Phelps Clawson

Buffalo Society of Natural Sciences, $4.00

H. PHELPS CLAWSON has set forth a very interesting idea in his *By Their Works,* namely to provide a historical and social background for an exhibition of primitive or, more accurately, anonymous art in the Buffalo Museum. In the American Museum and other institutions, there have frequently been guides or textbooks written around specific collections, there have frequently been guides time a total collection has been used as a base for a volume on primitive art.

The illustrations are well-chosen and good. The text is a reinforcement of the pictures and is informative rather than literary or philosophic. The result is a good book to have around, if a person is interested in art or ancient history. It is an essential to a teacher who has to use museum materials of this nature in class work. Mr. Clawson merits the thanks of museum workers and museum users for his valuable contribution to the literature on art.

GEORGE C. VAILLANT.

THE FOLK CULTURE OF YUCATAN
- - - - - - by Robert Redfield

University of Chicago Press, $3.50

IN our efforts to build a hemisphere solidarity in the New World, we find a community of ideas based on European culture, but in many of the Latin Republics we observe that a great sector of the population does not respond to these concepts and lives in a world part Indian and part Spanish colonial. Professor Redfield in *The Folk Culture of Yucatan* explores this important aspect of Latin American society, which, according to our North American white collar thinking, is a twilight zone. He does for Yucatan what he did for Tepoztlan in central Mexico, and what Dr. Elsie Clews Parsons did for Mitla in southern Mexico, namely a carefully detailed study of the impact and interrelation of different cultures and their effect on the community.

Yucatan is a geographically isolated state, having but a single port, Progreso, and a single city, Mérida. There is a large Indian population which retains its own language, and a small white group dominating the former in terms of economics and class. Thus, of all the areas in Latin America, Yucatan is the place where culture amalgamation and conflict can be studied under conditions most nearly approximating the ideals of the laboratory. The Division of Historical Research of the Carnegie Institution of Washington, under the Chairmanship of Dr. A. V. Kidder, implemented its historical research in archive and ruin by an analysis of modern social conditions. Doctor Redfield set up the organization composed of extremely able observers. Their research centered on four communities, an isolated Indian tribe in Quintana Roo, an Indian village recently opened to modern contact, a town exposed to continuous white contact, and the urbanized regional capital, Mérida.

Doctor Redfield summarizes the broad outlines of the findings in respect to such sectors of human interest as differences in life according to type of community, race and class, the Spanish and Indian heritages, culture organization and disorganization, views of life, money, land, and work, the nature of the family. He likewise analyzes the decline of the gods with the consequent transitions from holy day to holiday; medicine and magic; and our basic conflict today, the clash between the choices opened by civilization as opposed to the conduct rules of folk culture.

The result is a highly important book, the fruit of the measured judgment of the most experienced social anthropologist in North America, and the most intelligent. The powers at work in our society have to be evaluated and understood before we can gauge the social conditions in other communities and Doctor Redfield brings to his task a rich and fearless understanding. *The Folk Culture of Yucatan* must be read thoroughly, for the text is packed with carefully weighted considerations. There is no setting up of startling analogy for the sake of dramatization and steaming up reader interest. Yet Doctor Redfield avoids that crabbed virtuosity of playing jackstraws with technical terms, that perverts much of our academic writing. *The Folk Cuture of Yucatan* is an enduring bridge between the knowledge of the expert and the general understanding of the educated man.

GEORGE C. VAILLANT.

NATURAL HISTORY AND THE AMERICAN MIND
- by W. M. and M. C. Smallwood

Columbia University Press, $4.25

THIS book is one of a series, "Studies in American Culture," designed to provide historical reviews of aspects of culture often neglected. It is thus a history of natural history in America, and covers the period from Oviedo, who came to America in 1512, to the time of Agassiz and the development of biology and geology as sciences.

The early naturalists were heirs of the medieval age of faith, the world had been greatly enlarged by the discoveries of the East and West, and the scientific work of the Greeks had been only recently recovered. They were all somewhat naïve and credulous by modern standards, but from the first many of their observations in the New World were well-founded.

For a long time the influence of European naturalists and educational institutions was paramount in the field of American natural history. The great medical schools of Leyden and Edinburgh attracted students from the growing cities of the American seaboard, Charleston, Philadelphia, New York, and Boston. Many of these students studied natural history abroad, and when they returned, formed societies, started museums and botanical gardens, and taught interested persons. Soon work was being done and books appearing that were comparable to the work of European naturalists. By the end of the period described here, natural history had come of age in the United States.

The authors have taken a great deal of pains to gather the material together, studying original sources in European museums as well as in this country. A bibliography of about 90 pages is appended and the book is illustrated by ten selected reproductions. It is not a book to read for entertainment, but contains much of interest to naturalists.

J. E. Hill.

I LIKE BRAZIL

- - - - by Jack Harding

Bobbs-Merrill, $3.00

THIS is a book of first impressions, gathered on a trip to Rio, Pará, Manáos, Recife, São Paulo, and various other places. Mr. Harding talked to a lot of people and put down what they said, which covered a wide range from the 1930 revolution through the problem of coffee to the good neighbor policy. Dealing in first impressions, the author has no critical judgment on what he heard and wrote; hence one is surprised to find a number of such absurd statements as that all the forests along the banks of nearly all the hundreds of rivers in the vast Amazon system are second growth.

If Mr. Harding writes with a certain enthusiasm, and with an ear for the neatly turned phrase, the book is marred for the present reviewer by his spirit of broad-minded tolerance. Having announced in the title that he likes Brazil, he demonstrates his liking by giving many pages (all in a nicely tolerant way of course) to such things as the evil smells on an Amazon River steamer, the foolish way the steamer was run, the bad taste displayed in precisely those public monuments that the author picks out for detailed description, the lack of hot water in hotels, the hotel beds that reminded him of fakirs' spiked couches, and many similar trivia. Having told again and again how much he likes the Brazilian people, he ends his book with a rehash of the long-outmoded theory that they are enervated by the sun and spoiled by the bananas that are supposed to make work unnecessary, that shiftlessness is a national curse which does something irredeemable to people's souls.

When the author tells what others said to him, he has much in his book that is worthwhile, though scattered and disorganized; when he tells of his own thoughts and observations, his liking for Brazil seems to be that of a Southern aristocrat for the Negroes. This seems to this reviewer to be unfortunate, particularly at the present time and especially since Mr. Harding had a long talk with the Governor of Bahía about what we North Americans might do to cement closer and more friendly relations with Brazil.

E. P. H.

McGILLYCUDDY, AGENT

- - - - by Julia B. McGillycuddy

Stanford University Press, $3.00

THIS man, McGillycuddy, was a combination of M.D. and engineer, and in his early years was engaged in several government projects which made use of his talents in both of these lines. Among these he was assistant engineer and physician on the British-American Boundary Line Survey, chief engineer of the United States survey and exploration of the Black Hills, a member of the Medical Department of the U. S. Army during the Indian outbreak, and a surgeon in the cavalry from 1876 to 1879.

These activities gave him the background for a most important position as agent of the Pine Ridge Agency in South Dakota, a position he held from 1879 to 1886. Here he had charge of 9000 warlike Sioux in the largest Indian agency in the country. At the very beginning he told his Indians that, if they would select 50 full-blood Indian police to work with him, he would never call on U. S. troops, and he kept his promise.

His fearless and honest handling of Indian accounts earned for him the enmity of the insidious Indian Ring, whose trumped-up charges against him caused him to be investigated over and over again, but he was always exonerated. Had there been more men of his courage and wisdom as agents, the Indians would not have suffered the injustice that was so common on the reservations from the beginning of this period until quite recently.

In this fascinating account of frontier life, one meets such colorful characters as Custer, Buffalo Bill, Wild Bill Hickok, Calamity Jane, Red Cloud, Crazy Horse, and Sitting Bull. McGillycuddy was present at the unfortunate killing of Chief Crazy Horse, the great Sioux warrior, and the story is told in one of these chapters. Also, one of the rare accounts is that of the last great Sun Dance of the Sioux.

Te Ata.

BUTTERFLIES

- - - - - - by Ralph W. Macy and Harold H. Shepard

University of Minnesota Press, $3.50

BUTTERFLIES, a manual for the beginner and amateur lepidopterist of the northeastern United States, will be found useful and instructive. Although not intended for the specialist, the book, nevertheless, will prove valuable as an additional reference work in which are presented important locality data and miscellaneous notes on a great many species. Our exact knowledge of the butterfly fauna of the region which the book treats best, the upper Mississippi basin, has been greatly augmented by original investigations of the authors.

An introductory section, entitled "About Butterflies," treats of a great variety of subjects concerning these favorite insects. Very readable accounts are given in such varied chapters as "Butterflies in Folklore and Primitive Life," "Coloration and Protective Mimicry," "Butterfly Odors and Sense Organs," "How to Make a Butterfly Collection," and many others.

The greater part of the book is devoted to descriptive data on the imagos and developmental stages of the 173 species discussed. The descriptions are good,—relatively brief but, nevertheless, sufficiently full for the general student. Four colored plates and a number of satisfactory black-and-white illustrations make identification of the species concerned relatively easy. Instead of a fuller pictorial expression, the authors have offered verbal keys to the species, a proceeding which is somewhat of an innovation in this group of insects but which will bring to the beginner a fuller understanding of the more fundamental characters which separate the species and genera. The nomenclature used is that of the latest check list and is for the most part now well established.

For some unaccountable reason and in spite of the claims for completeness, three species which fall well within the range of the work are not mentioned—*Erora laeta* Edw., *Incisalia lanoraieensis* Shep., and *Neonympha areolatus septentrionalis* Davis. Although the omission of any species is to be regretted, the general student will be affected little by their absence, for they are rare or local forms which seldom are seen by the average lepidopterist.

W. J. Gertsch.

GUIDE TO THE FISHES OF THE GREAT LAKES AND TRIBUTARY WATERS

- - - - - by Carl L. Hubbs and Karl F. Lagler

Cranbrook Institute of Science, Michigan, $1.00

THE Cranbrook Institute of Science is to be congratulated on the publication of this little volume, perhaps the most important textbook for the classification and identification of North American fishes that has appeared for many years. The area covered is a large one, so that the 229 species and subspecies listed for it are fairly representative of our entire fresh-water fish life east of the Rockies and north of the Gulf states. Whereas the book is of necessity technical, no one can expect to differentiate the numerous similar appearing and often closely related species, which characterize the American fresh-water fish fauna, without mastering such technicalities as it contains. The text, and keys which make up a considerable part of same, are admirably clear and well-arranged. A map, a number of text figures, and well-chosen illustrations of some 85 different fishes are helpful.

J. T. N.

ABOVE THE BLUE HORIZON

Photo by Charles H. Coles

CUMULUS CLOUDS—emphasized by the use of a red filter

By CHARLES H. COLES
Chief Photographer,
The American Museum of Natural History

THE majestic pageant of the sky in its dramatic moments never fails to excite the enthusiasm of observers, especially if they are camera conscious. Recording these striking effects correctly adds new zest to one's picture-taking and is vitally important in many artistic compositions. Each atmospheric phenomenon has peculiarities of its own and must be dealt with accordingly.

Thunderhead clouds

Every now and then a striking cumulus cloud formation will be seen that the camera enthusiast is eager to picture. A huge anvil cloud piling high into the air, illuminated by the orange glow of a setting sun, is as dramatic a spectacle as one could wish. Particularly if a fairly bright sky appears behind it, the exposure meter will indicate a very high light reading, which may properly be cut in half to obtain a reasonable density in the negative.

If the cloud is lighted from the side, a polarizing filter may be clipped over the lens to darken the sky behind the cloud. As you no doubt know, the light from the sky is polarized to a maximum extent when the sun is at right-angles to the axis of the camera lens,—that is, to the left or right of the camera at sunset or sunrise. The filter must, of course, be orientated properly by looking through it at the scene to be photographed while rotating it between the fingers. When the proper effect is seen, the filter is placed on the camera lens. If rotating the filter produces no perceptible change, no advantage will be gained by using it.

If black and white film is used rather than color, a red filter may be used in place of the polarizing filter in order to increase the contrast between cloud and sky.

For sunny days with blue skies and white clouds, such as the high wispy cirrus or the cotton-like balls of cumulus, varying degrees of contrast may be obtained by use of different filters. Without any filter, orthochromatic film, such as Verichrome or Plenachrome, will hardly show a cloud in the sky except in those very few cases where the blue is exceptionally deep, as it is in the western part of the United States at high elevations. Under ordinary circumstances a light yellow filter will definitely improve cloud rendition with orthochromatic film. Deeper yellow filters can be used only with panchromatic emulsions such as Panatomic-X or Superpan Supreme film. These deeper yellow filters will reduce the recording power of the blue of the sky even more than the light yellow filters and make the clouds stand out even more strongly.

How a filter works

It should be understood that a color filter has the ability to change the photographic strength of a colored object such as the blue sky, but has no effect upon white or gray objects. A yellow filter depresses the recording power of blue, thus making it show darker in a print while the clouds remain unaffected. "Unaffected" is not quite accurate, because a filter always reduces the amount of light entering the lens, regardless of the color of the light. This reduction of the light makes it necessary to open the lens somewhat wider than normal. The additional exposure occasioned by use of the filter is called the "filter factor."

The deeper the blue of the sky behind the cloud, the greater effect any yellow or red filter will have in increasing the contrast between the two. For great contrast, the red filter is used. A step further is the addition of a polarizing filter to the red filter. With the latter combination a clear blue sky well above the horizon can be reduced to a dead black in the print. Maximum contrast between clouds and sky is achieved by the use of infrared film in the camera and a red filter over the lens. Faint cirrus cloud traceries show to best advantage with this combination.

Although many yellow filters are designated "cloud filters," they should not be used with low-hanging gray clouds. Actually, the filters affect the blue sky rather than the clouds themselves; therefore blue sky is one of the essentials in the use of a cloud filter. Gray skies are not affected by a filter, so there is no advantage in using one under these conditions.

Clouds for pictorial effects

Clouds alone make interesting photographic records, but it is when they are the background for some impressive landscape or natural formation that they take on special meaning and beauty. However, the filter will also change the gray value of colored objects in the foreground. As an example, suppose an American flag is to be photographed against a deep blue sky. If a red filter is used to darken the sky, the red stripes in the flag will appear practically bleached out. A light or medium yellow filter is the deepest color that may be used without changing the appearance of the flag drastically. A polarizing filter used in addition to the yellow filter will darken the sky further without altering the color of the flag.

An instance where a deep filter actually improves both subject and sky is when photographing Indians. The deep color of the Indian's skin is lightened by a red filter, while the sky behind is darkened. Thus the sky and skin tones are brought closer together in intensity, and far greater strength is given to the final print.

Do not use a red filter indiscriminately. Were a red filter to be used on a scene in which "palefaces" appear, the skin tones would register a ghastly white.

Don't be afraid of filters. They really help make some of the most effective land- and sky-scapes. Get a few filters and use them. A red, a yellow, and possibly a polarizing filter will fill all your requirements for years to come and help you make the most of spectacular cloud effects.

 Continued from page 129

all about the wonderful things in the world that you so want to know about . . .

M. S. Lowenthal.
Keene Valley, N. Y.

* * *

Sirs:

I consider this membership and the Magazine one of the most valuable things of the day and gladly subscribe again.

Mrs. James Mauran Rhodes.
Baltimore, Md.

* * *

Sirs:

I wonder how many readers of Natural History have ever seen the animal shown in the pictures below, taken at Crater Lake, near the southern limits of its range. This is a cony, otherwise known as a pika, rock rabbit, or lesser hare. Perhaps its outstanding peculiarity is that it "makes hay while the sun shines," actually cutting, drying, and storing "hay" for its winter needs. It is described as cutting grass for its hay, but at Crater Lake there is not a spear of grass, so they use the leafy branches of wild currant a foot long, large red elderberry leaves, and nearly whole monkey flower plants, as well as certain ragweed.

Some if not all writers give the impression that grass is cut and dried right where it falls. Not so here, for everything was immediately carried down to a point near their den and spread out on the rocks to dry. Sometimes they brought such a load that all you saw was what looked like an animated little green mountain sliding down the precipitous bank.

They live in natural passageways in loose rock and require a damp lakeside situation. Conies do not hibernate but are active all winter under the deep snows common in the vicinity. This variety is known as the "dusky" cony.

To secure pictures one must be up at 5:00 A.M. and down at the station by 7:00 A.M. all set for action. At about 7:30 the conies came out on the rocks to sun themselves. Later, after viewing the trail, they would cross it and locate suitable material for hay. On the way back they were always in a hurry. By 9:30 the morning's work was ended, to be resumed from 3:00 to 4:00. The photographs were made at a distance of 26 inches. In securing them, Everett Wilcox rendered great service through his acquaintance with conies while employed at a near-by boat dock.

H. E. Ransier.
Manlius, N. Y.

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.

Correction

Among Dr. Myron Gordon's water fleas in the September issue, through no fault of the author, the captions at the bottom of page 78 were transposed as well as the two at the upper right-hand corner of page 79.

Bird City of the

Few persons are familiar with the interesting bird city shown in these photographs, for its desolate location is in the Strait of Magellan, at the southern extremity of South America. The photographs are submitted by Professor V. Auer, who accompanied a Finnish expedition to the region.

The owners of the curious volcano-shaped nests are king shags, who share the little island with sea gulls, Magellanic penguins, and sea lions, all of which depend upon fish which they procure from the sea. At the time of nesting there is strong rivalry between the king shags and the gulls. For when the shags go to sea for fish, their thousands of nests, filled with eggs or young, offer choice pickings for the gulls. Battles between the defending shags and the aggressive gulls were observed by members of the expedition.

The life of these islets was vividly described by Sir Francis Drake and other early voyagers, and apparently it remains much the same today as it was when first viewed by white man.

Let Live

A Good Neighbor Policy Toward Wildlife

Recent laws passed in the Republic of Colombia inaugurate a laudable defense program for many forms of birds and animals. With exception of a restriction affecting one species of bird in a small Andean valley, there had been no laws whatever on the taking of bird life in that great country where 400 more kinds of birds are found than in Canada and the United States combined. The new decree prohibits hunting of upland plovers, robins, woodpeckers, herons, thrushes, and sparrows, and others. Ducks and geese are safe from the hunter between April 1 and November 1. Many interesting provisions were also made for the protection of four-footed creatures. The legislation was sponsored by T. Gilbert Pearson, President Emeritus of the National Association of Audubon Societies, who studied wildlife conditions in Colombia and conferred with other interested persons in the Republic.

A MINUTE AGO these king shags were sitting peacefully on their nests. One rose into the air, and a second later half the colony followed suit

THE TUSSOCK-LIKE NESTS are remarkably uniform in size and shape and are made largely of the birds' excrement

WHEN the sound and the fury are over, the bird city settles into comparative calm, for king shags brood as nonchalantly as barnyard fowl

THE APPRECIATION OF GEMS

Members of the American Museum and others interested in precious stones are invited to attend a series of free informal lectures. These illustrated talks will be given by Mr. Herbert P. Whitlock, author of *The Story of the Gems*, on Saturday afternoons at 4:00 in Room 319 of the Roosevelt Memorial of the American Museum of Natural History, as follows:

October 18: "What is a Gem?" (The relations between the various stones, and the answers to common questions in the layman's mind.)

October 25: "Diamonds from Mine to Market." (The travels of a diamond from its home to the showcase.)

November 1: "Famous Diamonds of the World." (The dramatic stories behind historic stones.)

November 8: "The Antique Use of Gems." (Amulets from historical times, and the evolution of the necklace.)

YOUR THANKSGIVING TURKEY

will be more fun

if the children have been "boning" on "A Quiz for Your Dinner" which will appear in the November issue of Junior Natural History Magazine.

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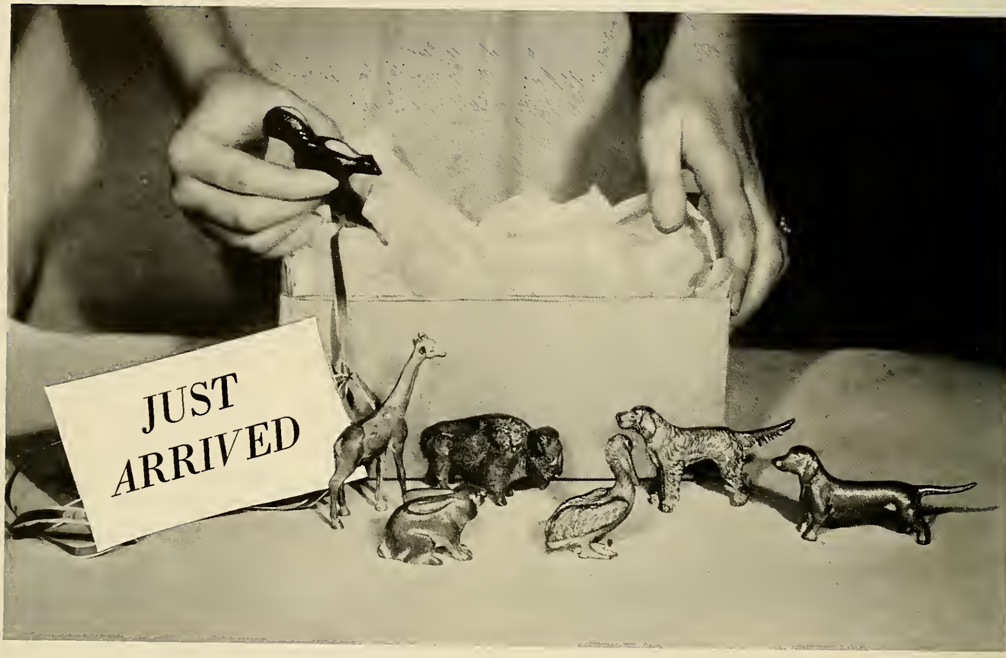

New Members of Our Metal Animal Family

Skunk, setter, dachshund, rabbit, pelican . . 35¢ each
3 for $1.00
Giraffe, bison . . . . 65¢ each
including postage

It seems unbelievable that wars and conquest should affect these docile and unsuspecting little animals—but they have. The manufacturer is greatly troubled in obtaining the metals from which they are made. The result is that their price will be more as of December 1st, 65¢ animals will be 75¢ and 35¢ animals will be 45¢, postage included.

Send for our list and take advantage of our animals at their present price.

The BOOK SHOP

THE AMERICAN MUSEUM OF NATURAL HISTORY

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November **NATURAL HISTORY** 1941

Jewelry Round the World · What is the Smallest Fish?

First Land Animals · Film of Life · Roy Waldo Miner

VOLUME XLVIII, No. 4

FIFTY CENTS

LETTERS

SIRS:

The accompanying photographs taken last spring by Mr. Charles Nash Miller show an Eastern Nighthawk nesting on a driveway within a dozen feet of hundreds of new automobiles being produced at the Nash-Kelvinator Corporation in Kenosha, Wisconsin.

The bird rarely left the nest except to search for food, and it hatched its young apparently oblivious to these most unusual surroundings. Perhaps it felt secure because of its natural camouflage, which was highly effective here, as seen by the close-up.

ROBERT STORTZ.

Kenosha, Wis.

Photos by Charles Nash Miller

* * *

SIRS:

. . . I sometimes wonder if any copy of your instructive magazine is read by more people than is mine. After reading it myself and having numerous guests glance through it, I pass it on to my son, a physician. After he and his family have read it from cover to cover, he puts it in his waiting room where a number of patients read it. When the next copy arrives, he takes the first to the U. C. L. A., where he is on the Executive Staff, and again puts it where it is read by a large number of students, while they await an appointment with him. When it is ready to be thrown out, the man collecting them glances through it and then passes it on to the janitor, who takes it home for his children to use in their school work. So its enlightening work goes on.

(MRS. F.) HELEN C. CONDIT.

Los Angeles, Calif.

* * *

SIRS:

. . . I also wish to tell you that I have never enjoyed any magazine as much as I have NATURAL HISTORY. Your illustrations are exceptional.

FRANK W. SHIMER.

Mt. Vernon, N. Y.

Continued on page 254

NATURAL HISTORY

The Magazine of the American Museum of Natural History

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

VOLUME XLVIII—No. 4 ★ ★ ★ ★ ★ ★ NOVEMBER, 1941

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Necklace of a Norwegian bride, silver and heavily gold-plated. The top piece depicts St. George slaying the dragon, and under him a coin shows King Frederick III of Norway and Denmark (1609). Nine other ancient coins of gold boast the heads of former kings. One is Frederick IV; the others are too worn to identify. The twenty-six little gold disks catch the light and tremble with every movement or even with the rise and fall of the bride's bosom as she breathes

เครื่องเพ็ชรพลอย

貴金屬

JEWELRY
ROUND THE WORLD

By W. R. LEIGH

All photos by Thane Bierwert

To appreciate the virility of a fine piece of Navaho silver, the sophistication in an intricate East Indian necklace, or the symbolism worked into a wedding crown from Norway, one must see these fine things daily, observe, handle, compare them. To understand their beauty and craftsmanship is to establish for one's self standards of taste, yardsticks to measure all artistry. Even as the sensitive finger tips touch the secret of precious crystal, jade, or turquoise, the eye and memory so trained are armed against exploitation, safe from deception by the tawdry knickknacks foisted upon the gullible in the name of art.

Only so can the young be lifted out of the commonplace that surrounds them in a machine-made age and be freed from the danger of clinging through familiarity to what is definitely unlovely. Contact with true art alone can teach them never to confuse what is merely bizarre with inspired originality.

حلية

Following this reasoning, we have circled the globe so as to be able to surround the young men and women who come to be taught design at the Traphagen School with an atmosphere in which unconscious absorption of good taste is possible and in which they must inevitably discard the imitative, the meretricious, and the false.

We have brought from all parts of the world some of man's most glamorous dreams of art, objects that combine beauty and fine craftsmanship and reflect skills that have been fostered by generations of the privileged in lands other than our own. Only a few of the treasures Fate has dropped in our lap can be shown here. These and hundreds of others form a cultural background for our work. Thus the wretched monstrosities that crowd the shops and struggle to break down our artistic morale are exposed to comparison with true beauty, and a new conception of the designer's art is attained. So far as possible we share with our pupils something of the thrill we found in discovering and collecting these things, and as the feeling for artistic quality is acquired, it becomes the foundation for creative work.

NAVAHO
ZUNI
CHILE
BOLIVIA
ARGENTINA
PANAMA
ZANZIBAR
SOMALILAND
INDIA
SIAM
TIBET
CHINA
NORWAY
ESTHONIA
ICELAND

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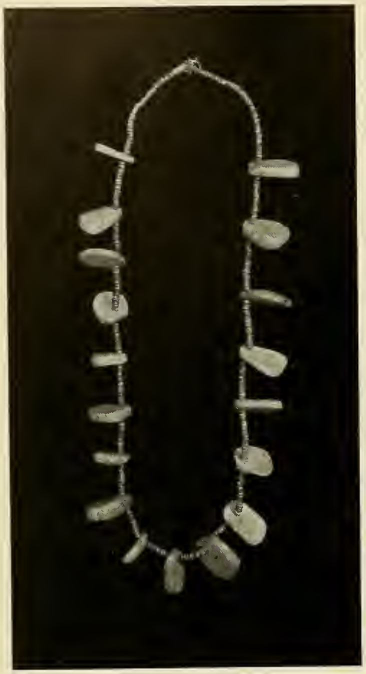


(Left) ONCE it would have bought a bride; now it might buy two, as turquoise of this size and quality is hard to find. This is one of the most primitive types of Navaho necklace, with wampum separating choice pieces of sky-blue stone

(Right) ONE OF THE RARE, early silver necklaces: a lucky find, indeed. The tiny hands on the encircling arm are never seen on later pieces. The origin of this form is lost in antiquity. Early Spanish bridles bore a similar crescent that can be traced to Moorish and Arab charms, which in turn resemble an ancient Roman harness ornament

OUR American Indian collection began in a humble way, but not just as a hobby, or for personal use. Jewelry is expensive, and almost every piece had to serve double duty,—as studio property for my Americana paintings of cowboys and Indians, and for the authentic costumes which my wife, Ethel Traphagen, uses in her fashion school. Often the pieces served us both, not once but many times. The collection has proved an unexpected source of pleasure and illumination to each of us.

We learned what to look for so as not to be deceived. Indians call silver "the metal of the moon." We learned that there are no authentic records of the Navahos making silver jewelry before 1850. One story said that Indians had been stolen as children and sold into slavery in Mexico, where they learned the craft, and afterwards escaped back to their own people. Other sources stated that the early traders brought their smiths with them into what is now New Mexico and Arizona, and that the Indians helping them grew skillful in the working of iron and silver. We heard gruesome stories, too, of murdered Mexicans whose silver trappings enabled the Indians to increase their knowledge.

We learned that the different kinds of silver used in Navaho jewelry help to determine the date and value of a piece. American money secured from the soldiers at Fort Defiance and Fort Wingate went into many of the early bangles. Previously fashioned from brass and copper wire, such bangles had been used by the Indians for gambling during their confinement at Fort Sumner, New Mexico. The American silver is rather bluish in hue and takes a higher, harder polish than the more yellowish Mexican. Mexican silver became popular after 1871 when pesos were furnished for the first time by Chah-leh Sani (Old Charley), who operated the first trading post in Navaho country.

We knew that turquoise had long been considered sacred in the eyes of the Navahos, but it remained for our Indian guide, "Gray Eyes," in the Canyon de Chelly, to tell us that all Navahos wear at least one bit of turquoise, even if it be but a bead tied in the hair. This affords divine protection, so that "the lightning will not strike nor the rattlesnake bite." Turquoise is said to have first been used in a silver setting in 1880, and not frequently until after 1900.

We learned to distinguish the clear blue color which appeals most to the Indian, and for which he will trade a horse. It is found to this day in the mine at Cerrillos, not far from Santa Fe, from which the first turquoise came long ere the conquistadors startled the painted desert out of its deep silence with the tread of a new civilization.

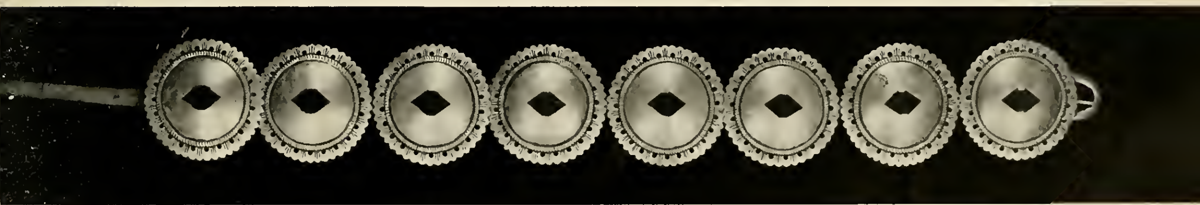
Not only color but hardness determines the grade of turquoise. Softer stones soon turn green with absorption of oil from the skin. The "Spider Web" from Nevada, much prized by Indians and collectors alike, is deep blue with black lines through it, and is becoming rare. There is an attractive mottled green turquoise from the vicinity of Tuba City; and the source of a pale robin's-egg-blue stone is known only to the Indian. One must beware of the low-grade dyed stone and the so-called "Persian turquoise," which are said to be imported from Tibet.

The polish of these stones also tells a story. The Indian does not get the high gloss that is imparted by the professional lapidary, and one need not be a connoisseur to detect the low-grade turquoise sold by unscrupulous American dealers, or the glass imitation turquoise beads that have flooded the Southwest from Czechoslovakia.

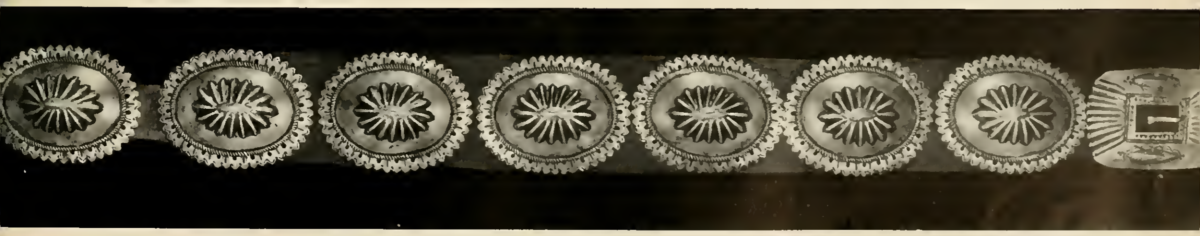
(Left) Our necklace is becoming more sophisticated, with three protective arms and a turquoise button in place of each hand. A symbolic "hogan," or house, now supplies something for the arms to guard, especially as it, too, is set with sacred turquoise. The "squash blossom," Hopi symbol of fertility, may be derived from the Spanish heraldic pomegranate, emblematic of Grenada, or from the small flower inside our sunflower's petal-ring

(Right) Genius is usually impetuous; here the artist chose to use only one "squash blossom," but added ten choice pieces of sky-blue turquoise to fill the vacancy. The photograph shows these turned in, but they hang outward on the owner's neck. The crowning glory of this necklace is the decorated "arms of God," embracing a superb massive "hogan" of turquoise

(Below) An old belt, rare today. Here you feel the Navaho's spirit, pure, unadulterated. His love of the beautiful "metal of the moon" prompted him to deck out all his wives—he may have had as many as four—and all his boys and girls to boot. As in all belts made before the Indians learned to weld silver, the strap is threaded through slits in the silver



(Below) Time has brought skill: welding has been discovered! The narrow strap of the old-fashioned belt was uncomfortable after a long day's ride. So when silver loops could be fastened to the backs of the silver pieces, the band widened. Invention, forever active, has also here evolved oval instead of circular *conchas,* so-called from the Spanish word for "shell." This belt weighs over three pounds and proclaims the Navaho's right to be classed as a finished artist. Today, instead of coins, traders supply the Navaho smith with slab-silver



The jewelry made by the Zunis, first probably in about 1880, can be distinguished from that of the Navahos, who taught them. To the pueblo Zunis it is the turquoise that appeals rather than the sheen of silver, which fascinates the nomad Navaho. More turquoise and less silver therefore marks the Zuni work, and flat-topped turquoise is preferred to the rounded stones more frequently used by the Navaho. The brown artisan of Zuni works naked to the waist because of the heat, which is increased by the small, but intense fire. His unruly mass of blue-black hair is scarcely kept out of his eyes by the crimson headband he wears. Nothing can distract him from his work, for he contemplates a finished creation—a gorgeous necklace, fit for the neck of any maiden on earth.

Here it is, a challenge to the proudest and the most adroit designers of the world. Fifty-eight silver beads support a pendant that shows all the Zuni's artistry in combining silver, turquoise, and red abalone. In it are seen the skies of New Mexico; the sunrise over the vast sacred mesa, Toy Yoliny, the "mountain of thunder"; the fervent noonday blue of the firmament, and the ardent red of the unforgettable sunset.

As in this example, the Zuni necklace sometimes lacks the "squash blossom" entirely; and some of the earlier ones had crosses alternating with the beads. Previously the Indian jewelry was made entirely by the men, but today as many as 40 Zuni women are engaged in the craft. The legends of the Zuni and their pantheon of gods, translated by Frank H. Cushing, constitutes a classic.

(Above) A ZUNI BRIDE'S BRACELET. Mexican dollars provided the silver for these four bands, fastened together by lateral binders and set with 28 pieces of turquoise. No two Zuni bracelets are exactly alike; the artists work like the smiths of India. The happy result is that we have here in America a source of original art work, expressing individuality unmarred by standardization

(Left) A ZUNI BRIDE'S NECKLACE. Fifty-eight silver beads support a marvelous turquoise matrix flanked by two pieces of red abalone shell, with a grand rectangle of blue matrix beneath. The ornamented arms of the crescent embrace the symbolic home, a triangle of unsurpassed turquoise. Such are the dreams of the simple Zuni artist, who sits in an adobe dwelling surrounded by his babies and their one or two mothers, in the shadow of his sacred mountain, Toy Yoliny

(Above) A FIVE-INCH SILVER EARRING typical of Chile's Araucanian art. These pendants are calculated to anchor the attention, for the idea of making one's self inconspicuous is not included in the philosophy of the Araucanian belle, who loves to be stared at

COLD WINDS DESCEND upon the Araucanians in their native forests on the western slopes of the Andes, so they wear thick blankets of vicuña or guanaco. And to keep these in place, they use long pins like the one above. Complete with design of Spanish origin, this fastener is intended not merely to hold the clothes on but to "knock one's eye out"

In the Araucanian Indian country of Chile, the conductor called out, "Temuco! Three minutes to wait."

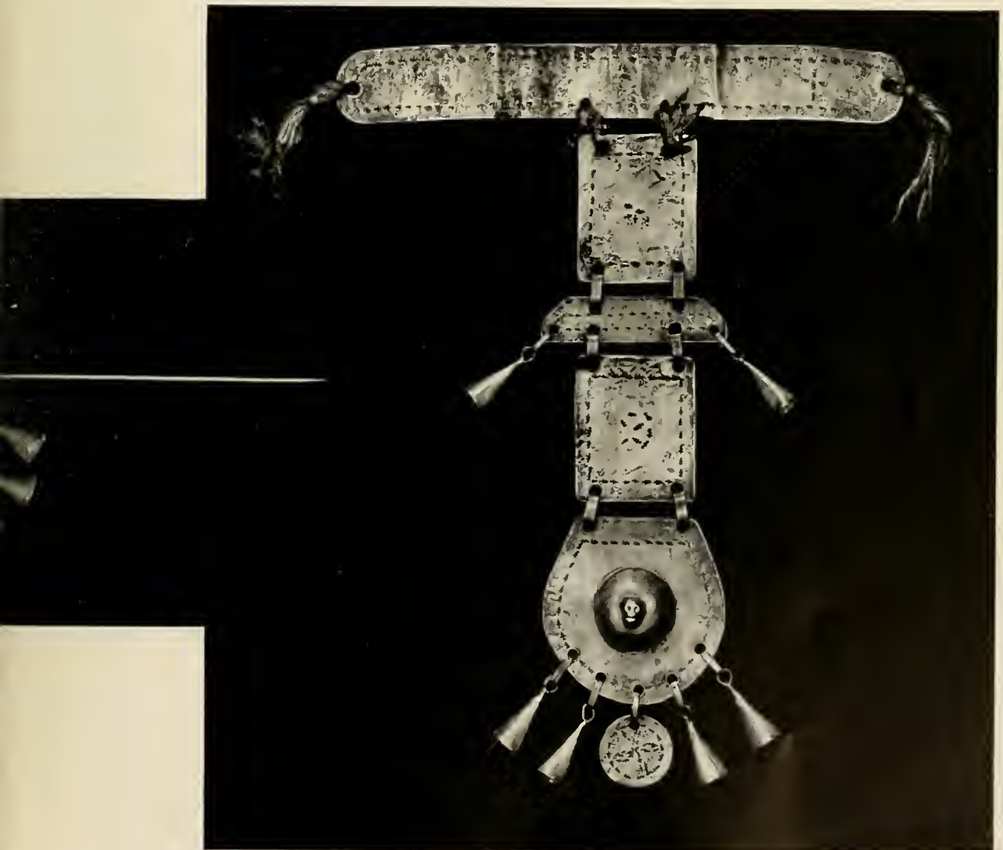
"Can I do anything in three minutes?" I said to myself. Scarcely was the thought formed when my eyes alighted on a man on the platform with a basket and something in his hands. He was alone, so I bounded to the station platform and made for him.

What he had in his hands was native tobacco. I glanced at his basket and beheld a queer jumble of silver objects—just what I was looking for. As I tipped the basket, the objects clattered to the concrete, and I saw the strangest assortment of savage ornaments I have ever seen. I seized the largest, the only complete piece. There was just time to show it to my wife, pay for it, and hop on the train. The necklace was a rare find, as I later learned.

The name Araucanian means "rebel" in the Inca language. These people, who call themselves "Mapuches," originally wore the skins of the guanaco, alpaca, and llama. They were never subjugated by the Incas, but they learned weaving and silversmithing from them.

The massive silver ornaments they wear are widely varied but always reveal Inca influence. Our necklace weighs one pound, and its bottom pendant, nearly four inches wide, bears the figure of a skull, a favorite emblem with the Incas. The surviving art of these people shows the strange way in which the savage mind combines the simple with the bizarre, the hideous with the beautiful, whimsically and naïvely jumbled. It gives us a glimpse of the primitive artist as a bold yet charming creator, working toward magnificent original goals.

(*Below*) MODERN HERITAGE of the Incas: a fourteen and one-half inch necklace weighing one pound, made by the Araucanian Indians of Chile. The bells have no clappers but tinkle together gently when the wearer walks. The silver strap at top was bent around the throat. Note the raised skull, doubtless a relic of the ancient day when human sacrifice and the impulse toward art flourished side by side



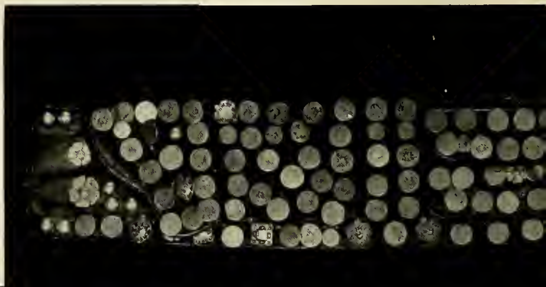
(*Right*) A GLOBE the size of a large orange decorates this Araucanian pin, and an eleven-inch needle makes it an effective one. The praying figure shows Christian influence, but the globe is probably the oldest form. Purer silver was used in these older pieces than today

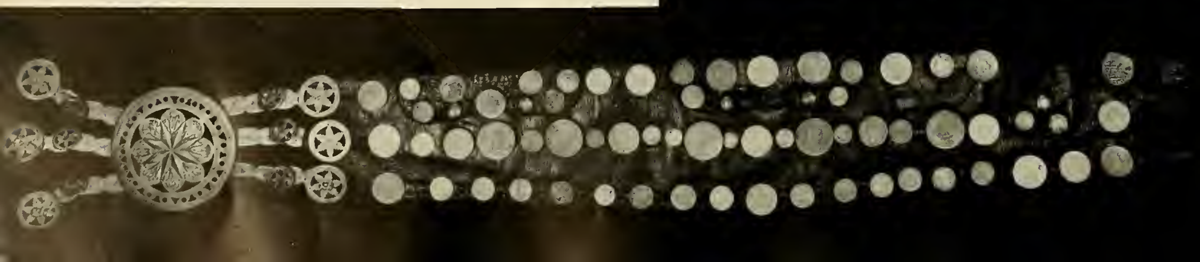
(Above) Scoffing at discomfort, the full-blooded Indian belles of Bolivia will load themselves with awkward and expensive trappings as willingly as women anywhere in the world. This is an eleven-inch silver earring, designed to flash restlessly with every slightest movement of the head. The women also wore elaborate gold ones, but no offer of money would tempt them to part with them, and the shops held out no hope of securing any. The design is more characteristic of Spanish Colonial times than the present

(Left) The nine-inch needle of this huge silver spoon will go through several thicknesses of blanket. Of Bolivian origin, it shows characteristically greater Spanish influence than the Araucanian jewelry. To embellish the pin, the artist chose a topaz and two garnets, one of which has been lost

(Right) The ornamental headpiece of this pin from Bolivia is six and one-quarter inches wide, and the needle thirteen and one-quarter inches long. The ornamentation is all borrowed from Spain

(Right) Masculine adornment reaches a high point in the Argentine cowboy, or Gaucho. Originally little more than a wage-slave, he rose to fame as Argentina's beef industry grew, and evolved a costume. His mentality, like his blood, was often an even mixture of white and Indian, and his costume is indicative. He was a rough-and-ready dandy and heart-smasher, handy with the lasso, the bola, revolver, and knife. His picturesque era is becoming a thing of the past. The 128 pieces of silver on this belt are from all over the world and include some religious medals. Note the holster





In the isthmus of Panama, a little grizzled man with a German accent, alone in a tiny shop, held out in his tremulous hand a living thing in gold. "It is a big price, oh yes! But it is the best one I have ever seen, except the much larger one the government presented to Charles Lindbergh." It had been excavated in Chiriquí Province, North Panama,—a thunderbird of pure gold, very heavy and not less than a thousand years old *(illustration at right)*.

The sources of these relics are often known only to the Indians, who—in violation of the laws, so we were told—dig in ruins lost in the depths of the tangled forest. In such ways rare pieces of art drift to the haunts of civilization, as messengers from a fabulous past, echoing extinct grandeur and primitive genius. If this golden bird could speak, how it could solve for us riddles which otherwise will forever remain in the twilight borderland between legend and history.

(Below) THUNDERBIRD IN GOLD: a three and one-quarter inch pendant from Panama, very heavy and not less than 1000 years old. The chain, added later, is of gold and of American colonial origin

BLOODY DUELS were fought over the division of cattle and the attentions of the fairer sex with Gaucho knives like this one. Its metal is engraved with crude drawings representing almost everything from a sunrise to a haystack. It is dated 1816. In the dance halls the Gaucho is not safe without his knife, and he is a wizard in the use of it

(Left) SOME OF THE COINS on this belt are old and rare, four of them dating from pirate days when crude pieces of silver bullion, known as "pieces of eight," without regular shape, were stamped and passed as money. The elaborate buckle is of heavy silver, and each small wheel has a copper center

(Above) THE CHOPINES of a sultana of Zanzibar. One would go far to find the equal of these raised slippers of silver and gold, whose tiny bells once tinkled in a sultan's palatial harem, just off the east coast of Africa. Red lacquer underneath is a relic of Chinese influence in Zanzibar

A SYMBOL OF SLAVERY became an object of adornment when the chain connecting the ankles was abandoned. The eternal urge for feminine adornment called forth the highest artistry of the Arab and East Indian silversmiths. A proud Arab lady wore these anklets willingly, though each one weighs a pound and a half. *(Front and side views)*

BARGHASH-BIN SAID, one of the sultans of Zanzibar, was something of a "gay dog." He built a lordly pleasure palace where, according to rumor, a hundred or more concubines guarded by eunuchs dwelt in magnificence and idleness, on this colorful island off the east coast of Africa.

The demise of this potentate brought swift and radical changes. The princely harem mysteriously burned to the ground almost immediately. The next ruler was adamant to all appeals of the aging beauties, and a wholesale pawning of their valuables began, as they perforce returned to a modest life.

We visited the sad ruins of the once fairy realm. The mango trees were as superb as ever, but the gardens, fountains, and ornamental bridges were abandoned to the elements. The overgrown foundations of the palace showed gaping tunnels leading into suspicious obscurity and twilight networks of masonry. Not unwillingly, we entered a tunnel and groped our way from chamber to chamber. Bats as big as pigeons clung to the ceilings and flopped above our heads.

The pawned possessions of the unfortunate ladies were scattered all over Zanzibar; every merchant seemed anxious to acquire some. Upon our arrival only the costliest objects remained. Humble little "holes in the wall" yielded treasures, covered with dust and dirt, which only the initiated could spot.

One was a pair of raised slippers, or chopines, of silver and gold, once the property of a sultana, which are shown at left. Each platform is of elaborate chased silver, edged with little silver bells to frighten demons and warn the master that the wearer is approaching. The toe-post is of gold, with gold bells. Few of us realize that chopines were once worn in London and Paris. Shakespeare speaks of them in *Hamlet*. Nor is it generally known that a good many hundred years ago a Chinese junk was wrecked off the coast of Lamu, an island near Zanzibar, leaving an influence that can be seen today.

TO prevent purchased damsels from running away from loosely guarded harems in the old days, hobbles were put on their poor little ankles, connected by a short chain which made running impossible. To make the horrible things more tolerable, feminine love of adornment took a hand. Grace they could never have, yet something beautiful could be made of a necessity. So gradually a rivalry grew up as to who could possess the most attractive hobbles.

Thus in time the hobbles changed from objects of humiliation to fashionable and cherished adornments. When the harems became better guarded, the chain connecting the anklets disappeared, and the hobbles evolved into anklets. Ah! What a pitiful tale of pathos and degradation, yet art has glossed all this over so that we admire the artistic display and forget the rest.

Having become emblems of rank, the finest anklets had the most exquisite art of the Somali and East Indian silversmiths lavished upon them. The costliest were of heavy silver, but hollow to prevent their being burdensome *(at left)*. The cheaper ones are of thinner silver but are filled with pitch to make them seem heavy and expensive.

OF all the amber in the world, none can surpass the glorious semitransparent, wave-streaked amber of Madagascar. It is of the most luscious golden color, worked into beads the size of small hens' eggs. Madagascar is the fabulous realm to which Sindbad the Sailor journeyed during the heyday of Arab civilization. And here, in bygone ages, grew some of the rarest of the resinous trees which exuded gums that have come down to us fossilized as amber.

The silver prayer box above was pawned by a favorite wife of a former sultan, but when it fell into our hands, half of the necklace was missing. Then began the search for the other half. Six honey-amber and four silver beads had to be matched. Not a shop in Zanzibar was overlooked. Here we found two amber beads strung on a piece of banana leaf and hung on a nail in the wall; there two silver beads were discovered unexpectedly in a shop window. Finally our prayer box necklace was complete.

The choice silver box still contains prayers from the Koran, written on parchment. Ah! had we but the story of that necklace, what a tale it might unfold!

(Above) A LAVISH SOMALI PRAYER BOX, suspended from a necklace of the finest honey-amber from Madagascar, interspersed with silver beads. Prayers from the Koran still reside in the silver box, protected from evil spirits by the jingling bells beneath it

(Right) A WHOLE CLUSTER of tiny silver bells raises the homely hairpin to an object of artistic beauty in the boudoir of the fanciful Arab belle

(Left) ONCE THE PRIDE of a sultana, this comb with gold and silver zones contrasting beautifully, shows some of the finest craftsmanship to be found in Arab art. The same general form in wood is used in many parts of Africa. This was one of the objects that had been in pawn for years in Zanzibar. It was found by the author's ingenious guide, George Washington Number 23, who learned from the old Arab who sold it that he had inherited the comb from his father, along with other treasures of the late sultana

(Left) AGAINST the satin-brown skin of an Arab belle, this highly polished silver armlet illustrates the Oriental designer's persistent aim to produce a striking color effect. Nine zones appear in each armlet. The central is the pineapple, between bands exhibiting the pomegranate flower; the rest are conventional. The hand-wrought design lends a charm that no machine can impart

(Left) ARAB "COMPACT." In looking at the ancient Egyptian frescoes, many take note of the peculiarly elongated eyes of the people, but few realize that it is an artificial effect, gained by the use of liquefied charcoal. The same fashion, six or eight thousand years old, prevails today, and no Arab lady's costume is complete without the kohl-container and applicator. The stopper of this one screws in. When out of use, the stick is thrust behind the belt

IN the Salisbury Hotel, in Nairobi, there appeared at our door, which opened directly upon a large sun-drenched court, a tall, slender, aristocratic brown man. He was not of these parts. He had palm-leaf mats for sale.

"We have little use for such things," I said after we had bought a few.

"What are you interested in?" he asked.

"Amber, silver, gold objects," I replied.

"Oh," he said. "I will return tomorrow."

About the same hour the next day he appeared and exhibited before our astonished eyes the most magnificent silver and amber necklace we had ever

seen,—not perhaps the most expensive, but the most artistic. It was an epic poem of feminine adornment, a masterpiece sprung from the brain of a consummate creative artist, unshackled by any inhibitions and boldly expressing a romance and glamour such as we Occidentals are rarely capable of.

"What is this?" I exclaimed.

As soon as I glimpsed it an inner voice cried out, "This you must have, no matter what the cost." My wife and I were equally fascinated, unable to tear our eyes from it. The necklace was massive, rich, gorgeously irregular, barbaric.

It was a necklace for the queen of a harem, with clusters of little ornamental bells to scare away evil spirits and to notify the lord of the approach of his chief wife. Two of the large beads were held together by silver wire, and we discovered curious red-brown flecks in the depressions of the design covering the large crescent.

We had purchased in the bookshop of Nairobi *The Mad Mullah of Somaliland*—a life of Seyyid Mohammed Abdulla Hassan. On the jacket there was a portrait, frankly fanciful, of that renowned despot of British Somaliland who had kept the English at bay for 21 years. I had been reading about this renegade, whom no white man had ever seen, when the merchant appeared with the necklace.

He was looking at the picture on the cover, and he said, "That isn't anything like him."

"How do you know?" I countered.

"I have seen him."

"Where?"

But my man became evasive, distrustful. I looked at his hands, which were slender, beautiful, and had never done manual labor. "Who can this be?" I asked myself. We have since believed that he was a son of the Mad Mullah.

"What is your name?" I asked.

"Mohammed Hassan," he replied.

I felt him closing up on me and I repeated my original question, "What is this?"

"That," he answered, "is a necklace worn by the wife of the Mad Mullah." We gasped. "It was purchased in Aden by the mother of the bride as a wedding present. She, the bride, gave it to her younger sister when the latter married a neighboring chief."

I already knew from the book that in British Somaliland cattle-raising was the occupation of the dominant caste. They were cattle kings, near counterparts of our Texas variety, and like them, got into frequent quarrels over the wandering herds.

"And how did these two beads become split?" I asked.

"By backhand stroke of a saber. It cut off the head of the first wife of the neighboring chief, during the sack of a village," came the unemotional reply.

"She was wearing this necklace?"

"Yes."

"And what are the curious flecks down in these interstices?"

"Blood," he replied.

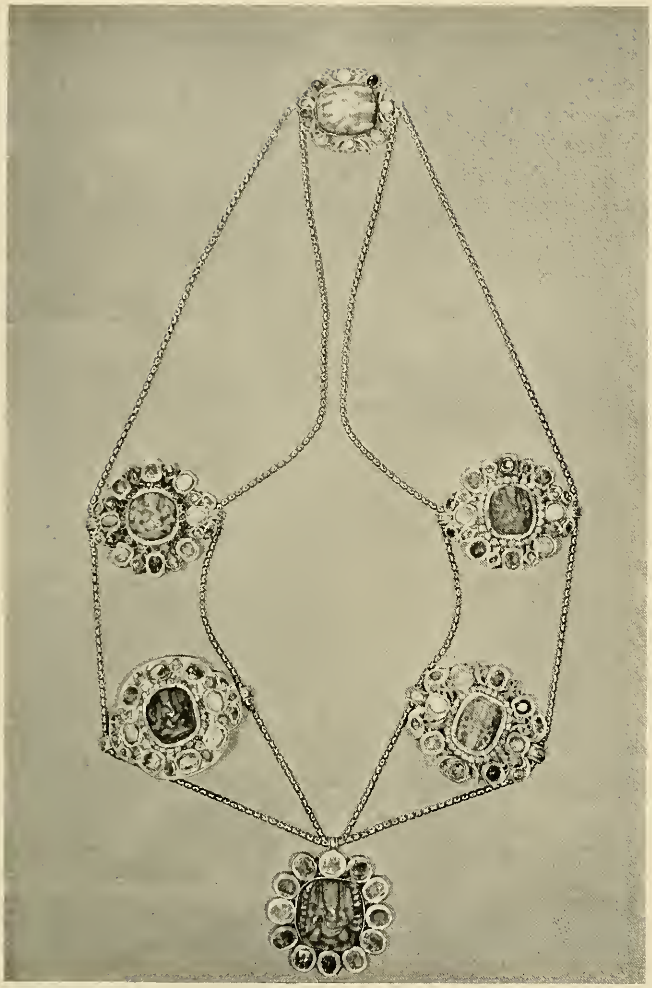
Besides this necklace, the man, whom I now knew to be a Somali, showed us a saber in a beautiful silver scabbard on which were engraved inscriptions from the Koran. It had a wonderful handle, but when I fitted my hand into it, I found it small. Seeing my trouble, the man took hold and drew the weapon from its scabbard. His hand fitted so perfectly that the suggestion that he was its owner was inescapable.

That evening we showed the necklace to Mr. and Mrs. G. Lister Carlisle, Jr., who were sponsoring the safari for the Lion Group for the African Hall of the American Museum of Natural History. The following day Mrs. Carlisle bought the saber, and later presented it to us. Upon re-examination we discovered on the scabbard, crudely engraved in the silver, the name "Mohammed Hassan."

Circumstantial evidence suggests that this man, from who we afterwards got a written history of the necklace, was an officer in the army of the Mad Mullah. Perhaps it was he who dealt the blow and split the two beads, with the very weapon which bore the name "Mohammed Hassan."

(Left) NECKLACE OF THE MAD MULLAH'S WIFE: the silver and amber Somali piece whose unique story Mr. Leigh tells above

SOMALI SABER with blade of Damascus steel, the weapon whose past may be linked with the ill-fated necklace opposite



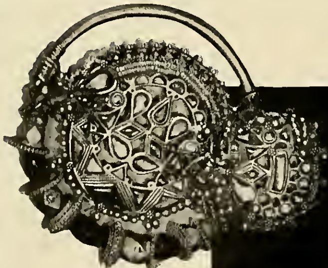
A MARVELOUS example of fourteenth century East Indian art is the necklace shown at left. It was originally a votive offering in a Hindu temple, where it no doubt remained for many years. Then it was presented by some government potentate to a prince, Galitzine, Minister Plenipotentiary of Russia at the Indian Court.

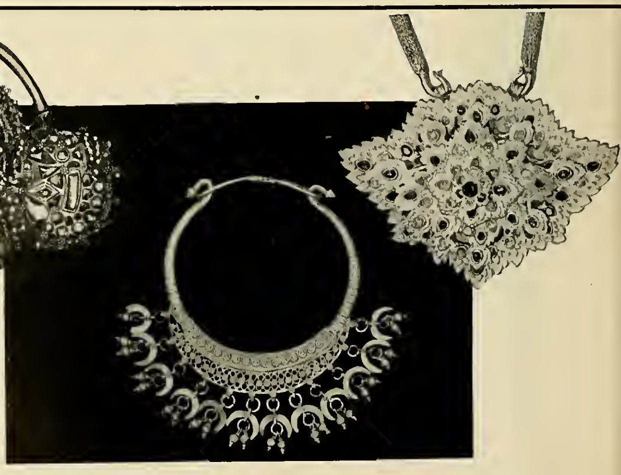
During Philip IV's time, Velasquez painted the portrait of the Dowager Princess Galitzine, probably because of her exceptional beauty. The portrait, in which she wears this necklace, is said to have hung prior to the Revolution in the Hermitage Gallery in St. Petersburg. In 1893 the necklace came into the possession of Madame Shadrin, wife of the last governor of St. Petersburg, who was herself born Princess Galitzine.

Emeralds, rubies, pearls, sapphires, moonstones, topazes, amethysts, mother-of-pearl, aquamarines, garnets, lapis lazuli, cat's-eyes, turquoise-matrix, and

(Left) A DISTINGUISHED EXAMPLE of fourteenth century East Indian art: the necklace of the Princess Galitzine. Fourteen different kinds of gems surround the six coral disks in heavy gold settings. The largest represents the elephant-headed god Ganesa, who is invoked at the beginning of every Indian book or epic poem. Golden chains replace the original Oriental cords. The lady who wears this necklace may scorn the endless duplication of mediocrity in the Machine Age, for she knows that there is not another one like it in the world

THE EXPRESSION "NOSE RING" strikes a decidedly discordant chord in the Occidental, but esthetic value belongs in the realm of opinion and custom. From Bombay, the example in gold at right is set with many precious stones and weighs a quarter of a pound. It would certainly interfere with kissing, but kissing is unknown in the East



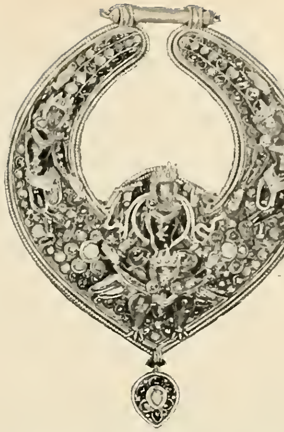


(Right) EAST INDIAN DESIGN in its pure form: a solid silver necklace weighing close to two pounds. It has twelve crescent moons, corresponding to the twelve months, and is fastened by the looping of two lotus buds. It is a typical form among Mohammedan Indians and Arabs, and would be worn by a merchant's wife

diamonds, surround the six circular pieces, no two of which are exactly alike. In this country such a design would be thrown out by our leading makers of rare jewelry,—uniformity is demanded. But in India our god of Uniformity is flouted and despised, while the god Balance is heeded with due reverence.

We can reconstruct the birth of this masterpiece. A raja's wife is seated with some of her ladies about an onyx table on which is a huge pile of precious objects: much gold and silver, cut and uncut gems, brooches, bracelets—a vast accumulation handed down through the generations for, perhaps, 500 years. Here in a fragrant garden, amidst the splash of many fountains and the songs of tropical birds, they discuss with the jeweler the designing of the new necklace. The jeweler has no show-cases; he does not advertise. He sits cross-legged on the floor, with his tools scattered about and a small hot blaze of fire with which he evolves his works of art.

The mass of materials is spread out; all take a hand in suggesting. Excitement runs high; dozens of changes are made; and the artisan untangles each artistic dilemma, bringing beautiful order out of chaos. And so the design is born, the only one of its kind. The beturbaned, barefoot smith carries away the materials selected and in ten days returns with a creation which is the despair of the Occidental, because it outrages every one of his canons and yet bowls him over with envy and admiration.



(Above) MEASURED in terms of this half-pound nose ring, the belles of the vast Tibetan plateau must be equal to any sacrifice in the name of beauty. It is a choice gem of the jeweler's art, composed entirely of gold and precious stones. Measuring six and one-half inches in length, it hung far below the chin, and the owner, while eating or drinking, was obliged to hold it up out of the way, thus exposing the reverse side, equally gorgeous. Emeralds, rubies, turquoises, diamonds, rock crystals, topazes, moonstones, and amethysts, set in yellow gold, give it a radiant color scheme

(Right) AN ORNAMENTAL Tibetan prayer box of pure silver. Here we have an object regarded with the deepest reverence among those devout people who live all their lives at 16,000 feet above sea level. It is suspended by a beautiful chain of coral, silver, and turquoise beads. The front of the box bears a picture of Vishnu surrounded by a rainbow, painted on rice paper. Inside the box are many prayers on parchment, rice paper, and satin. Age speaks from every part of the piece. It was acquired in Pekin, where some pilgrim had probably parted with it under dire necessity, fully intending to redeem it but never able to

THE DELICATE LADY who wore the necklace at left was mild and gentle of mien; the chief part of her education had been devoted to dancing. The necklace is of gold, chain and all, and is set with 69 gems. Its design carries one immediately to Siam—to enchanting temples in the jungle and little brown girls wearing their odd tapering crowns

IN CHINA the upper court ladies allowed their fingernails to grow to fantastic lengths to prove that they never demeaned themselves by performing the most trifling labor. To protect them they wore silver guards from two to three inches long, like these at left and right. This is perhaps the most outlandish form that vanity has ever assumed on this earth. Men, too, have followed this weird custom — aristocrats, officials, and scholars. But the custom has waned, or disappeared, since the Revolution of 1912

At the head of the Hardanger Fiord there is a zigzag road that climbs from the water's edge, up and up. From tremendous heights, where everlasting snows gleam in the summer sunlight, torrents flow down. With tumultuous and thunderous expostulations, the waters battle savagely with the rocks. And winding through the chaotic roar, amid frightful declivities and wreaths of drifting spray, climbs the road, crossing and recrossing the stream. Tucked away along its course, on shelves and benches of the mountainside, a marvelous little village, Merok, is strung out. There is an unforgettable view of the vast fiord, where bees and birds add their music to that of the water.

Here and there, pretty maidens with golden curls appear. Amid such surroundings what else could they be but charming,—charming of person, charming of spirit. If you doubt it, look at their glorious adornment, a beautiful bride's crown we found there. Something of the music of that mountainside, something of the long starry boreal nights, appears in this headdress for a queenly Viking maiden. A mind that grew in these surroundings was needed to create it, and only faces and forms native to this Norwegian landscape could grace it.

Imagine the original massive gold, silver, and bejeweled masterpieces of royal adornment which were the sources of this beautiful object. A mental picture is conjured up of stately queens in towered castles, of glittering halls, and regal gatherings. There arises also another picture of a quaint shop and an ingenious artist-smith, busy creating the forerunner of this glorious piece. The shop is small, the

A NORWEGIAN BRIDE'S CROWN. With a violet ribbon passing under the milk-white chin, and the golden locks swaying to the dancing feet, the violet-blue-eyed Viking maiden who wore it must have made a lovely picture. Seven crowns form the circle, held aloft by fourteen lions. The pendant bunches of grapes are symbolic of fertility. The gems are garnets and emeralds. Between each two crowns stands a silver Pan blowing his pipes, and there are seven faces of brides with flowing locks. The crown is but one piece of a spectacular bridal ensemble, which descends through the generations

(Left) PEASANT DAUGHTERS wore modest adornment, but the emblematic bunch of grapes was never absent. In this bride's necklace, the central coin of gold bears the head of Franciscus and is dated 1754. One of the smaller coins is marked 1727, but the other two are too worn to be read

(Right) GOOD LUCK TO THE NORWEGIAN BRIDE. A married couple adorn the pendant disk, the woman seated on the man's knee, with a child and an eagle on either side. Two cupids hold a floral wreath above the central couple, and castle turrets rise in the background. Attached to this disk are three emblems, all protective

man simple—it happened centuries ago.

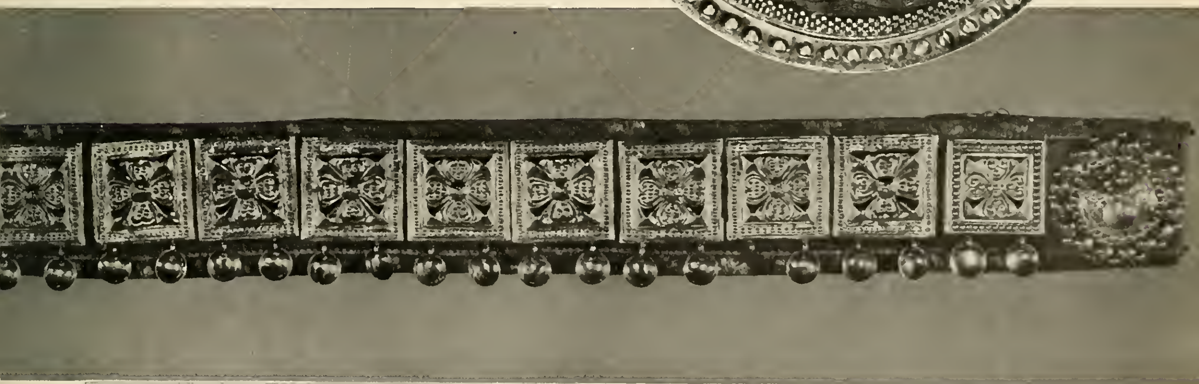
It has been gratifying to see this ancient "loot" of ours, gathered from the four corners of the world, reborn as motifs for present-day modes. Professional designers have found their inspiration in many authentic old pieces in our collection, but most exciting has it been to see student designers in our own school use the material in the creation of new patterns, a number of which have been developed and sold from coast to coast.

A new understanding of what is true and real in artistic design is necessary to the future of American art. Failure on the part of professional artists to make full use of museums and other collections, as much as poor taste on the part of the buying public, has made possible a world market for atrocities. In our travels we have seen an ever-increasing quantity of garish gimcracks being sold. Opulent and apparently educated tourists purchase curios in Egypt or Turkey marked as having been made in factories in Birmingham, Czechoslovakia, or Japan.

In the new era approaching, the Machine Age, America has a great task to perform in preserving cultures that have taken thousands of years to build. The debased and spurious must ever be recognized and rejected, and a fresh culture built up. Commercialism and exploitation of the merely trite in art must be combatted wherever they show their ugly heads. Only in this way can new artistic ideals of beauty arise, like the fabled phoenix which appears on so much of our older art, from their modern ashes.

(Right) THIS ESTHONIAN bride's breastplate, nine and one-half inches across, was worn in the center of the breast, attached by a pin. Etched with crosses, birds, and floral designs, it is extremely rich in appearance and weighs one pound

(Below) THE WELL-TO-DO BRIDE wore a silver belt, gold-plated, composed of fourteen pieces, each adorned with little concave disks that sparkle with every slightest movement. The vermilion-red cloth, edged with brocaded green ribbon, adds color



THE ICELANDERS were a hardy race, whose lives are expressed in the austere simplicity of their ornaments. This bride's crown from the author's collection, wrought in gold probably from Norway, reveals all their dignity and simplicity. It is similar to that worn in Ireland 700 years ago, or before the conquest by Strongbow. In Iceland it reflects the dim, shadowy past, back toward the time of Leif Ericson

BALANCED

NATURE

The mountain lion, coyote, and other predatory animals serve as a cushion between man and a host of potentially destructive creatures

By Sherman Baker
Deputy Game Warden, State of Arizona

Why Pick on

The man with the big hat stops his Ford pickup cautiously, and reaches over.

"Gimme the gun," he mutters to his wife in the seat beside him.

It is getting dark, and the colors are draining out of the Arizona sky. In the fading shadow of a big mesquite beside the road, a grayish form about the size of a small German shepherd dog slinks away.

There comes a sharp crack, then another. The sound seems small and unreal in the immensity and vastness of the landscape.

"It's a damn ky-oat. I got him," the rancher says sharply, with pride in his voice.

The car grinds gears and swings away toward the darkening mountains. Beside the road a coyote thrashes in the dry dust, twitches feebly, then lies still.

This is a familiar scene in any Western state. It is a rare Westerner who won't go out of his way to kill a predatory animal. And many are the wandering cowpunchers who have practiced their roping on the dodging coyote, and have dragged a coyote to death among the cactus and the rocks. Our true Western rancher hates the coyote with an intense and personal sort of hatred. And with an intensity varying with the frequency he meets them, the rancher despises the hawk, wildcat, cougar, eagle, and others.

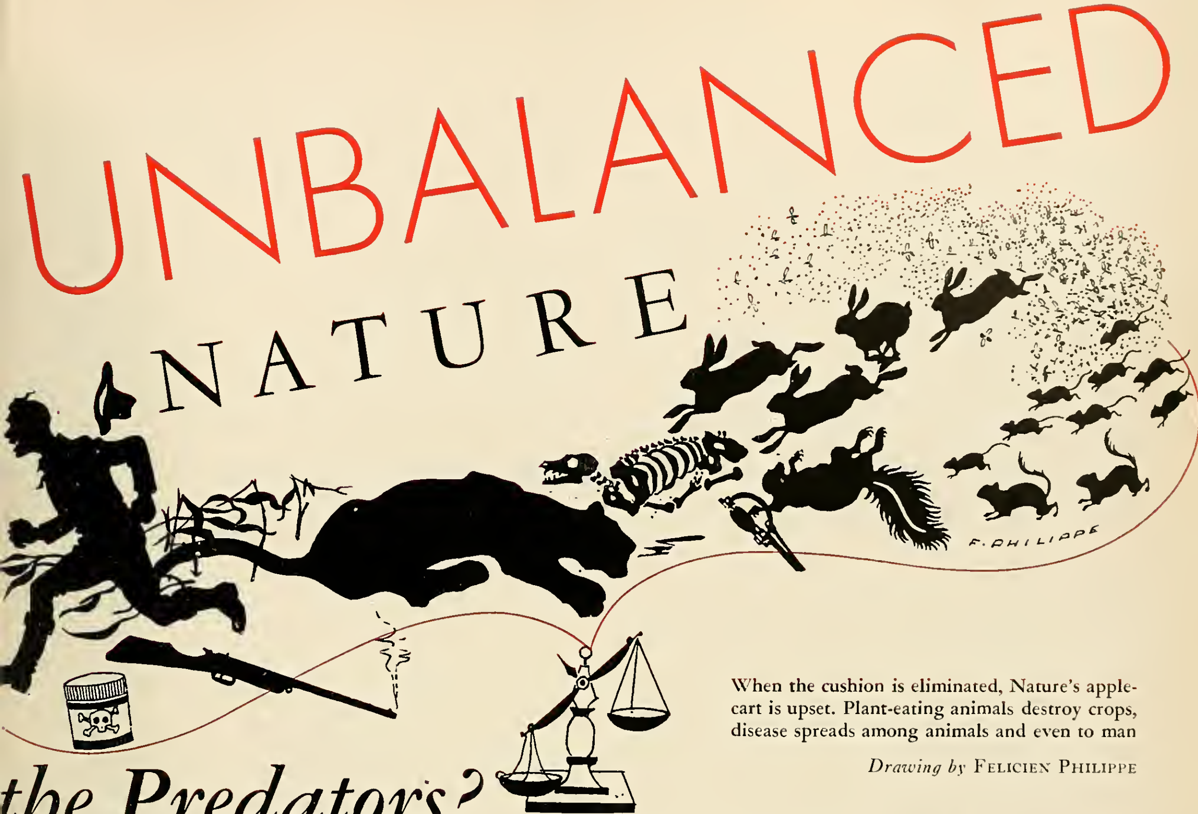
Because of the present war the conservation-minded Fish and Wildlife Service of the Government is being subjected to increasing pressure for complete extermination of the predators. The campaign of wildlife slaughter by strychnine carried on by the old Biological Survey in the name of "National Defense" during the last war is still fresh in many memories. The American Society of Mammalogists called the Biological Survey "the most destructive organized agency that has ever menaced so many species of our native fauna."

"But why not?" the rancher or the hunter may ask. "The predatory animals do plenty harm. They do a lot of damage to livestock. They, especially the coyote, are a menace because of rabies."

Hunters haven't much good to say of them. "Predators kill off our game animals. I, for one, can't compete against a mountain lion when I go deer hunting!"

Both the hunter and the rancher are right, to a certain extent. They both act according to what they think are their best interests. But actually, is the extermination of the predators to their best interests, and to the best interests of a Nation in Arms? Some of us think not,—some of us who are both ranchers and hunters.

In New Mexico a friend of mine runs sheep. One dark night a "killer" coyote got into the flock and left a trail of blood. One sheep after another this coyote



When the cushion is eliminated, Nature's apple-cart is upset. Plant-eating animals destroy crops, disease spreads among animals and even to man

Drawing by FELICIEN PHILIPPE

the Predators?

had slaughtered, apparently just for the sake of tasting blood. My friend the sheepman is vociferous in his demands for the complete extermination of the coyote. This sheepman has a real grievance, and in sheep country the coyote and other predators must be controlled. But even the sheepman admits that not every coyote acts this way. Only certain individual coyotes who get the "killer" habit run amuck in this manner. Government authorities estimate the total loss of sheep from all causes to be from five to twelve per cent of the flock. The main causes of loss are poisonous plants, diseases, and parasites. In spite of the occasional "killer" coyote, loss to Western sheepmen from *all* predatory animals is only from one to three per cent of the flock. The use of trained shepherd dogs will keep to a minimum sheep losses from predators.

In cattle country the story is different. Many progressive cattlemen admit that the coyote is relatively harmless to their livestock, and that as the least of several evils the coyote is to be preferred to, for instance, the harmful rodents which he holds in check.

I have seen some cases of living calves with their ears or tails chewed off presumably by coyotes, but there are not many more serious complaints by modern cowmen against this predator. In my particular locality—a remote, mountainous section of Arizona—I have yet to find a cattleman who has any definite, objective complaint against the coyote, although all the local cowmen follow the tradition and kill the coyote on sight. Most of the wild stories about cattle losses from coyotes emanate from "old-timers" whose tales grow with each telling. At the old McKenzie Ranch in New Mexico during one spring about 1000 cattle out of the herd of 6000 head had been found dead and chewed by coyotes. This situation occurs frequently, and this typical fact has been the foundation of all sorts of wild reports about the danger of coyotes to cattle. A further investigation of the death of these 1000 cows showed that they had all died of starvation during a bad drought year. And the coyotes had chewed the dead carcasses!

The coyote or bobcat steals an occasional chicken or turkey from isolated settlers. The chicken squawks loudly, very loudly indeed. And that squawk echoes and re-echoes throughout the community until we might think that Hitler's parachute troops had finally landed and had captured the county courthouse. Of course, it is impossible to obtain any actual figures on poultry losses to predators, but I sincerely believe the actual number to be comparatively small. However, it is quite thrilling to hop out of bed on a cold night, grab for the old .30-30 and run outside to the chicken house, with your dog barking excitedly at your heels, the children calling from the windows. It is the old surging thrill of the chase, right down from paleolithic times. And the midnight coyote hunt, embellished and enlarged, makes interesting conversation around the kitchen stove of an evening. One of my neighbors, resident in my wilderness locality for over 20 years, complains bitterly of the frequent bloody depredations on his chickens. When actually pinned down, however, he confessed, "Wal, reckon I lost a couple of hens to a ky-oat back in 1921, and mebbe one or two to skunks or bobcats since then. And one three years ago to a hawk."

Coyotes and other animals do contract that dread disease, rabies, or hydrophobia. But authorities tell us that the coyote does not act as a "reservoir" of the disease, but gets it from the dog. It is much easier to control rabies in the dog than it is in wildlife, however. Dogs can be inoculated against the disease or, during an epidemic, they can be muzzled. You can't do that to coyotes and skunks,—and, in spite of popular superstition, rabies is *not* endemic among skunks.

"Well, how about our game animals?" the hunter may repeat. "Everybody knows that the predators kill game. Everybody knows that a mountain lion, for example, kills an average of one deer per week, or 52 deer each year. If that isn't killing off our game animals, I'd like to know what it is!"

Again the average hunter, who feels this way, is right, to a certain extent. Carnivorous animals live largely on herbivorous animals. Nobody questions that. Predators kill game animals, and the hunter's figures on the yearly kill of a cougar are probably correct.

But the question is much more complicated than that. Wildlife is not just a simple matter of so many cougars and so many deer, for instance. There exist in nature many complex and subtle relationships that we do not even suspect. It is not possible, for example, to produce more game merely by killing off the predators. In some areas the opposite has been true. Sometimes the exterminated species has acted as a check on some unforeseen condition, and a new and unsuspected problem arises to baffle the wildlife expert.

In the years 1907-1919 a single Government hunter killed over 600 lions on the Kaibab National Forest on the north rim of the Grand Canyon. The Forest Service and the Biological Survey had decided to exterminate the mountain lion, to "save" the deer for the hunter. What happened in the Kaibab is well known to all wildlife lovers. It may best be summarized in the following quotation condensed from a report of the National Park Service, an organization with a progressive and intelligent interest in conservation:

The cougar, the bobcat, wolf and eagle were all completely exterminated by 1919. The deer increased and reached such numbers that they ate more forage than the forest could produce. By 1924 more than seventeen hundred deer were counted in one meadow. The deer kept increasing and the forest diminishing. Winter came, the deer died of weakness and starvation, and those that lived ate every leaf and twig they could reach, until the whole country looked as though a swarm of locusts had swept through. It will probably take fifty years of careful game management to cover the scars. If there had been more moderate hunting of both deer and predators, the situation in the Kaibab would not have occurred.

And, to make the situation more complex, clumsy and wholesale methods of extermination aimed at one particular species, such as the coyote, often fail in their purpose and exterminate valuable and useful species.

When a mountain lion kills a deer, he kills the deer that he can get most easily. The sickly and unfit deer fall first, and in that way the cougar acts to keep the deer stock healthy and at its best. With game animals, as with everything else, continued existence is a matter of the survival of the fitter. Diseased and unfit animals and birds fall first to the mammal or bird of prey. The hawk gets the diseased quail first. The mountain lion gets the unfit deer first. The coyote gets the sick cottontail first. By keeping the game stocks at their best, the predator really aids, rather than hurts, the hunter.

Hawks and eagles are shot on sight, indiscriminately, throughout the West. Ornithologists have recently been puzzled by the rapid increase of epidemic illnesses among our game birds. As far as we know, nothing of the sort happened to the quail, dove, and turkey our pioneers roasted over early campfires. Perhaps the reason is that our wrongly-educated hunters have shot the predatory birds on sight, and thereby unwittingly destroyed one of nature's best checks on epidemics among game birds.

"Yeh," the hunter or the rancher may again say. "What you say may be true. The ky-oat and the rest of the predators may not really do so much *harm*. But I certainly can't see that they do much *good!*"

The villain in the play hasn't even one good side to his character. The villain in real life usually has some redeeming qualities. When a bobcat gets our chicken, it is hard to realize that predatory animals have anything but bad qualities, but, like the real-life villain, our real-life predators *do* have good sides to their characters. Let us try for a moment to look at these good sides.

In the first place, the predators have one good side to their natures that will appeal especially to the hunter. This good side is that important matter we have just discussed—keeping the game animals healthy and fit so that John P. Nimrod can bring home a fat buck to his admiring wife and children. A second beneficial quality of the carnivores, especially the much-maligned coyote, is their action as scavengers. By the prompt elimination of rotting carcasses of both wild and domestic animals, the predator becomes a sort of practical public health officer in the general animal economy. By preventing the persistence of carcasses on the domestic watersheds, he effectively reduces the hazard of microörganisms pathogenic to man.

In most states hunters are permitted to shoot only the bucks. In consequence, the does have increased, are tamer, and cause a lot of damage to crops and orchards. The predators, if allowed in normal numbers, help to keep down these harmful does, taking the unfit first, of course.

A fourth point in the predators' favor is that many predatory animals are valuable fur-bearers. Authorities state that in California alone—and California isn't a particularly good fur state—private trappers make at least one million dollars annually. Wanton destruction of the predators at any time of the year destroys a valuable fur crop.

A fifth entry on the credit side of the predators' ledger is that there exists some sort of dynamic relationship between the predators and the edible flora in any given area. In other words, the number of carnivores in a locality is a mathematical function of the number of herbivores and the available feed. Nature has thus preserved a subtle and delicate balance. Man should think twice before he meddles with this dynamic balance. The Kaibab situation is an example.

A sixth and final point that I want to bring out in favor of the predaceous animals is that they perform useful service to mankind by acting as a check on harmful rodents. We all know that the coyote keeps down the range-eating jack rabbit. What many of us don't realize is that the coyote, and other predators, keep down the possibility of man's frequent contamination with two very serious diseases—tularemia and bubonic plague. In California, two outbreaks of those horrible illnesses have been traced directly to the local extermination of the coyote and the subsequent increase of the rabbit and the ground squirrel.

The Old West was full of animal gangsters. The lobo wolf and the terrifying grizzly bear committed mayhem, murder, rapine and robbery up and down the mountain trails of the early West. Some idea of the multitude of grizzlies that roamed the plains a hundred years ago may be gained from the notes left us by the trappers of the first half of the last century. James O. Pattie saw 220 grizzlies in the course of one day. When the white settlers began to come in, the wolves and the bears killed cattle and horses, and even men and women. The grizzly was more guilty of the latter, for the American wolf was never as ferocious as the European wolf. But the grizzly and the wolf have almost completely disappeared from the United States and no longer constitute a personal or economic problem to American ranchers.

The rest of the American predators are afraid of man. The jaguar (*Felis onca hernandesii*), *el tigre* of the Mexicans, is extremely rare north of the border. The mountain lion (puma, cougar, catamount, panther, or "painter" according to locality) is comparatively well scattered in some of the more sparsely-settled districts of the West. In my range of mountains—an area of over 100 square miles of uninhabited wilderness—cattle graze peacefully beneath the evergreen oaks. I see frequent lion tracks along the cattle trails. But in the five years I have lived here, I know of no instance of a mountain lion having killed the ranchers' livestock. The mountain lion is one of the most cautious, secretive and wary animals we know of. It is a notoriously cowardly animal, with no record of ever having attacked a man even when wounded or treed by dogs. They are so cowardly that they can be treed by a noisily-yapping little fox terrior.

Intelligent people are more and more beginning to consider the predaceous animals as "occasionally harmful, but usually beneficial." If poultry and sheep are properly protected, wildcats and coyotes devote their attention to rabbits, other small mammals, insects, wild berries, and so on. The fox destroys large numbers of harmful field mice, rabbits, ground squirrels and insects. The mink and the skunk commit depredations on poultry, but more than pay for it by destroying muskrats, meadow mice, grubs, noxious insects of all sorts. And the badger feeds largely upon ground squirrels and other burrowing mammals and insects.

"So what?" asks the rancher or the hunter, or the public in general.

"Just this—" we may reply. "Maybe you think the predators are all bad. You have as much right to your opinion as I have. But the next time you lift the muzzle of your shotgun toward a hawk, or point the sights of your rifle at a coyote, just remember that the predator may be evil, but that he is at least not a complete evil. Remember that in some hunter's or rancher's Utopia, when the predators are completely exterminated, and when some sickness sweeps away the quail, or the deer, and when the rabbits are eating away all the grass for the nation's beef and mutton supply, remember that the predators would have prevented that epidemic from wiping out the game, and the rabbit from multiplying so prodigiously. A sound program of conservation for National Defense means *control,* but not extermination, of the predatory animals. Remember, just as you are about to squeeze the trigger, that the predator isn't really such an enemy to man, after all."

THE QUEST FOR

Most fishermen strive to catch the biggest fish, but one of the most fascinating searches has been for the world's smallest fish, a creature so tiny that no hook is delicate enough to catch it and 16,000 of them make a comfortable—and delicious—meal

WORLD'S SMALLEST FISH:
the "dwarf pygmy" *(Pandaka pygmaea)* in actual size

YOU CAN BUY 16,000 delicious fish for only a few cents at Lake Buhi in the Philippines, but their total weight would be no more than a pound! The palm of the hand at right is scarcely covered by 100 or more fish caught in this lake, and they are apparently not even the smallest kind

THE SMALLEST FISH

By E. W. GUDGER

Honorary Associate in Ichthyology,
The American Museum of Natural History

ONE of the questions most frequently asked of of us here in the Museum's Department of Fishes is, "What is the largest fish?" For 22 years I have been answering that it is the whale shark, that ocean Brobdingnag, which has been measured up to 45 feet. At some future time I am going to bring together all the data for it and other marine giants in the endeavor to ascertain what *is* the largest fish and to settle the question.

Another frequent question is, "What is the smallest fish?" Various brief attempts have been made to give the answer, but no effort has ever been made to present the full picture of the search that brings together all the interesting points in the natural history of these little fishes. To present these findings is the purpose of this article, but to achieve this end, one must reverse the usual procedure in fish stories.

The usual story is as follows: *A* tells about a big fish that he caught; *B* narrates the story of his catching a bigger one; whereupon *C* relates the story of the biggest one—the one that got away. Now this article (fish tale, if you will) recounts the finding of an adult fish so small that its discoverer proclaims it the smallest. Then another searcher finds one still smaller, so does another, and still another, until a tiny fish is found, a fish so Lilliputian in size that all hands agree that the lowest limit must have been reached.

In January, 1902, Dr. H. M. Smith published a note on a minute Philippine goby, which aroused such widespread interest in the question that Einar Lönnberg published an article on small fishes in the same year. Later A. W. Henn (1912) and Jessie Elliott Drayton (1933) took up the search. However, these articles are all so indefinite, incomplete, and unsatisfactory, that they may be passed by without further comment. Thus the way is clear and possibly the time ripe for an endeavor to find what *is* the smallest fish.

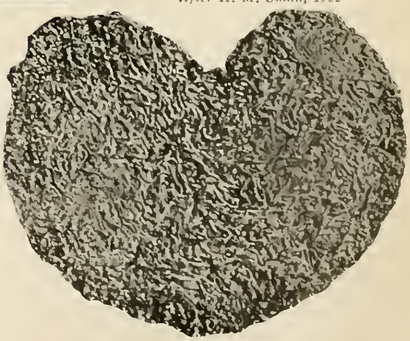
In seeking to ascertain what is the smallest fish, it seems well to go downward from small to smaller to smallest. This seems logical and it will make the story chronological. Starting near the middle of the last century and working up to date, it will be in-

Photos by Hugo Miller

(Above) HOME OF THE SMALLEST FISH: picturesque Lake Buhi. This small but beautiful body of water on the island of Luzon in the Philippines possesses more kinds of minute fishes than any other section of the world

The strangest fish cakes on earth. Thousands of the world's smallest commercially valuable fish form these *sinarapan* fish balls, esteemed as a delicacy by natives and whites in the Philippines

After H. M. Smith, 1902



teresting to follow the various steps by which various students of fishes have pushed our knowledge forward to smaller and smaller forms. Following this "downward path," the reader and I will at last reach a "dwarf pygmy" that must be the irreducible minimum in smallness for adult fishes and indeed for all backboned animals.

One requirement in this search is to have a considerable number of specimens to determine the range of size in any one of our small fishes. Above all, we need females in breeding condition to determine the size of adult females. In the males, with no gravid females present, it is not possible, save by microscopic examination of the gonads, to determine whether the fishes are adult.

Smallest North American fishes

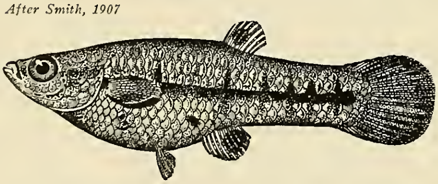
The search for the smallest fish was first prosecuted among North American forms. This is due to the fact that in the fresh waters of the United States there are certain cyprinodont (carp-toothed) fishes called "top minnows," notable for their small size and for the fact that many of them are viviparous, or "live-bearers." (This means that they give birth to young able at once to swim, seek their food, carry on their own lives.) Among these little fishes are certain ones long thought to be the smallest of all fishes.

So far as I can find, the man who first announced that he had found the smallest fish was C. F. Girard. In 1859 (82 years ago) he wrote, "The smallest fish so far known to inhabit fresh waters is *Heterandria formosa*. . . . When full grown the female measures about an inch in total length, and the male six-eighths of an inch."[1] These little fish came from South Carolina and Florida along with other somewhat larger related forms, all having teeth like carps and all closely akin to them. That the reader may see how this fish looks, there is reproduced here a drawing of the fish enlarged about three times, and along with it are others showing the fish in natural size. These latter are from Samuel Garman's book, *The Cyprinodonts* (1895). Garman does not speak of the size of these drawings, but, as those of the females measure 25 and 29.5 mm. respectively and that of the male 19 mm., it is clear that the figures are drawn in natural size. And they are so reproduced here that the reader may have visual evidence of the extreme smallness of this little "top minnow."

It will be of interest and value here to give another bit of the interesting natural history of these small cyprinodonts. These little viviparous fishes are called "top minnows" because, in order to feed at the surface, they swim with back and mouth at the top of the water. In their natural environment, they feed largely on mosquito larvae at the surface of the water, and hence help keep down mosquitoes. Their extremely small size fosters their larvivorous activities. Mosquito larvae hide in the growths of water plants along the edges of lakes and ponds. Our little fishes readily penetrate among the plants and feed on these larvae. One of these active little fishes will in a short time devour his own weight of mosquito larvae.

Now it is well known that certain mosquitoes are the transmitters of the germs of malarial and yellow fevers. The International Health Board of the Rockefeller Foundation, in its fight to eliminate malaria and yellow fever, has enlisted the services of many small fishes in various parts of the world, among which it has found these top minnows to be its most valuable "mosquito fleet" auxiliaries. It has widely distributed these and other similar ones around the globe to the great benefit of the people in regions subject to these diseases. The fishes are

After Smith, 1907



(Left) THE AMERICAN "TOP MINNOW" which in 1859 was thought to be the smallest fish in the world: *Heterandria formosa,* enlarged three times

After Garman 1895

The female is mightier than the male. At right: two females and a male between them, all life-size. These Lilliputian fish feed on mosquito larvae and have served nobly as a "mosquito fleet" against malaria and yellow fever "planted" in ponds, tanks and cisterns to keep them from becoming breeding waters for the mosquitoes which transmit the diseases noted.

Twenty-six years after Girard's account, O. P. Hay described in 1885 a cyprinodont from Florida waters so small that he stated it might contend with the fish we have just described for the honor of being the smallest known vertebrate.[2] He had two specimens from Florida. The largest was seven-eighths of an inch from tip of snout to tip of tail. The smaller (for which unfortunately no measurements are given) on dissection was found to be "a female with well-developed ova." Hay's little top minnow (to which he gave the name *Heterandria ommata)* is a first cousin of Girard's *Heterandria formosa.* Hay gives no illustrations of this fish, nor do I know of any.

Both these fishes and their close kin are so small that their measurements are better given in metric units, which enable us to record minute differences more exactly. In this system an inch equals 25 millimeters. Thus Girard's specimens were 25 and 19 mm. long respectively. Hay's larger fish (a male) was 22 mm. long. It is unfortunate that he did not give the length of the other and smaller specimen —"a female with well-developed ova."

South American rivals for smallness

C. H. Eigenmann in 1909, in describing some fresh-water fishes of British Guiana, listed a number of other very small cyprinodont fishes.[3] Among these was the little viviparous *Acanthocephalus bifurcus.* "Some of the females but 20 mm. long are with young." The smallest male (in breeding colors) measured 19 mm.—three-quarters of an inch. Here then is a live-bearing fish 20 mm. long with the ovaries filled with numbers of babies ready to be set free to seek their own living. Eigenmann published no illustration of his fish.

Still back in the past (1895), Samuel Garman, in his great work on the carp-toothed fishes, established the form *Heterandria minor* from specimens from Villa Bella, Brazil. Of the fishes of this species, he says, "The length of the males is about seven-tenths of an inch [17.5 mm.] and of the females about eight [20 mm.]. Females of three-fourths of an inch [19 mm.] in total length contained fully developed embryos." And thinking that he had found the smallest Heterandria and indeed the smallest cyprinodont, he named this little fish "minor" (i.e., smaller than any other). It was at that time the smallest known fish. Garman gives no illustration of this "minor" fish, nor have I been able to find one.

Leaving behind these little American top minnows, our search for the smallest fish in the world now takes us to the Old World, but to what was in the year concerned an American possession—the Philippine Islands. The story involves two stages in research as will be seen presently. The fishes to be studied are gobies.

The gobies (order Gobioidea) comprise a large group of some 600 species of coastal, estuarine, and fresh-water fishes from all over the world save inside the Arctic and Antarctic circles. The gobies are mainly carnivorous, mostly small in size, and they abound in the Philippine Islands. A. W. Herre, in his book, *Gobies of the Philippines and the China Sea* (1927), has listed no fewer than 173 species in the surrounding waters. The gobies are small fishes, ranging generally from 100 mm. (four inches) down to less than 25 mm. (one inch). Perhaps the greater number of forms range in size below two inches. Various species do not attain a size larger than about 20 mm. in length.

It would be interesting to list all of Herre's little Philippine gobies smaller than 20 mm., but I shall note only those smaller than Garman's "minor" cyprinodont, the males of which measured 18 mm. and the gravid females 19 mm. The gobies now to be studied are so small that they would seem to have reached the *ne plus ultra* in diminutiveness.

"The smallest known vertebrate"—1902

In 1901, a small collection of fishes came from the Philippine Islands to the U. S. Fish Commission, in Washington, D. C. All were collected in Lake Buhi in southern Luzon. This is a small but beautiful lake about six miles long by three wide and having an average depth of about 160 feet. Its surface is about 325 feet above sea level. It is said to have been formed by a volcanic explosion and eruption prior to the Spanish Occupation ". . . when one side of Mount Iriga was blown out, and hills of lava were scattered for miles to the southeast of the mountains."

These fishes from Lake Buhi were carefully studied by Dr. H. M. Smith, referred to above. Among them was a species of goby which Doctor Smith announced to the world in *Science* on January 3, 1902, as "The Smallest Known Vertebrate." Later in the year in a fuller and more formal paper (*Bulletin U. S. Fish Commission,* XXI, 167) he included illustrations of both the male and the female fish, and described this little goby in more detail, giving its natural history so far as then known. He named it *Mistichthys luzonensis* ("smallest fish from Luzon"). This is surely a long name for such a short fish. Nor is its native name, *sinarapan* (sin′-ar′-a-pan), much shorter. In 1902 it was the smallest adult fish that had ever been described.

Doctor Smith fortunately had numerous specimens of both sexes to study. The form and general makeup of the fish are shown in the drawings of the male and female specimens at the foot of this page, where the fish are shown magnified six times. The inset below each figure represents the actual length of the fish in the flesh (13 mm.). The fish are almost unbelievably small. "The average length of 50 specimens taken at random, both sexes about equally represented, is 12.9 mm. [one-half inch]. The average length of males is 12.5 mm., the minimum under 10 mm., and the maximum 13.5 mm. The average length of females among specimens at hand is 13.5 mm., the minimum under 12 mm." These figures show how inadequate inch measurements are, and how necessary it is to use the metric system in giving sizes of these minute fish. But it must be emphasized that these are *adult* fish.

The females contained ripe eggs. Indeed, when some females were placed in alcohol, perfect eggs were extruded. These eggs averaged 0.5 mm. in diameter and were probably the smallest fish eggs on record in 1902. Their extrusion by the female shows that this fish, unlike the cyprinodonts studied, is egg-laying, not live-bearing. It should also be noted that the maximum size of this little goby is far less than the minimum size of Garman's little cyprinodont called "minor" (13.5 mm., against 19 mm.).

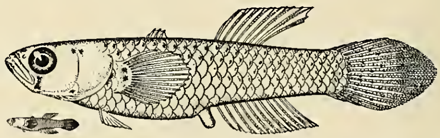
Smith's studies were made on preserved material, but Herre (who then lived in the Philippines) visited Lake Buhi, collected many specimens, and so far as possible studied the natural history of Mistichthys. In fresh specimens, he found these "minute fish" to be transparent, with large black eyes and some few dark spots sparingly scattered over the body and in some parts making faint stripes or bars. The fish are found in vast numbers, mainly around the shores. They seem to breed throughout the year.

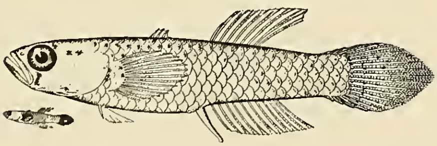
Commercially valuable

Incredible as it may seem, these little fish are used as food. They are the smallest fish having a commercial value. In fact they are food fish of considerable importance and are in great demand. Of them and their capture—they are of course too small to be taken even in a reasonably fine-meshed net or trap—Doctor Smith's correspondent, Dr. Zeller, assistant surgeon, U. S. A., wrote as follows:

> I enclose herewith samples of a strange article of diet greatly relished by the Bicols, among whom I have been stationed for the past eighteen months. Rice and fish are the staple articles of diet for most Filipinos, and in the provinces of the Camarines there is little variation from these two. Fishes of every size and many varieties are prepared in every conceivable form, but the samples enclosed are unique in that they are found here and nowhere else. . . . Many varieties of fish abound in the lake, but by far the most numerous are these minute specimens. They are called in the native Bicol tongue *sinarapan,* and when dried in the sun on a leaf are called *badi.* They are caught by a large sheet of close web, which is dipped under wherever a school congregates. They are put into tightly woven baskets, from which the water soon drains, leaving a compact mass of fish. They are not minnows or immature fish. They are adults and attain no greater size. The natives buy them eagerly; and when the little fleet of fishermen return from their morning's quest and place their baskets upon the ground in the market place, they are instantly surrounded by a crowd of waiting children who, armed with every sort of dish, are anxious to take home the family meal. They bring three or four potato tubers, a handful or two of rice, or a few copper pennies and in exchange receive about a pint of fish. In the kitchen the fish are made up with peppers or other spiced herbs and they do not taste bad. The soldiers have become quite fond of this food, and liberally patronize the little native restaurants where it is served.

A SHORT FISH with a long name: *Mistichthys luzonensis,* which means "the smallest fish from Luzon." At right is the female; below is the male, with insets showing actual size





In 1902 it was the smallest fish that had been discovered, but a smaller fish was destined to be found, and in the same island in the Philippines

After Smith, 1902

For illustrations of the cakes of *sinarapan,* as for those of the fish, I am indebted to Doctor Smith. These cakes are made up of vast numbers of the minute fish. "The number in one pound is about 16,000."

Herre writes that another little goby, *Mirogobius lacustris,* of which mature adults vary from 15 to 19 mm., also has a commercial value. These little fish, unlike *sinarapan,* are not made into dried cakes but ". . . are fried in cakes, cooked in vinegar, made into *sinagong* or stew, and pickled, and are a greatly esteemed delicacy. At times they occur in the Manila market."

In reference to the commercial value of Mistichthys and its use as food, Herre adds that, "*Sinarapan* are fried in oil, or boiled with vegetables, and have a delicious flavor. When more are caught than the local market demands, the surplus is salted or dried in cakes and exported to the neighboring towns in Camarines Sur or Albay Provinces."

It is interesting to find that the use of these minute fishes for food around Lake Buhi had been recorded nearly half a century earlier. Dr. F. Jagor had collected and sent to Germany in 1860 numbers of very small gobies from Lake Buhi, with the statement that under the native name of *roron* these were daily consumed in great quantities. They were probably *sinarapan.*

Since these little fish are of such commercial value, certain rules and regulations governing the fishing are based on their habits. Of these Herre says:

> I believe that *sinarapan* [which live at the bottom] rise to the surface with the diurnal movement of the plankton on which they feed. The unusual method used to capture them is based on this habit and provides a roosting place on which they gather in swarms. From time immemorial they have been caught in large quantities by the people living about the lake and are regarded by them as a staple article of diet of superior delicacy. The right to catch them is let by the municipality to the highest bidder, who then has the exclusive fishing privilege for such part of the lake as he has leased.

Doctor Zeller has described one method of taking *sinarapan,* and Doctor Herre, from personal observation, has described another and more interesting one. His account of this will add to our knowledge of the natural history of Mistichthys. He writes:

> A full-grown bamboo stalk, ten meters or more in length, is cut, the butt sharpened, the branches removed except the three or four uppermost twigs, and a palm leaf wrapped around the topmost meter or two. The contrivance, called *abung,* is then set firmly into the lake bottom where the water is deep enough to leave a little of the tip and a spur of the palm leaf protruding above the surface so the fisherman can find it easily. During the day the *sinarapan* come to rest upon the palm leaf. About the middle of the afternoon the fisherman goes out to the *abung* which he has scattered about in his leasehold, and begins to fish with a triangular net or *sarap*. . . . The *sarap* is mounted on a **Y**-frame of bamboo and with it the *abung* is swept from the bottom of the palm leaf to the top, and usually from a half liter to a liter of *sinarapan* is caught on each. The fish are dumped into a large basket from which the water drains at once, leaving what appears to be a mass of some strange wriggling, skipping, transparent insect larvae, in which the large black eyes are the only conspicuous part.

These tasty little gobies are the prey of many larger fishes. At times, eels, halfbeaks, and several kinds of larger gobies (their cannibal cousins) are taken with them in the nets. Thus, Herre records a goby *(Vaimosa dispar),* ranging from 18 to 40 mm. in length and states that "many of them had the mouth greatly distended with *sinarapan* when captured, the tails of as many as three or four protruding."

Doctor Smith's article in *Science* aroused great interest, as is witnessed by its translation and republication in French, German, and Swedish. Then Doctor Smith himself wrote a short article for *St. Nicholas* Magazine (June, 1902), which is valuable just here, because in this he had a sketch of the *Sinarapan* drawn on a smaller scale than the ones already reproduced; and—most fortunately—underneath the head of the fish in the larger drawing is an illustration of the "least fish" in *natural size,* one-half inch long. This charming combination is reproduced that the reader may get a visual impression of just how little this "least fish" really is.

But small as is the little fish (13 mm.) shown in Doctor Smith's small illustration, a smaller fish is now to be presented.

Despite Smith's announcement in 1902 of the finding of Mistichthys with an average length of only 12.9 mm., the smallest fish had not been found and was not to be discovered and recorded for another quarter of a century. This was done by Herre in 1927. He had two new species of small gobies which he placed in a new genus called Pandaka, from a Philippine word appropriately meaning dwarf. However, the first of the Pandakas, which he designated as *pusilla,* meaning little, was not a new record for smallness.

Smallest fish on earth

In the discovery of *Pandaka pygmaea,* we have at last come to our journey's end. But without seeing specimens, it is hard for one to realize that a female fish only 10 mm. long (two-fifths of an inch) can be adult and capable of reproducing its kind. Years ago, Doctor Herre sent me some specimens, and they are before me as I write. They are so minutely small that even under a strong magnifying glass one can make out few details. A microscope must be used. Because of this, Herre named this least fish of all, *Pandaka pygmaea*—the pygmy dwarf or the dwarf pygmy. For a like double superlative we recall St. Paul's "After the most straightest sect of our religion, I lived a Pharisee."

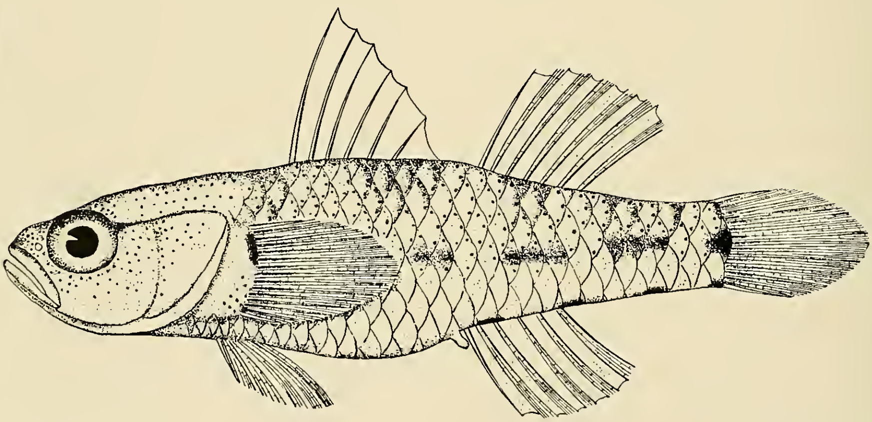
We turn then to the most minute fish thus far ever recorded, and because these breeding fish are so unbelievably small, it will be well to quote Herre's exact words:

> Here described from seventy-five specimens, 7.5 to 11 millimeters in length. Adult males are less than 9 millimeters long; adult females, with the belly distended with eggs, are from 10 to 11 millimeters long. This is unquestionably the smallest fish yet described, averaging 2.5 or 3 millimeters less in length than the famed *sinarapan* (*Mistichthys luzonensis*) of Lake Buhi. I have examined all the minute fish thus far known from Polynesia and North America, and none is as tiny as this species.

Here let us pause to consider the drawings showing the structure and also the extremely small size of this pygmy. The drawing below shows our Pandaka enlarged 15 times. It is surely a trimly built little fish. Even more interesting is the small figure on the title page of this article showing the pygmy in its real "grown-up" size.

Herre's natural history data concerning the dwarf pygmy goby are buried in his book. Consequently, two years later (1929) he published in *Science* a brief note entitled "The Smallest Living Vertebrate." From this it will be interesting to quote his final paragraph describing this ichthyological atom.

> Compared to all other Lilliputian fish from various parts of the world both *Mistichthys luzonensis* and *Pandaka pygmaea* are very much smaller, even when not so very much shorter. They are both slender fishes and in life are colorless and so nearly transparent that only their large black eyes are visible. Conditions in the Philippines and especially in Luzon have produced an extraordinary variety of gobies, but it is remarkable that the island of Luzon should have produced the two smallest specimens of fish in the world, both gobies.



THE SMALLEST FISH IN THE WORLD enlarged to fifteen times its actual size: *Pandaka pygmaea,* whose life-size portrait is shown on the first page of this article. The "dwarf pygmy" is a trimly built mite, colorless and nearly transparent

After Herre, 1927

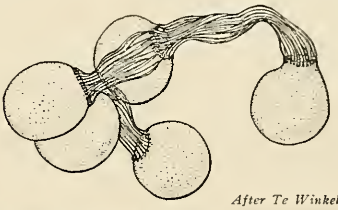
One wonders what are the conditions in Philippine waters and especially in the one island, Luzon, that have given rise to these Lilliputian forms—not only Mistichthys and Pandaka, but many others less than 25 mm. long when sexually mature. However, on this matter even Herre, who knows more about these atomic gobies than anyone in the world, does not proffer a conjecture.

Cell size

One other matter calls for brief consideration in studying these miniature fishes. One does not need to look twice at an illustration of one of these small gobies to know that all its organs and tissues are of miniature size and proportions. Then comes the reasonable question, "Are the cells they are made of likewise smaller than those of larger fishes?" Fortunately this problem has been studied by Dr. Lois Te Winkel in a thoroughgoing article on Mistichthys published in 1935.[4] She formulates the matter thus: "A most important point is whether the extreme dwarfism of Mistichthys [Pandaka and the other minute gobies noted above] is due to a reduction in the size of cells [composing the body]." This subject, she has studied in the literature and by microscopic work on sections of the bodies of Mistichthys, other gobies, and of bony fishes in general. The subject is technical but can be discussed briefly in general terms.

Most students of microscopic anatomy agree that gland cells and those of other organs that are constantly being torn down and rebuilt vary little in adult size and are not correlated with body magnitude. But permanent cells, like those of nerve and muscle, which early attain their normal proportions, do vary somewhat in size with body size, due to individual growth of the cells. Thus, "Except for brain and muscle cells, the size of cells in the mouse and the elephant is approximately the same. . . . Large animals differ from small animals chiefly in cell numbers and not in cell size." In her minute goby, Doctor Te Winkel found that certain highly specialized cells are somewhat smaller than those measured in other bony fishes. She states that the reduced size of these cells, is in all likelihood correlated with the minute adult size of Mistichthys. But the general conclusion may be drawn that the unusually small size of these tiny gobies is not accompanied by any unusually small size of the cells making up the tissues of the body. Some other cause or causes must be found for this dwarfish condition.

However, before leaving this subject, there is one cell of Mistichthys that is so small in comparison with all others of its kind in fishes that it deserves special consideration. The egg (a single cell) is, like the fish, minutely small. Smith in his imperfectly preserved specimens noted the eggs as being 0.5 mm. in diameter. In far better preserved material, Doctor Te Winkel found 20 to 40 round or oval eggs in the ovary of a female. These eggs measured 0.37 to 0.4 mm. in diameter—*less than the size of the period at the end of this sentence.* These are the smallest fish eggs on record, but their describer notes that "they are *relatively* very large—the largest diameter being one-twenty-fifth the body length of the female fish."



After Te Winkel

INFINITESIMAL "CAVIAR": five eggs of Mistichthys, the "least fish"—in 1902. Here enlarged 35 times, they are actually the size of the period at the end of this line.

Doctor Te Winkel's figure of five of the eggs *enlarged 35 times* is reproduced here. They are tied together by their intertwined filaments. Gobies are bottom dwellers, and these adhesive filaments serve to fasten the eggs to shells and stones. But the eggs of Mistichthys rise to the surface and are found in patches entangled with one another, with algae, and other small objects. There they hatch, and the young then go to the bottom.

Why all these very small fishes attain and maintain in adult life such minute sizes is at the present time an unsolved problem. Fortunate will be he who can find the key to the mystery.

Furthermore, the question will not down. "After a search of 68 years, going ever from a little fish proclaimed the smallest to one still smaller, down to an adult 10 mm. long,—have we found at last *the* smallest fish?" Who knows? The future only can answer.

[1]C. F. Girard, in *Proceedings of the Academy of Natural Sciences of Philadelphia*, II (1859), 62.
[2]O. P. Hay, in *Proceedings of the U. S. National Museum*, VIII (1885), 555.
[3]C. H. Eigenmann, in *Annals of the Carnegie Museum*, VI (1909), 52.
[4]Lois Te Winkel, "A Study of Mistichthys, with Special reference to . . . Reduced Size," *Journal of Morphology*, LVIII (1935), 463-534.

When specifically concerned with smallness, the published reports of the authors mentioned in this article are listed under SIZE in Bashford Dean's *A Bibliography of Fishes* (1923), III, 498.

THE FILM OF LIFE

By G. Miles Conrad
Assistant Curator, Comparative and Human Anatomy, The American Museum of Natural History

Among all the strange things that men have forgotten, G. K. Chesterton once commented, the most universal lapse of memory is that by which they have forgotten that they are living on a star. In all the measureless realms of space, our planet is the only particle of matter supporting any known life. And of this celestial particle, only the thinnest surface film manifests that miracle of which you and every tiniest living cell are a part. The final mystery of life will perhaps never be solved. Whence

Scattered through the infinity of space are countless spiral nebulae—star systems so vast as to dwarf our solar system to insignificance. From out in space we would have to train our most powerful telescope on a very small part of the right one of these star systems to

1

see our sun, with its nine planets, of which the earth is one. Singling out the earth, we move closer and see that a hazy atmosphere clings to the surface of the globe, through which we recognize—

2

the continents. Solid land makes up ⅓ of the surface, water ⅔. Crawling over and clinging to the sides of this whirling planet is life. The faint green of plants covers large areas; movement of animals is almost everywhere.

3

If we were to cut the earth in two in our cosmic laboratory, we would find that the liquid surface is but the thinnest coating and that the solid portion is the true core. A few feet underground all life ceases.

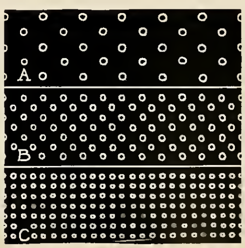
4

it came and whither into the infinity of time it may depart, no man can tell. But we can, in never-ending fascination, explore its limits, its necessities. Philosophers have said that matter cannot exist without mind to comprehend it. Science, admitting that some things are imponderable, says with surety that life, in all its manifold variety, has been shaped by certain forces. The following pages explain five factors, the failure of any one of which would banish all life as we know it from the universe.

An enlargement of the edge of our earth section where air, land, and water meet, shows that life is confined to a thin "film" about ten miles in depth. This is the only realm containing any known life in the vast immensity of space.

6

We see life in the air (atmosphere), in the water (hydrosphere), and on the land (lithosphere). The molecules making up air (A) are relatively far apart; those of water (B) closer; and those of the lithosphere (C) quite solidly packed.



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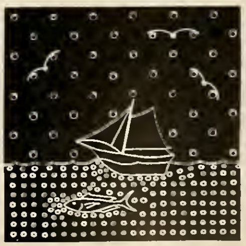
The closer together the molecules are, the greater the supporting power, but also the greater resistance to an object moving through the medium. It is harder for a bird to keep from falling than a fish, but it can travel faster.



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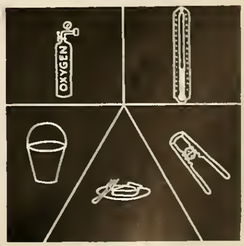
At least five factors influence the presence of life whether in the air, in water, or on land. These different but usually interacting factors are (1) oxygen, (2) temperature, (3) moisture, (4) food, and (5) pressure.



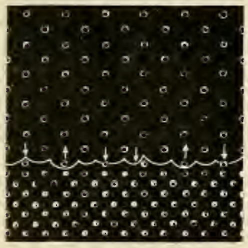
Oxygen, as a colorless and tasteless gas, is found almost everywhere on earth. Sometimes it is in combination with other elements but, fortunately for animals, it is commonly found "free" as high and as deep as
9 life can penetrate.

Many life processes are "oxidations," in which oxygen combines with other substances in the body to produce energy and heat. A candle flames brightly in a steady supply of oxygen but flickers and dies when the oxy-
10 gen is exhausted.

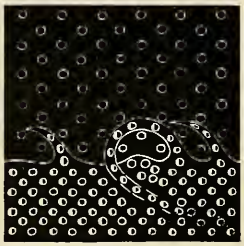
Just as the fuel in an engine is ignited in the presence of oxygen to produce energy, so does the combustion of food in the body produce muscular power. Without oxygen, protoplasm — the basic substance of life—disinte-
11 grates.

At sea level the normal content of the air is 20 per cent oxygen (○) and 79 per cent nitrogen (●), plus small traces of other gases, such as argon, krypton, neon, and so forth. This is more oxygen than is generally needed
12 by animal organisms.

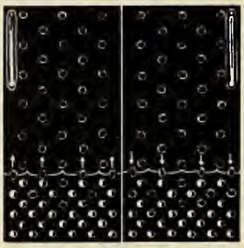
Most of the oxygen dissolved in water is derived from the air. It is captured in two ways: by diffusion at the surface and by agitation. Diffusion is a continuous process but too slow to meet the needs of water creatures.
17



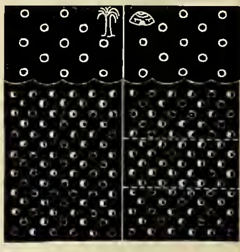
But agitation by waves and waterfalls is most effective in supplying oxygen to the waters. Air is captured and pulled under the surface by curling waves. The amount of oxygen water can hold depends on temperature and salt
18 content.



Warm water cannot absorb as much oxygen as cool. That is why polar waters support an abundance of marine life, which few people realize. Conversely, water containing a lot of salt cannot hold as much oxygen as fresher
19 water.

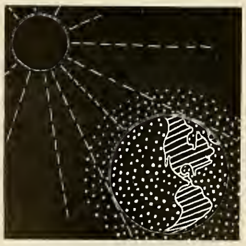


The warmth of tropical waters causes them to have relatively little oxygen in the top 1800 feet. But polar waters have three levels: *surface* layer, with much; *middle* layer, with little; and *bottom*, with a fair amount. The
20 great depths have none.



The original source of all warmth on the earth is the sun, even that of the earth's molten core. This is easily checked when we remember that nights are so often cooler than days, a sunny day warmer than a cloudy one.
25

Each hemisphere receives the same amount of heat in a year. But where the rays strike vertically they penetrate less atmosphere and are hotter. So, the heat varies with latitude and, since the earth's axis is tilted, with the
26 seasons.



Land and water absorb the heat from the sun more readily than air. Indeed, much of the heat from the sun passes through the air to the earth without loss and warms the air only after it has warmed the land and the water.
27

When land and water grow warmer than air, they radiate their heat,—causing convection currents to rise, unequal pressures to develop, and winds to blow. These things, coupled with the earth's annual orbit, make
28 our seasons.

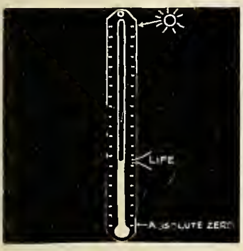
But under the stress of extreme muscular activity, oxidations will apparently proceed more efficiently with 3 or 3½ times the oxygen normally needed. Excessively higher amounts are deadly but are never found in the natu-
13 ral environment.

At high altitudes and in great ocean depths, oxygen is deficient. At 18,000 feet there is about half the oxygen there is at sea level, so the heart and lungs must do twice as much work to provide the body with the same amount
14 of oxygen.

Amounts of oxygen in water vary greatly, and many water animals have developed accessory breathing organs. A number of fishes rise to gulp air. This is dissolved in water, which in passing over the gills yields its oxygen to the
15 blood.

The atmosphere is the main source of free oxygen. The heavier gases, oxygen and nitrogen, hover close to the earth and do not occur much over 35 miles above sea level, the absolute upper limit at which life could
16 exist.

From the heat of the sun's surface to absolute zero are 11,291° F.; and of this, life is limited to a range of 150°, or about 1%. Protoplasm, the basic stuff of life, freezes at 23° F. and coagulates at 158° F.
21



Under different conditions of heat and pressure, all matter may exist as a solid, a liquid, or a gas. If it is not to solidify or boil away, life must remain within the narrow range of temperatures which limit the thin film of life.
22

Animals can be divided into two groups: warm- and cold-blooded. The warm-blooded maintain a constant body heat regardless of the weather. This is efficient, because the internal chemical processes can then continue at a con-
23 stant rate.

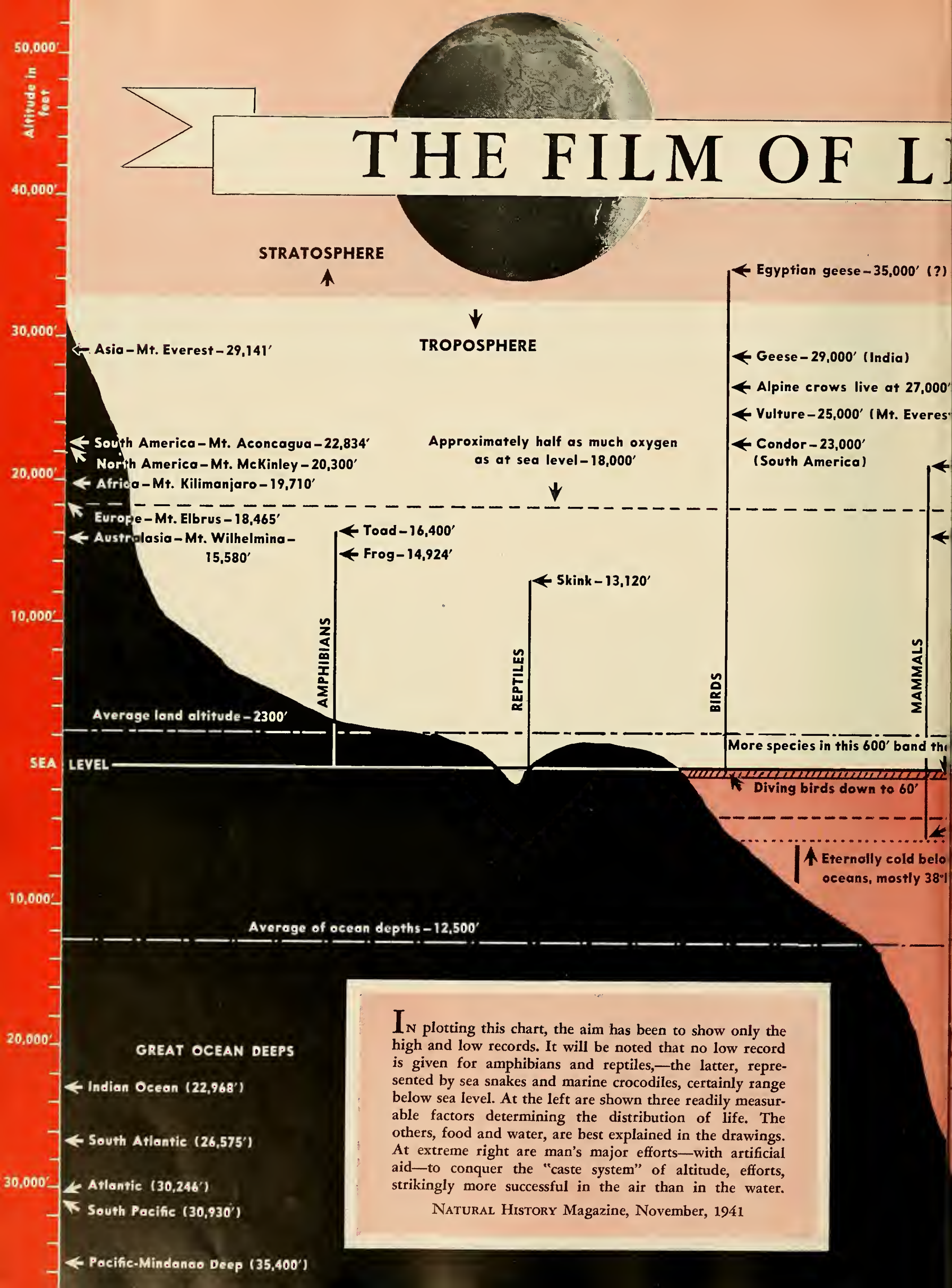
On the other hand, the body heat of the cold-blooded animal varies with the temperature of its surroundings. Thus, extreme of cold or heat will upset the internal chemical balance, and performance will be inefficient and er-
24 ratic.

The higher we go, the colder it grows, until we reach space where the temperature is —459° F. Snow line ranges from near sea level in the Arctic to 16,000 feet in the tropics; 3000 feet above this it is apt to be too cold
29 for unprotected protoplasm.

The air does not readily absorb heat and is disturbed by cold and hot winds, hence temperature varies greatly over the earth, from —130° F. to +149° F. But in the oceans, the range is only from 27° F. to 88° F.—*ideal for*
30 *protoplasm!*

Water is never found in a chemically pure state in nature. It is the "universal solvent" in which are dissolved the foods and wastes of living organisms. There is every reason to believe that life originated in the water.
31

Most of the animals that subsequently evolved moved into an atmospheric environment, but none have ever been able to break completely away from the primordial water environment, even after hundreds of millions
32 of years of evolution.

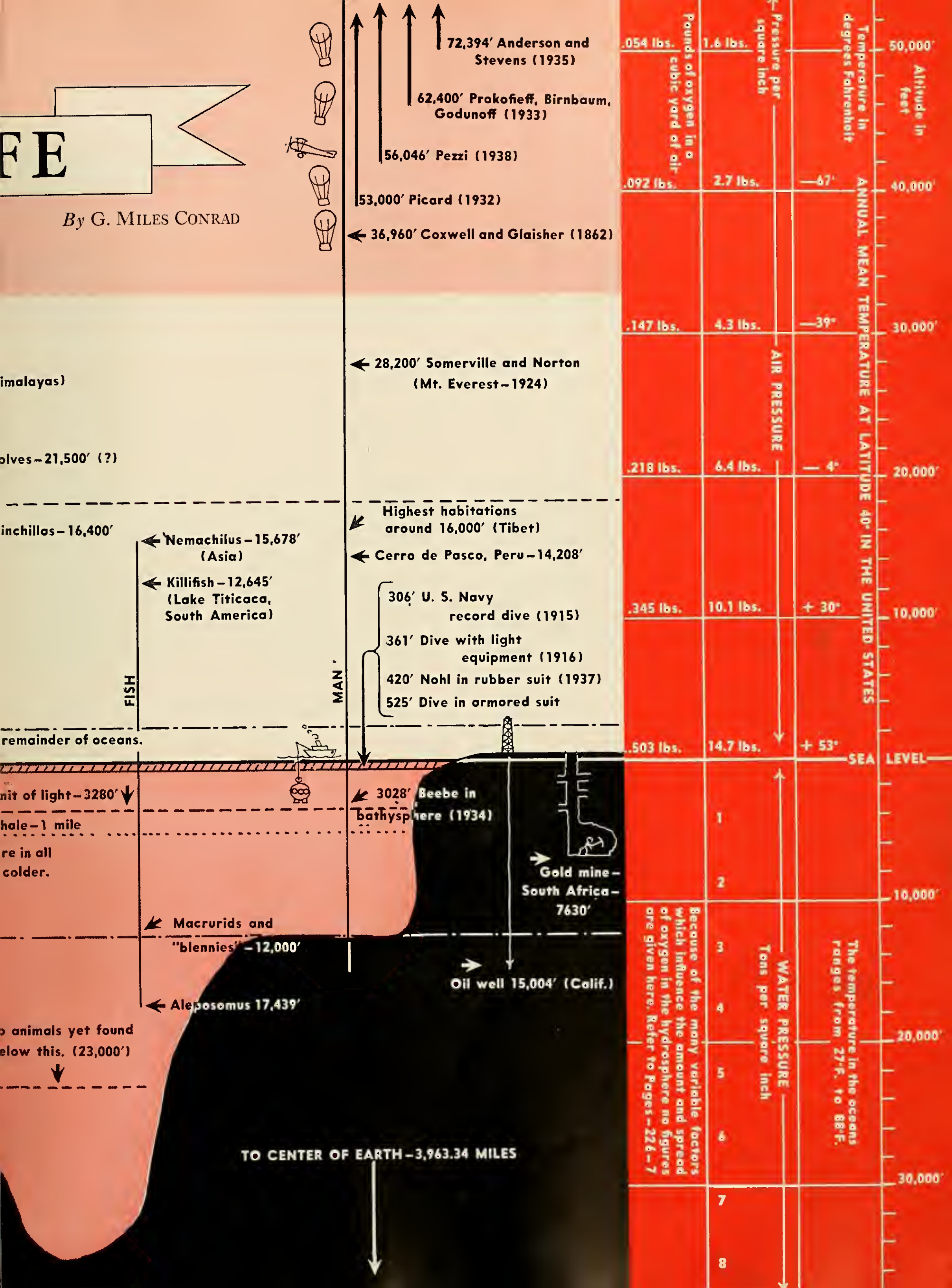


In plotting this chart, the aim has been to show only the high and low records. It will be noted that no low record is given for amphibians and reptiles,—the latter, represented by sea snakes and marine crocodiles, certainly range below sea level. At the left are shown three readily measurable factors determining the distribution of life. The others, food and water, are best explained in the drawings. At extreme right are man's major efforts—with artificial aid—to conquer the "caste system" of altitude, efforts, strikingly more successful in the air than in the water.

NATURAL HISTORY Magazine, November, 1941

FE

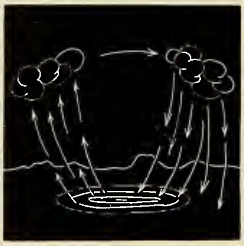
By G. MILES CONRAD



33 Indeed, so tied to the primitive environment are the land animals that they carry fluids in their bodies which contain a percentage of salt similar to that of the seas. To maintain this internal salt solution, water must be available.

34 Water vapor is found up to an altitude of twelve miles, above which no animal could possibly exist. This vapor, derived originally from the hydrosphere, is condensed and precipitated in the form of rain and snow.

35 The "sprinkling system" of the atmosphere is a perpetual motion process whereby water taken from the reservoir of the hydrosphere (oceans, lakes, and rivers) is redistributed over both the lithosphere and hydrosphere, aiding life greatly.

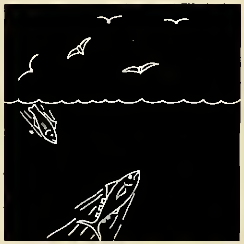


36 To dwellers in the hydrosphere, water is obviously no problem. Although water is customarily divided into "salt" and "fresh," the distinction is merely a quantitative one, for most fresh waters contain a liberal solution of salt.

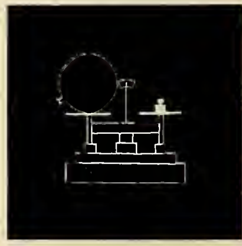
37 Pressure is squeezing or compression; it is the power of our fingers to crack the nut. Life is under constant conditioning by just such squeezing. Normally the internal pressure of an animal equals the environmental pressure.

38 But whether the animal lives in air, water, or on land, when it moves toward the earth's center the pressure increases. And if it moves in either direction too rapidly, trouble follows, for the pressure balance is disturbed.

39 If the animal descends too rapidly, external pressure will try to crush delicate organs. If he ascends too rapidly, the body tends to burst. But only animals that travel up or down quickly need special pressure adjustment mechanisms.



40 The pressures acting upon life are of two sources: air and water. It is hard to realize that air has any weight, but at sea level the 150-mile-high column of air over our heads weighs 14.7 pounds, or "one atmosphere."

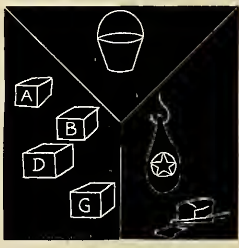


41 The higher we go, the lower the pressure becomes, until the vacuum of space is reached. However, a column of water only 34 feet high exerts a pressure of one atmosphere, and a short distance underwater one suffers from the pressure.

42 In the great oceanic depths, pressures are so great that they are measured in tons. But it must be emphasized that as long as the internal body pressure is the same as the pressure of the environment, the organism suffers no harm.

43 Food must provide, (1) the energy for running the living machine and the material for the generation of body heat, (2) the materials necessary for the renewal of worn-out protoplasm, and (3) materials for growth.

44 The stuff used by animals for food is (1) inorganic (water and salts), (2) vitamins, and (3) organic materials (proteins, carbohydrates, fats, and oils). In a sense, food is sun-energy stored by plants and taken by animals secondarily.



45 Animals that eat other animals are eating food that has all been manufactured from plants. To flesh-eaters, the rabbit is a food factory, transforming impalatable greenery into meat and exhaling carbon dioxide that the plants can use.

46 Plant-eaters are limited in their range vertically by the limits of plant life; but flesh-eaters frequently exceed the plant ranges. The ocean is less favorable to plant growth than the land, because sunlight penetrates only shallowly.

Thus ends our "news reel" of *The Film of Life,* with its five actors—Oxygen, Temperature, Water, Pressure, and Food—limiting the vertical range of animals to a thin film in the vast immensity of space.

GEM FOR NOVEMBER

The golden brown of the topaz is supremely fitting for this autumn month, though many stones that pass as this distinctive gem are but clever pretenders

By Frederick H. Pough

Acting Curator, Geology and Mineralogy, The American Museum of Natural History

THE least known and least appreciated of all common gems is that selected for November. Even among the ancients there was considerable confusion in the use of the name *topazos* (from the Greek, meaning "to seek"); and mineralogists are extremely uncertain as to exactly which stone was meant. By many it is thought to have been the peridot. Pliny tells of an "Island of Topazos" that was almost perpetually shrouded in fog. But once mariners reached the spot, they were able to obtain the stones in reasonable abundance from the natives, who alone, according to the legend, could detect their presence. Probably other stones also traveled in the topaz omnibus, but we cannot distinguish them today. Chrysolite of the Bible may well have been our topaz.

Mineralogists have never confused, in modern times, the mineral topaz with any other substance. Topaz is a complex compound of aluminum, fluorine, and silica. Like tourmaline, quartz, and corundum, it is a distinct mineral, and like them, it comes in many colors—red, blue, yellow, or green. There is a universal misconception that topaz is brown, and by circuitous reasoning that a brown gem is always topaz. Modern mineralogists have never been guilty of confusing the topaz with anything else—but, oh! the jewelers! The jewelers have been mixed up ever since brown quartz was found in Spain and marketed under the name of "Spanish" topaz." "Cape rubies" and "evening emeralds" have deceived no one in the trade; no books have been written in which garnets were confused with rubies, or emeralds with peridots, or diamonds with rock crystal. But volumes have been written in which topaz was confused with almost everything brown.

After "Spanish topaz" had been marketed for a number of years, the discovery was made that amethyst which had been heated attained a similar shade. To the jeweler this opened up wonderful possibilities, for the supply of faulty amethyst suitable for "burning" is very large. Today the stores are filled with "topaz" which should more properly be sold as citrine quartz. The value and source of amethyst and most citrine quartz are the same, the latter merely having passed a brief interlude in an electric furnace. There is also a natural citrine very similar in appearance to the heated amethyst, and it, too, is sold as topaz.

Topaz is one of the most attractive of all gems, a stone with a lively fire. A fine golden brown topaz is indeed a beautiful jewel. Few stores carry it, and those that do, sell it under the name "precious topaz" to distinguish it from the far less precious citrine quartz. The finest stones come from Brazil, the only locality now known for gems of this type, though similar stones once were found in Russia. But brown is not the only color of our true topaz: another common hue is pale blue, looking for all the world like a light aquamarine but having far brighter internal reflections. These, too, come from Brazil, but since they are so little known in this country, most are sold locally. A colorless topaz is sometimes cut and sold, often as white sapphire.

The story of the changing of amethyst and other gem colors by heat is an interesting one. Topaz itself is susceptible to heat treatment. When rich brown Brazilian stones are placed in sand and slowly heated they become, on cooling, a fine violet pink. The coloring is permanent, and treated stones are known as "pinked" topaz. They were formerly more in use than now. Many old pieces of jewelry are set with pinked topaz,—often with a colored foil backing that intensifies the color. To avoid such trickery for improving the hue or brilliance, all stones should be set so that the buyer can see the back of the stone.

The Morgenthau Topaz. From Japan this stone traveled to America, where it was cut in 1915 by Anthony J. Espositer. Its 444 facets represent about 100 hours of tedious and exacting work

AMNH photos

The world's largest topaz. Found in Brazil, this unique mass of fluosilicate of aluminum weighs 596 pounds. Examining the crystal are Mr. Whitlock, Curator Emeritus of the Department of Geology and Mineralogy, Mr. Faunce, Vice-director of the Museum, and the author

The mystic powers of topaz are perhaps a little indefinite because of the confusion accompanying the name. Topaz is mentioned in the Bible as forming one of the gates of the Holy City. Having the ruby's power in reverse, it was supposed to quench the heat of boiling water. Insomnia and asthma were cured by the powder taken in wine. Topaz was said to confer cheerfulness upon the wearer, to calm the passions, and prevent bad dreams. A gem held in the hand by a woman at childbirth was said to lessen the suffering.

Yellow sapphire is often called "Oriental topaz," and this has not decreased the confusion. Yellow sapphire is usually more golden than true topaz, but otherwise resembles it closely and has about the same value. It is found in Ceylon and elsewhere, wherever corundums are found. Oriental topaz myths undoubtedly refer to this stone, rather than to the true topaz.

The name is singularly appropriate, for even as Pliny's isle was usually lost in fog to the seeking mariners, so may the elusive topaz today bewilder the seeker of his true November birthstone. You "pays your money and you takes your choice," and in most cases it will be citrine quartz.

ARIZONA EXPEDITION

By A. L. Rand

Research Associate, Department of Ornithology
The American Museum of Natural History

What will explorers do on that not-too-distant day when the last country has been explored? This story of motorized animal photography and behavior experiments in the field suggests new worlds to conquer and shows how Museum expeditionary work carries on in spite of the war

For twelve years or so Mr. Archbold and I have been discovering new animals in the far-flung islands of New Guinea and Madagascar. From our last expedition to New Guinea we described ten new mammals and 40 new birds,—and the work on the collections isn't finished yet. But foreign conditions made this kind of exploration out of the question for the time. We were left with an organization for exploration and no place to explore. It is a situation that will some day confront the whole exploring fraternity, when the map has no more blank spaces.

Many times, in tropical jungles or in alpine grasslands, we had caught glimpses of animals doing something, something that would have required a season of study to understand. But, because our work was to get collections, this was impossible. As we often laughingly put it: "If it's a rare animal, we shoot it; if it's not rare, we leave it and look for one that is." But we still retained an urge to find out how animals lived and why they did things. Now, with our field of exploration closed, it seemed the time to develop our ideas for an expedition to discover facts, rather than things. We knew that we wouldn't have to go far, for there are many, many things unknown about our commonest animals. Mr. Archbold, too, had an interest in portraying the activities of nocturnal animals in color photographs and in developing methods for this that we could use in distant fields.

We decided on southern Arizona for the 1940 season and established headquarters there in the foothills of the Rincon Mountains, near Tucson. We were in the cactus and mesquite country. Back of us were the steep Rincon Mountains with the oaks and pines of the Transition zone; in front of us was the desert plain of the Lower Sonoran zone with its forest of giant cactus, the saguaro, stretching away to the distant mountains.

The Southwest is particularly rich in small mammals. Many of them are called rats or mice. Rats and mice to the laymen are nasty, noisome creatures that haunt closets and pantries. But those are house mice and house rats. They have a whole host of outdoor relatives, cousins many times removed, that are well worth becoming acquainted with. If only these little animals, as graceful in form and as beautiful in color as squirrels, had other names than rats and mice, they would undoubtedly be more attractive and better known. But also, they are shy, nocturnal creatures, not easy to know. There are the kangaroo rats, which make wonderful pets and never try to bite. They hop like little kangaroos, store up food against a time of scarcity, and can exist without drinking, because their body manufactures water from their dry food. They can be kept for months on a diet of dry oatmeal, a diet that will cause even house rats to die from food deficiencies.

There are also the grasshopper mice, tiny creatures that kill and eat prey like a carnivore. There are the deer mice, which are agile climbers; and there are wood rats, which make huge nests armed with cactus spines. These last belong to a group that has gained renown as trade rats, because when they steal an object from a camp they often leave something in exchange. A moral sense has been claimed for this behavior, but the accepted explanation is more prosaic. It is that the rat is already carrying something and when he finds something he likes better, he leaves what he already has. Hence, the trade.

These inhabitants of the Southwest were some of our subjects for close study.

Motorized photography

The many mammals we saw along the road in the headlights of the car as we motored over the desert at night gave Mr. Archbold an idea for night photography. He mounted a motion picture camera with sixteen-inch lenses on a truck, with a battery of lights and a generator to supply them. This outfit permitted mobility and gave a beam of light that lit up the hills for miles around. With this we cruised along the roads, photographing animals caught in the beam of light. The use of Kodachrome film of course necessitated much more light than if we had been using black-and-white film, but the results were worth the extra trouble.

Most of our night photography was done along the road that went through the near-by Saguaro National Monument. Jack rabbits were our best subjects. Both the black-tailed jack and the taller, slimmer, white-sided antelope jack were common here; but it was always the black-tailed jack rabbits that got caught in our lights. They became confused in the glare, hopped this way and that—sometimes right up to the truck—giving excellent opportunities for pictures. Cottontails were of course common but had the annoying habit of scurrying from one clump of prickly pear to another and, though not going far, usually managed to crouch in a shadowy place.

There was one night of rare good luck when a pack of javelinas trotted, with apparent unconcern, across the road in front of the truck. These little peccaries, or wild hogs, push but a short way over the border from Mexico. In fiction they are usually represented in herds of hundreds. Surrounding a hunter who has wounded one of their number, they smash his gun and rip his boots to pieces with their savage tusks as he pulls himself onto an inaccessible ledge of rock. But in Arizona they are one of the shyest animals. They are considered game and have the protection of the law for a closed season.

Irony

Occasionally kangaroo rats darted through the mesquite, but they too usually paused in shadow. So we decided to try a set for them. On a mesquite flat near the ranch house, the largest of the kangaroo rats, the bannertail, had made many burrows and mounds of earth, as is its custom. The many little tracks in the sand showed that the burrows were in use, and the photography truck was set up about 50 yards away. All was made ready to switch on the lights as soon as the animals arrived, and as darkness fell we used hand torches to try to locate them. We saw diamond-icy gleams of spiders' eyes reflected everywhere, and we picked up a night hawk's orange-reflecting eye before we saw the ghostly shapes of the bannertails. The switch was thrown, the generator roared to life, and the whole mesquite became as bright as day. The bannertails seemed to take wing, so far and fast did they leap. Though we waited until midnight, they were too shy to return. Disgusted, we gave it up. At home I turned on my bedroom light,—and there was one of the sought-after rats sitting up in the middle of the floor! In an instant I realized it was a household pet, but there was the fleeting thought of the irony of waiting for kangaroo rats in the desert while they were waiting by my bed.

Photography was only part of our work. In our research program we had assigned ourselves certain tasks. The young of the ring-tailed cat had never been described, and Mr. Richardson set out to do this. The ringtail's nearest relatives are the racoon and panda, though it is more cat-like in many ways. It has a pointed muzzle like that of a fox and a huge ringed tail, the latter a much grander ornament than that of a racoon. Thus its biology is of especial interest. Outdoor wire-mesh cages were constructed, and Richardson set wire cage-traps among the rocky ledges of the mouths of near-by canyons. In these he caught his breeding stock. They did well in the cages, proving nearly omnivorous, and in due time young were born in captivity. They were blind, scantily haired little creatures that even then showed the dark rings on their tails. By bringing two young back to New York with him, Richardson raised them until they were nearly adult, thus obtaining a complete record of their growth.

Instinctive or learned?

Behavior studies were another phase of our work. As to how birds recognize their enemies, whether instinctively, or through learning from their parents, or through experience, there are diversified views; and I worked on this, using the curve-billed thrasher as a subject. It was a common, hardy bird, and young ones removed from the nest throve in captivity. The diet finally worked out for them was canned dog and cat ration, and chili and cornmeal. This last was at the suggestion of an old Mexican I had helping look after the birds. It is a staple Mexican diet and is said to be used in raising young mockingbirds in Mexico, where they are kept as cage birds.

At various ages these birds, whose previous experience was limited to their nest and their cage, were tested as to what they feared. They fled from a ring-tailed cat loosed in their cage, and this seemed to indicate an instinctive fear of them. But the birds responded in a very similar manner to a rabbit. An electric train, at rest in their cage, was ignored; but when put in motion, all the birds flew from it. It finally appeared that fear was instinctive, but enemy recognition was not. The birds were afraid of large, strange, moving objects, and it was only through experience that they learned what not to fear.

Some desert quail we raised showed us how an unpleasant personal experience can have a lasting effect on a bird's behavior. I had twelve of these charming chicks, little balls of fluff, and inadvertently left the door of their cage open so that a road runner got in. It ate three of the quail and seized another by the wing, badly breaking the skin before the quail escaped. The effect of this experience was that ever after, this chick was much more excitable than its companions, running to shelter at alarms that the others did not notice. However, mere *witnessing* of the misfortune by the other eight chicks, which we might call vicarious experience, had not affected them.

Bluff plays an important part in fighting in the animal world. The raised hackles of a dog, the displayed crest of a kinglet, the puffing and blowing of a hog-nosed snake, help to intimidate an opponent and may make actual fighting unnecessary. Our young thrashers had an intimidation display in which the wings were spread, the mouth opened, and a loud cry given. We saw this effectively used against a cactus woodpecker. These little woodpeckers, raised from naked, blind infancy, were always quarreling amongst themselves and with every bird with which they came in contact. But once, when one attacked a thrasher, the latter gave its intimidation display—pure bluff—, and the little woodpecker was startled into leaving it alone.

The look that killed

Often I have heard the figurative expression "scared to death." But I no longer use it, for I saw one of my birds actually scared to death. It was one of two road runners that I had raised from the nest. These birds have an elaborate ceremony used in combating snakes, and to find out how they responded to other enemies I started with a great horned owl. The owl, put into the cage with them, walked toward them. The road runners darted away and fluttered against the wire of the cage. The owl watched in apparent astonishment, then walked about the cage, and the road runners followed it. This was repeated several times and illustrates one of the general rules in bird behavior: the following of a retreating object, the retreat from an approaching object. Finally in retreating from the owl, one road runner went behind a box on the floor of the cage. The owl went up close to the box, on the other side, and stood peering, swinging his head in a circle. The road runner came stalking sedately around the end of the box and met the owl face to face. The road runner simply turned, lay down, squawked, twitched its feathers and died—scared to death.

Our studies on captive birds rewarded us well for our efforts. But as opportunity offered in the field, we found new aspects of the fauna that continually intrigued us. This was an arid country, and for part of the spring the only available water for many miles on these desert flats was found in the man-made reservoirs. Thus the presence of water birds at these ponds, some of them freshly made, came as a surprise. Here, on the spring migration we found coots, cinnamon teal, scaup duck, willet, sandpipers, herons, and egrettes. A flock of snowy egrettes, circling over the giant cactus desert, always impressed me with its incongruity.

Cactus "dormitories"

On a morning ride through the desert I always saw a great many birds' nests. Some of the giant saguaro cactus were riddled with the nest holes of the gilded flicker and the Gila woodpeckers. Of course not all were now occupied by their excavators; some furnished homes for such birds as the elf owls, screech owls, crested flycatchers, and purple martins, but many were empty. It seemed as if the woodpeckers went on making holes far beyond their needs. The little domed stick-nests of the verdins, tiny gray, yellow, and chestnut relatives of the chickadee, were also numerous, and this is understandable when we know that the male also makes a sleeping nest, and that these nests in the stiff branches of desert shrubs endure, even if not used, for more than a season.

The big cactus wrens also make sleeping nests, even the young of the year, and this explained the abundance of these retort-shaped nests, usually in cholla cactus, where the nests remain for more than a season. The abundance of curve-billed thrasher's nests, almost invariably in cholla cactus and in all stages of construction and disintegration, puzzled us at first. Then we found that not only do they have a nest for the eggs and another for the male's sleeping quarters, but the birds may start several nests in a season. In raising additional broods, they shift to one of the nests they have partly completed earlier in the season, while some nests are never used. This further illustrates their well-known relationship with wrens, which habitually make cock or dummy nests. One night we made a flashlight photograph of an incubating thrasher. We knew there was a second nest below the one in which the bird was incubating, but did not think to look at it then. When the plate was developed, we discovered that there was a second bird, presumably the mate, asleep on the other nest.

The antics of a pair of flickers going to bed one night amused me. The male had already chosen the nesting site, and before dark he was accustomed to retire there to sleep. This was before the eggs were laid, and the female usually slept in a near-by hole. But one night he found the female ensconced in the nest hole. She was looking out as he came to the opening. He seemed to seize her by the nape and hustle her out, after which he went in to sleep, leaving his mate to find her own sleeping place. Certainly there is scant chivalry among birds. The male had adhered to the behavior pattern that calls for him to pass the night in the nest cavity.

The phainopepla is a striking, characteristic bird of the Tucson flats, about the size of a cardinal. It has a crest and is shiny black, with big white patches in its wings. It is usually seen sitting conspicuously on the tops of mesquite bushes, or making circular flights that display its colors to advantage. The open country, with sparse shrubbery, allows the birds to be seen from a distance, and the phainopepla's brilliant plumage and open habitat are correlated with its habit of making itself conspicuous by sight to a prospective mate and to rivals, instead of singing as do many other birds.

Arizona brought to the Museum

The new hall of North American Mammals in the American Museum of Natural History offered us an opportunity to bring home a section of this country. One group that we collected portrays the Tucson flats from a place on the slope above Malino Canyon and presents the black-tailed and antelope jack rabbits. The slight elevation chosen for the scene allows a view over the extensive "forests" of saguaro cactus, the most characteristic vegetation here, and Arizona's State flower. Accessories include barrel cactus, yellow flowering paloverde, and the red-flowered ocotillo. Actual specimens were sent to the Museum by air mail, so that flowers would be in the hands of the preparators before they withered. The background will be done from Kodachromes taken on the spot. Across the eastern plains rises the distant jigsaw silhouette of the Tucson Mountains, like cut-outs pasted against the sky. It will not be easy to get the characteristics of the country in the three by three by five-foot space allotted to this group, characteristics that are space and distance.

The time is to be sunset, when the rabbits are out feeding; when red, or orange and gold, typical dry country colors, flood the sky, and the distant hills have turned purple; before the nighthawk begins its bubbling cry, before the screech owl wakes, and just before the eerie thrilly voice of the west—the coyotes' chorus—drifts down from the hills.

The expedition lasted only from January to June, but in the amount of work done it demonstrated to our satisfaction that such an expedition, even if it discovers not a single new animal, can still accomplish a great deal.

The first *Land* Anim

By Alfred S. Romer*

Professor of Zoology and Curator of Vertebrate Paleontology in the Museum of Comparative Zoology, Harvard University

Life had existed in the water for many millions of years before the first backboned animals ventured on land. What lured them to take this epoch-making step? Better food, more air, or greater safety might seem the answer. But the true reason is as astonishing as the fact that the "accident" of their adventure populated the land with the 30,000 species of animals we know today

Fishes are all very well in their way. As Doctor Gregory pointed out in last month's Natural History, we owe much to these lowly relatives of ours. In them were developed the basic bodily patterns that have made the backboned animals, or vertebrates, dominant among animal types; and in the course of the ages fishes have evolved into a vast array of types which successfully carry on almost every mode of life available for water dwellers.

But this is only the beginning of the story. Above the primitive fish lay other and greater opportunities for the vertebrates. Beyond the banks of streams and lakes where our early ancestors swam, lay the land. Plants had already emerged from the water in ancient days to clothe the earth, and primitive insects and a few other lowly animals had also come ashore. The vertebrates were not slow to follow. From the fish stage there developed four-legged land dwellers which, stage by stage, gradually conquered the surface of the earth.

The general nature of the steps, and the evolutionary position of the animal types which were affected were shown in the chart accompanying the preceding article in this series. From the lobe-finned fishes as ancestors there developed the amphibians, inconspicuous today but of vital importance in early times as the first vertebrates to set foot on land. From early amphibians, with the development of a shelled egg capable of being laid on land, came the first reptiles, which had definitely left all traces of a water-dwelling stage behind. Once these first reptiles were firmly established there began a great wave of evolutionary

TIMETABLE OF THE AGES

Eras	Periods	Estimated time since beginning of period (in millions of Years)	Important events
CENOZOIC (Age of Mammals)	Quaternary	1	Man
	Tertiary	60	Rise of mammals
MESOZOIC (Age of Reptiles)	Cretaceous	120	Extinction of great reptiles
	Jurassic	155	First birds
	Triassic	200	First mammals; Reptiles differentiate and dominate
PALEOZOIC (Age of Ancient Life)	Permian	225	REDBEDS
	Carboniferous	275	Amphibians abundant; first reptiles; First amphibians
	Devonian	340	Fishes abundant
	Silurian	375	
	Ordovician	450	First traces of vertebrates
	Cambrian	550	Lower animal types abundant; no vertebrates

*Doctor Romer is one of the world's leading authorities on the first land animals. He has collected, studied, and described many of them, and has toured America and Europe in this line of scientific investigation. He has for many years explored the Texas Redbeds, where this chapter in the early life of our continent has its setting.—Ed.

What happened when fishes first came out on land is vividly revealed in the Redbeds of Texas. These rocks contain the remains of many transitional animals—hang-overs from earlier days and forms hinting of things to come

ls

Drawings by Francis Lee Jaques

3 Conquest of the land was assured when archaic reptiles like *Seymouria (above)* stepped ahead of their amphibian ancestors. This animal lived in what is now Texas

2 The fins have become five-toed hands and feet. This primitive amphibian was probably well able to breathe air but had to return to water to lay its soft eggs. *Cricotus,* described in the article, closely resembled this animal, *Diplovertebron*

1 *(Left)* The first use of fins as limbs is seen in this lobe-finned fish of about 30 million years ago. Both pairs of fins have developed into strong paddles. This is *Eusthenopteron,* whose backward cousins were still living when the Redbeds were formed

development which resulted in the appearance of the dinosaurs and other spectacular creatures of the Age of Reptiles. And eventually the characteristic birds and mammals of more modern times emerged.

The development of these more advanced types will form the theme of later articles in this series. Here we shall stick to fundamentals. We shall examine some of the early four-footed animals and try to find how and why and in what guise they accomplished that most dramatic step—emergence from the water to the conquest of the land.

For undertaking such an inquiry no better opportunity is afforded than in the early land fossils found in the 250-million-year-old Redbeds of western Texas.

Archer, Baylor, Wichita, Willbarger are the counties whence come the Redbeds fossils; Wichita Falls is the local metropolis; Seymour and Archer City smaller towns, which are often headquarters for Redbeds fossil-hunters. It is a land of rolling, brushy prairies, of great herds of cattle, occasional farms, with here and there a cluster of the oil derricks that have brought much prosperity to the region; a land with some unpleasant features—heat and thirst of a summer and an unpleasant abundance of rattlesnakes,—but on the whole a pleasant country to work in, full of the friendliness and hospitality of the Southwest. Here and there on the hillsides are the "breaks" for which the collector searches—places where storm waters have washed the earth bare and exposed beneath the soil the underlying clays, shales, and sandstones, often red in color, where fossils may be found.

Bones were first discovered here in pioneer days, two-thirds of a century ago, by old Jacob Boll, a Swiss botanist then teaching in Dallas. Their importance was realized by Professor Cope of Philadelphia, who immediately employed him to explore the field. Boll gave his life in this quest: he was taken ill and died soon after in his tent on the lonely prairie, with only a frightened boy to tend him in his agony. But others soon followed, and the work of many men over several decades gave us a considerable acquaintance with the life of Texas in early days.

Order of events

In the diagram on page 236 is a simplified geologic "timetable," listing successive eras and periods of the world's history. This shows the place of these Redbeds in the sequence of world events and their strategic importance in the study of the conquest of the land. These deposits were laid down at the close of the Carboniferous period (the period when the greatest coal deposits were formed) and the beginning of the succeeding Permian period which marks the end of the Paleozoic era, the Age of Ancient Life. This part of present-day Texas was then not a high prairie, but a low-lying delta country, apparently subject to occasional droughts, but covered with a rich vegetation. Across this lowland meandered slow streams, which arose in mountains situated in what is today east Texas and which emptied to the west in a great sea. In these streams and on their banks lived animals of many types, showing every stage in the emergence of vertebrates from water onto land.

Thus, in the Redbeds we find, existing at one time, representatives of a whole series of evolutionary stages,—just as in a single city we see buildings in use which represent different periods in the progress of architecture. There were typical lobe-finned fishes of the sort from which the land animals got their start; there were creatures that lived partly in water and partly on land; and there were even early reptiles, which had left the water entirely.

The fish ancestors of land animals were represented in Redbeds times by a form known as *Megalichthys,* "the big fish" (really not very big, only a foot or two in length). Like his other lobe-finned relatives, *Megalichthys* had what it takes to be the ancestor of a land form,—stout fins with muscles and bones, which needed only to develop further to become the typical leg of a land animal, and well-developed lungs for air breathing. By Redbeds times his cousins had already reached the land as amphibians, the class represented today by frogs and toads, newts and salamanders. But *Megalichthys* himself stayed on as a form old-fashioned even in those days, living for the most part a contented existence in his ancestral streams.

Next in evolutionary order among the animals of the Redbeds we see representatives of the earliest type of four-footed creatures. The advance had occurred a number of millions of years before, but an exceedingly archaic representative of the transitional type was present in the amphibian *Cricotus.* This fellow was an animal of fairly good size, ranging from a yard up to five feet or so in length. In general his appearance was somewhat like that of some of the modern salamanders, with a rather long and slender body, a long tail, and four short and feeble legs. But in internal architecture *Cricotus* was quite different from these living amphibians and in many ways exceedingly similar to his lobe-finned ancestors and relatives. Further, while *Cricotus* had developed land limbs, most of his existence appears still to have been spent in the water. He was potentially a land animal; but in reality this ancestral type of amphibian was little more than a four-legged fish.

How did land life begin? Why did amphibians such as *Cristotus* ever leave the water at all? Why did

Heat, thirst, and the danger of rattlesnakes must be reckoned with in the exploration of the famous Redbeds for the earliest land animals, but the region also offers the hospitality and charm that are characteristic of Texas. This land, now dry, was a low-lying delta country with luxuriant vegetation when the ancestors of all our modern land animals struggled to establish themselves

their ancestors ever develop their fins into limbs capable of locomotion on land? Many answers to this problem have been suggested, but most of them are highly unsatisfactory.

"To escape from enemies," some have said. But the ancestral lobe-fins were among the largest and most aggressive fishes in their native puddles.

"To gain new food supplies," say others. But both early amphibians and their fish ancestors were not vegetarians but eaters of animal food, and there was little animal food on land at the time. There were some primitive insects, to be sure, but so slow and clumsy were the legs of the old amphibians that even an archaic cockroach would have had no difficulty in escaping.

"The lure of atmospheric oxygen" is another fine phrase, but it is pure poppycock as an explanation of the emergence of amphibians. For, as we have seen, the ancestral lobe-fin had competent lungs, and he did not need to leave the water to breathe. By simply lifting his nose to the surface of the pond, he would have the world's oxygen supply at his command gratis.

The real answer to the problem of the development of land limbs appears to be a simple one, although seemingly paradoxical: *legs capable of land locomotion were developed to enable their possessors to stay in the water!*

To visualize the situation, let us compare the type of life led by our friend *Cricotus* with that of his relative *Megalichthys*, who represented the fish stock from which he had come. Both appear to have led, in Redbeds times, much the same sort of life. The fish spent his life in the water, feeding upon minnow-like fishes found in abundance there. So, too, lived the amphibian *Cricotus*. He had legs but apparently used them only a little. Small fishes too were his diet, and like the fish he was essentially a water dweller. Under most circumstances the fish was as well off as the amphibian,—perhaps even a bit better adapted to an aquatic life, for the dangling legs of the latter would be an impediment in swimming.

But it appears that hard times knocked at the door even in Paleozoic times, in the form of drought. The geological evidence strongly indicates that in the later periods of the Paleozoic era when all this happened, large regions of the earth were subject to great seasonal droughts. In regions plentifully watered at other times, the streams would be reduced to mere rivulets, deep pools would become foul and stagnant mudholes or even dry up altogether. What then would be the fate of lobe-finned fishes? For a time, and if the drought were not too severe, all might be well enough. They could come to the surface and take in air to make up for the oxygen absent in the water. Even if the pool in which they found themselves dried up completely, they might burrow into the mud and survive for a time.

But what if the drought were really severe, if the water did not return soon? Under these circumstances the immobilized lobe-fins would soon die.

Not so the amphibian. Under such circumstances his newly-developed legs showed their usefulness. *Cricotus* cared nothing for the land,—it was water he sought; and, unlike his finny cousins, he could seek it. Abandoning the dried-up pool and his dying lobe-finned relatives, he could crawl (although slowly and probably painfully) up or down the stream channels or overland; and then, reaching another pool in which water still remained, he could plunge in and resume his normal aquatic life.

Legs were not, we believe, "invented" as an adaptation for land life, but were a happy accident. Originally, it seems, they were merely an adaptation to help the fish-like animals that bore them to survive drought.

Cricotus, then, represents a first stage in amphibian evolution. By Redbeds days other members of the group had branched out greatly and passed far beyond his primitive level toward a true land life. For example, there was *Eryops,* who was a common Redbeds amphibian—a large form, six feet or more in length, powerfully built and having massive, if rather short, legs. *Eryops* may have been to some extent aquatic, but he probably spent much of his life ashore; and other amphibians of his time may have lived almost entirely on land.

Yet chained to the water

Almost entirely, but never completely. And here lies the reason for the eventual failure of the amphibians as land dwellers. The fault lies in their old-fashioned reproductive habits. A fish's eggs are, of course, laid in the water. So, too, are those of typical amphibians. Each year (as today among the frogs and newts) all amphibians must return to the water to lay and fertilize their eggs. The young, as is easy to see in the case of frog tadpoles, pass their early days as purely water animals, using gills for breathing and eating aquatic food. Then comes a violent change, a metamorphosis—the gills shrivel, lungs and legs develop, and many internal organs undergo marked reorganization: the tadpole changes into an adult which can exist on land. But even so, the adaptation to the land can never be complete, for the grown amphibian must be able to return annually to the water for breeding purposes.

This sort of thing is obviously highly inefficient. Suppose, for example, that the reader's car had to be so designed as to be used also as a motorboat. Such a machine can be made, but it would be expensive, inefficient for either line of work, and would probably have difficulty competing with either a proper boat or an ordinary automobile in its proper medium. So with the amphibians. Though able to survive drought conditions such as existed in the early days of the group, they are not remarkably good performers in the water. And the reptiles which arose soon after them are far better adapted for life on land. Faced with keen competition in both environments, the amphibians quite understandably became a "discouraged" group, greatly reduced in numbers, until today they constitute but an insignificant element in vertebrate life. The land they have almost entirely abandoned. At present a few toads range far afield, but most amphibians cling close to the banks, and some salamanders have slumped backward to a state in which they never emerge from the water.

Signs of such degeneracy were present even in Redbeds days, when amphibians were still fairly abundant. An example is *Diplocaulus,* seen at the water's edge in the illustration reproduced on page 243. This grotesque little creature had a broad, flat body and a flat and ponderous head. The limbs were so tiny that they could hardly have lifted the head above the water and surely could not have carried the animal about on land. Such a form was only fitted for a permanently aquatic life, and presumably it spent its days as a mud-grubber in pond bottoms.

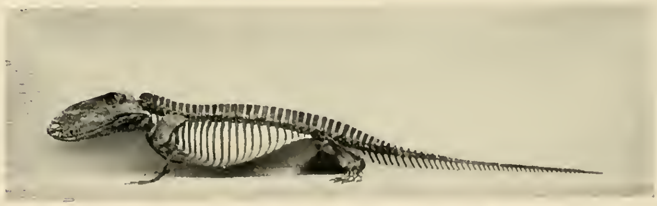
The late Sherwood Anderson once entitled a short story "The Triumph of the Egg." This would be a fitting title for the story of the development of the reptiles, which had originated from a progressive amphibian stock shortly before the Redbeds times. In the Redbeds are very primitive stem reptiles (cotylosaurs), best typified by *Seymouria* (named for the county seat of Seymour near which its remains have been found). *Seymouria* was a rather small and stockily built little fellow *(see illustration*

The Oldest Known Egg

THE KEY TO PERMANENT LIFE ON LAND: the earliest and only true egg from the Redbeds. The amphibians, though able to live on land, were obliged to return to water to lay their eggs, which had no shell to protect the delicate embryo within from drying up. This fossilized egg, discovered half a dozen years ago by a keen-eyed collector, Llewellyn Price, epitomizes one of the most dramatic chapters in the conquest of the land. Possessing a protective shell, it represents the basic patent which enabled animals to break the chain tying them to the water. The method of giving birth to living young was a still later development

(*Below*) THE SKELETON of *Ophiacodon,* reconstructed from the preserved bones. Here we have a primitive reptile which, however, had feet and skull that foreshadowed the emergence of mammals, the dominant class of animals inhabiting the earth today

Geo. Nelson photo



A PRIMITIVE ANCESTOR OF THE MAMMALS. Certain of the reptiles, like *Ophiacodon* below, led the way in the direction of our vast assemblage of familiar four-footed animals of forest and field

From Prehistoric Life, *by P. E. Raymond, Harvard University Press* *on page 237)*. In his skeleton there are a few features which seem to show that structurally he was a reptile. But he was an exceedingly archaic one, and in many ways quite close to his amphibian ancestors.

The real reasons for the success of the reptiles over the amphibians lie not in the build of the adult body but in the mode of reproduction. The amphibian, as we have seen, is chained to the water. Since the young must develop there, and since the adult must periodically return there for the egg-laying season, the amphibian can never become a purely terrestrial animal. Not so the reptile. For in this group there has been evolved a new type of egg, which can be laid on land. This sort of egg is still laid by turtles and many a lizard and snake today. It is still present in even a few mammals (although most now bear their young alive); and it is found on our breakfast tables in the enlarged form adopted by the reptiles' avian descendants. The egg is protected externally by a shell, which is absent in amphibians. The shell, although firm, is porous; thus oxygen may enter and allow the growing embryo to "breathe." Within the shell a series of liquid-filled membranes gives additional protection to the young and prevents it from drying up. Still further, to supply the food which the encased youngster now cannot gather for itself, much of the egg is composed of a nourishing yolk. So equipped, the tiny germ inside the egg can skip the tadpole stage entirely and grow within its protecting shell and membranes to a point where, on hatching, it can at once take up an existence on land. By the shell-covered egg, the reptile has been emancipated from the water and can now become completely adapted to terrestrial life.

Oldest known egg

We have long felt confident that such a type of egg had been developed by the Redbeds animals that we characterize as reptiles. But fossil eggs are rare, although many a cobblestone in fossil deposits looks like such an object. The first—and only—true egg from these beds was discovered half a dozen years ago by a keen-eyed collector, Llewellyn Price, who immediately recognized its nature and importance. It is a small, oval, iron-stained mass, not at all exciting to look at. But its battered and cracked surface shows tiny patterns of the sort seen on many reptile eggs, and the microscopic structure shows definitely that this surface is an egg shell. This is the oldest known vertebrate egg—approximately twice as old as the famous and more abundant but relatively recent dinosaur eggs from Mongolia *(see photograph page 241)*.

Once finally released from the water, there began the spectacular evolutionary development of the reptiles and their descendants. Even in Redbeds times we see the beginnings of this reptilian radiation. And, most interestingly, the commonest reptiles of those early days (pelycosaurs) even showed the beginning of mammal-like tendencies.

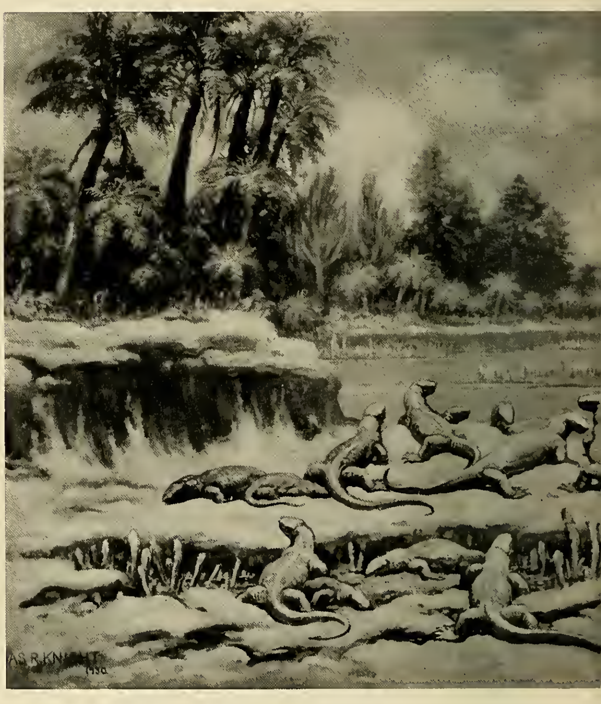
The mammals, the warm-blooded, hair-bearing and intelligent animals that include man among their members, are such progressive forms that one might think that they developed late in the history of reptilian life. The reverse is actually true. As will be noted from our geological timetable, the first mammals appeared as early as did the dinosaurs. Advanced, very mammal-like reptiles were present at the beginning of Mesozoic days, and in Redbeds times their ancestors, as pelycosaurs, had already branched off from the main line of orthodox reptilian evolution.

Typical members of these primitive mammal ancestors are such forms as *Ophiacodon (page 241)*. This reptile was still very archaic, still very close to the primitive reptile type. He was, however, a bit slimmer, a bit longer-legged, and in details of feet and skull he shows the first faint traces of characteristics which later emerged full-fledged in the mammals.

Evolutionary experiments

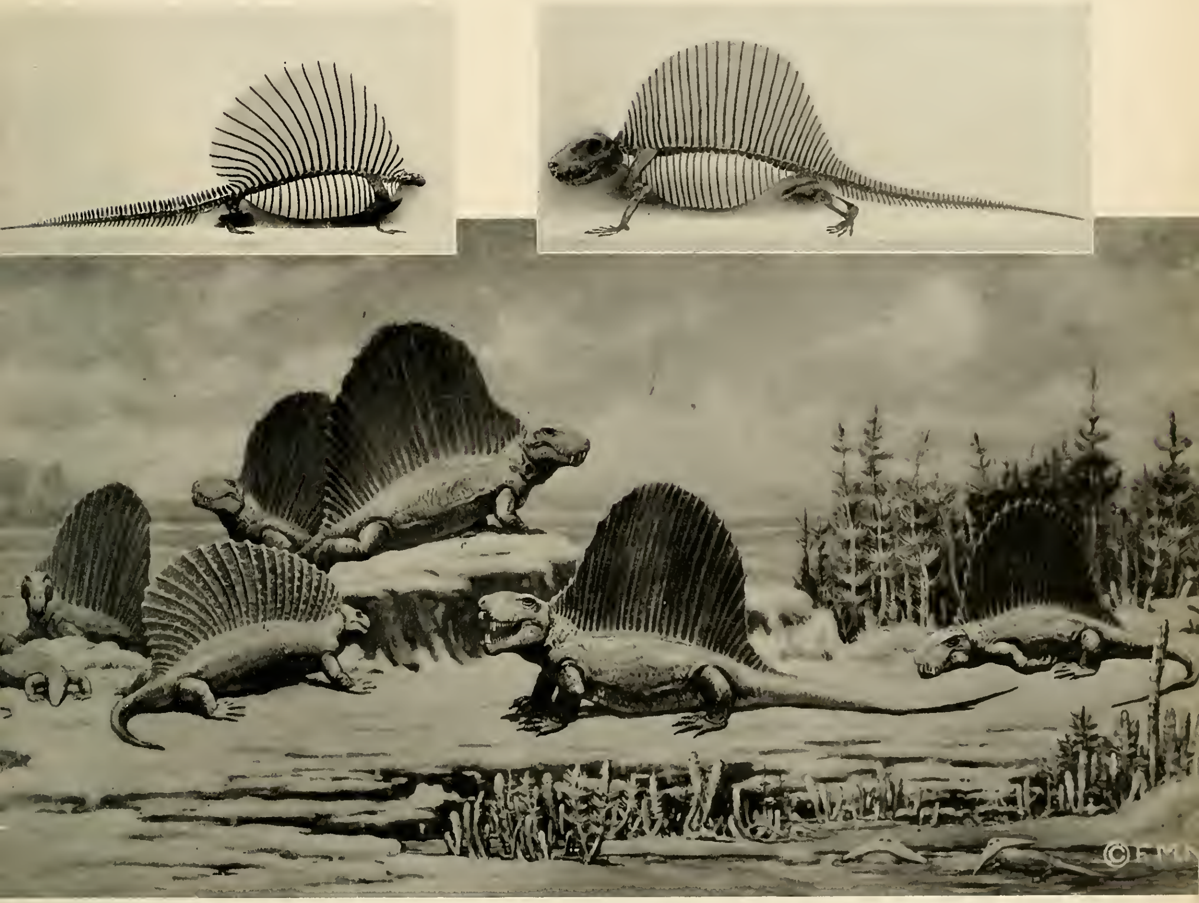
No group of animals ever kept solely to an evolutionary main line; always there occur side branches, varied, short-lived "experiments." Among the pely-

SAILS? A short-lived evolutionary experiment among the early land animals was the development of peculiar extensions of the back among the reptiles known as pelycosaurs. This scene, reconstructed from scientific sources by the well-known artist Charles R. Knight, vividly shows the Texas landscape as it appeared a little over 200 million years ago. Two forms of "sail-carrying" reptiles are illustrated, *Edaphosaurus*, whose spines were shorter and had knobby side-branches, and *Dimetrodon*, whose "sail" was supported on long, smooth spines. Whether these animals went sailing around their prehistoric lakes with these appendages cannot be said. But, as any sailor knows, if they floated with the "sails" projecting above the water, they would most certainly have had to reckon with the wind



The reconstructed skeletons of these "sail-carrying" reptiles are shown below. At extreme left in the painting is a small reptile of the time, named *Casea*. At the water's edge at lower right, the grotesque little amphibian, *Diplocaulus,* raises its ponderous head above the water; its limbs were too weak to carry it about on land

Geo. Nelson photos



Field Museum photo

cosaurs such development resulted in the appearance of reptiles with peculiar "sails." The bones which cap the back in any ordinary animal grew upward as long spines between which, we believe, there stretched a continuous covering of skin. Two such types are shown in a mural by Charles R. Knight *(see illustration)*. In one *(Dimetrodon)* the spines supporting the "sail" are long but smooth, slender rods; in a second *(Edaphosaurus)* the spines are shorter but with knobby side branches that have been compared with the yardarms of a ship. The purpose, if any, of this peculiar type development is quite unknown. The original describer of these forms suggested facetiously that these reptiles went sailing about the Redbeds lake with them. This idea is not better but also no worse than any other that has been advanced.

Redbeds animals were not as big as those of later days. Although some of them are rather peculiar in build, they lack for the most part the "glamour" of some of their more advanced and spectacular descendants in later geologic periods. My brethren in the bone-hunting game may have their dinosaurs or what not; the writer, at any rate, prefers these older fossils. The study of Redbeds animals is a difficult and tantalizing process. Collecting them is often a dreary task, fraught with heat, thirst, and discouragement. But these ancient fossils are important and their collection well worth the trouble. Land dwellers have progressed far beyond the condition of their crude and ungainly Redbeds ancestors. But the first steps in any process are the most important ones; and, both literally and figuratively, the first steps in land life are revealed to us through the animals of these ancient beds of the Southwest.

A MODERN GULLIVER

As Curator of Living Invertebrates, which comprise eleven-twelfths of the animal kingdom, Roy Waldo Miner shuttles back and forth between the fascinating intricacies of a microscopic Lilliput and the overpowering grandeur of Coral Seas

By D. R. BARTON

MUSEUM visitors entering the Hall of Ocean Life for the first time, or even the twenty-first, will be struck by the astonishing beauty of the exhibit at the far end. There stands the Bahaman Coral Reef Group, one of the most complicated exhibits ever attempted by a museum organization. It has taken twelve long years, thousands of dollars, and probably more equipment and assorted brain power than any other project in the history of the institution. A sheer 35 feet of plate glass forms the front of the exhibit. More than half way to the top, a balcony spans the show case horizontally. The balcony itself simulates the deck of a yacht anchored in warm Bahaman waters. A magnificent background by Frances Lee Jaques* shows huge, billowing clouds, pink flamingos and wind-blown palms, all in the path of the trade winds, which shape the entire topography in an east-to-west direction. But this is merely the beginning. We have only to descend the stairway to be confronted by 30 feet of ocean floor in living color. Here the giant elk horn coral gives colorful variety to the scene. Feathery, trailing gorgonians float upward and delicately tinted fishes dart out from the shadowy waters between the formations of coral and sponges which have been restored to natural colors and arranged in the same positions they occupied when five Museum Bahaman expeditions were sent out to find them.

Almost everyone knows the astonishing fact that over 40 tons of living coral were dredged from the ocean floor and put into this single exhibition case, a tour de force involving eight and one-half tons of iron work and some remarkable feats of engineering. For this group had no recipe. It was something that had never been done before, and the difficulties arising from the fact that the stresses and strains under water are not the same as those on land had to be worked out by Doctor Miner and his corps of assistants as they went along.

Nearby, a companion exhibit has recently been completed. This is the Pearl Divers Group, based on investigations around the South Sea island of Tongareva. A spectacular display, it contains ten and one-half tons of coral, re-tinted and composed into the exact position from which it was wrenched from the Tongarevan lagoon at a place where the precious pearl shell grows luxuriantly. Together, these two exhibits are the embodiments of the prolonged labor of so many highly skilled individuals that some believe that their complexity will not be equalled in the Museum for years to come.

AMNH photo by Coles

ROY WALDO MINER

Roy Waldo Miner, the man who made them possible, has spent a fair share of the last two decades under water, gliding eerily along tropical sea bottoms, looking for just the proper settings and specimens. He has braved death in the shape of man-eating sharks, moray eels, octopuses,

* *See also* D. R. Barton, "The Odyssey of a Bird Artist," NATURAL HISTORY, May, 1939, p. 298.

barracuda, and huge sixteen-armed starfishes equipped with poisonous spines. As with all the other lethal denizens of the deep, Doctor Miner knows one of the latter when he sees it, and treads warily. However, if he ever had taken a false step, native divers claim that the sea star could easily have been made to repair its ravages. Their advice is to flip this sea-bottom hedgehog over on its back and let the powerful suckers go to work on the wound before the poison spines have had a chance to worm their way into the blood stream. Fortunately, Doctor Miner never had to test the efficacy of this remedy, but he did once narrowly escape an altercation with a quartet of sharks by following another of the natives' helpful hints. The incident occurred in a coral "cave," 25 feet down, where Miner was busily snapping pictures with a special waterproof camera (one of the less arduous preliminaries to building coral reef groups). The sharks, who entered via the only exit, displayed the keenest interest in this unusual performance and, in fact, became so brazenly curious that Miner was forced to stake all on the wisdom of the native diver's formula which is to lunge at the man-eaters, threateningly swishing the arms. It worked. The inquisitive sharks turned tail and huffily swam away. But Doctor Miner hates to think what would have happened if they'd called his bluff, and he refuses to endorse the formula as foolproof. So if you swish a threatening arm—and lose it—don't sue.

To discover why Doctor Miner gets himself into such fixes, we must go back to the day a gathering of Museum officials were knitting their brows at one end of the Hall of Ocean Life wondering what, apart from the already superabundant whales, they were going to use to fill the vast space at the other end. On being consulted, Miner suggested a coral habitat group. For, while the coral polyp may be one of the smallest sea creatures, its ramifying structures of living rock reach staggering proportions. The Australian barrier reef, for example, is 1400 miles long. Much as he would like to, Miner could not promise to bring this living mountain ridge back to the Museum, but he was quite confident that something perfectly adequate to the specifications of the Hall could be found nearer home on Andros Island in the Bahamas. He submitted plans, models and—a budget. It looked like a big job. But he put himself on the spot by guaranteeing success. Thus dangers and discomforts could not be allowed to stand in his way.

A Bumpus protégé

Though he has engaged in such bizarre tricks of the trade as stunning tropical butterfly fish underwater with an elaborate cap gun attached to a bamboo pole,* Roy Miner started out with much less startling ideas in mind. Like his illustrious colleague and erstwhile professor, William K. Gregory,† Roy was early destined for the Episcopal ministry. Son of a renowned classical scholar, and younger brother of a clergyman, he grew up amid a scholarly New England atmosphere in North Adams. At Williams, where he was a member of the class of '97, he studied the classics and sciences in equal amounts, scoring high grades in both, but leaning slightly in the direction of biology, partly owing to the inspired teaching of Dr. James Ingraham Peck, who persuaded him to take a summer course at Woods Hole Marine Laboratory. This was, Doctor Miner recollects, "an eye opener." So enthusiastic a student did he become of all the marine forms of life, and so diligent was his work, that he quickly attracted the attention of Dr. Harmon C. Bumpus, one of the outstanding zoologists of that day. Seven years later when Miner walked into the director's office at the American Museum, Doctor Bumpus remembered him instantly and at once put him to work on a part-time basis. Miner's subsequent activities raised Bumpus' already high estimation of his skill as a biologist, and before long the Director induced the young man to give up teaching for a permanent post on the Museum Staff.

During the years leading up to this offer, Miner had gone through the Theological Seminary, passed his canonical examinations with flying colors, and then made up his mind against the ecclesiastical way of life. At loose ends, he decided to market his fund of classical and scientific information at the Berkeley School for Boys in New York. There he met up with another teacher who wanted to start a school of his own, and Miner joined forces with him. Together they opened the Kelvin School, Miner handling the biological sciences and classics as before. Even today his proficiency at Latin is the envy and wonder of his curatorial colleagues. Though he has not taught for 30 years, he can still reel off in five minutes, a lengthy English translation that would cost his associates many hours of brain-cudgeling and dictionary thumbing.

His first job at the Museum put him directly on the road to his most spectacular success in later life, for he was assigned to the coral collections and spent a good deal of time on identification and reorganization of the material. But young Miner was a long way from specializing in this or any other field. In those days the Museum was not nearly so departmentalized as now, and the Invertebrate Section, of which he became Assistant Curator under William Morton Wheeler, was obliged to concern itself with a motley array of scientific material and equipment including amphibia, reptiles, forestry, and last but not the least curious of all—scientific instruments. However, Miner's tastes in scholarship had always been on a catholic scale and he wasn't even slightly perturbed to be set to work counting all the rings on all the specimens of trees in the Forestry Hall. Just as he had enjoyed the minutiae of Hebrew manuscript comparisons at the Theological Seminary, he now took delight in organizing detailed data to be handed over to the Forestry Department when that division of Museum activity at last came into being. This penchant for painstaking spadework is characteristic of Doctor Miner. Even in his present executive capacity, he likes to do everything he possibly can himself.

Nor were trees his only avocation during these early years. A fine all-round biologist, he worked a good deal with vertebrates and later actually wrote his doctor's thesis on one of them.‡ But though he had previously done some mammal dissection for the Preparations Department, fish were the particular life form that came under his scrutiny, and he became so accomplished a student of their ways that Bumpus asked him to choose between continuing as Associate in Invertebrates or becoming

*This is the only way to catch them alive so that the gorgeous radiance of their natural colors can be recorded by an artist before they fade.

†*See also* D. R. Barton, "The Evolution of an Evolutionist," NATURAL HISTORY, April, 1941, 234.

‡*The Pectoral Limb Musculature of Eryops.*

Chief Curator in the Fish Department. But Miner remained true to his "first love."

Showman

One of the things that prompted Director Bumpus to offer Miner a curatorship in Ichthyology was the fact that the latter wound up in a dead heat with Doctor Lucas, Director* of the Brooklyn Museum, when both competed for an essay prize offered by the National Fish Congress at Washington,—the subject: Public Exhibition of Fishes. The essay was written at Bumpus' suggestion shortly after Miner had supervised this Museum's first public display of the finny tribe.

Though his undoubted talents as an ichthyologist were never put to the supreme test, Miner has proved over and over again that he is a master of Museum "showmanship." Axiomatic in curatorial credos is the tenet that executive duties, including those of public instruction, consume a man's research time. Yet Miner has tackled many of the "internal" study problems of his department singlehanded, is on intimate terms with the projects of all his assistants, and keeps up with the latest publications in the field without slackening his pace at the external work—the public exhibitions.

Unique among the curators in possessing a full-fledged preparations department of his own, Miner is a Museum version of the Hollywood writer-director-producer. A benign Svengali, he has the knack of bringing his own dreams to fruition by evoking the best in others. And all the magnificent displays in the Ocean Life and Darwin Halls are glowing testimony to this gift.

The artists and technicians under Miner's direction have changed from time to time over the years, but three of his hardy perennials† have received attention in these pages and a fourth, Chris Olsen, whom Doctor Miner justly terms his right-hand man is already well-known to readers of this Magazine and the public at large, as the man who paints pictures under 20 feet of water with weighted brushes, in order to preserve the exact coloring of the undersea conditions which he must reproduce on Museum backgrounds as well as among the interlacing branches of the coral specimens themselves. For coral quickly dies on exposure to air and must be carefully re-tinted prior to its installation within a group. In fact nearly all color in these large groups is restored artificially, which helps to explain the number of artists required.

Olsen may well be termed Doctor Miner's Man Friday of Brobdingnag, but his Trilby of Lilliput is Herman Mueller, whose lung power and wondrously manipulative fingers have wrought the rotifers and other creatures living in one-half inch of ordinary fresh water pond bottom into a magical glass blower's world magnified one million times by cubical measurement. Working from drawings made by Dr. George Childs under Doctor Miner's direction, after careful microscopic study, Mueller has created for the admiration and instruction of all, the ecological situation of several species of rotifers, including those which, as Doctor Miner describes them, "build beautiful tube-shaped homes for themselves of spherical bricks of transparent mucus." Many of these creatures are so small that a whole colony could occupy a pinhead, yet some individuals in Mueller's reconstructions are as large as a young lobster. Under Miner's direction, Mueller has spent the better part of 35 years immortalizing these popularly neglected animalcules and many other lowly forms of life. And the result cannot be duplicated for accuracy and beauty anywhere else in the world. All during their long association the scientist has worked with collecting apparatus and microscope to find something the glass blower could not reproduce, but he has never yet succeeded. Miner's fame would remain secure on the score of this particular Trilby alone. But there are other singers in the cast—George Childs, for example, who devotes an entire year to making a single model of a worm. The anatomy of sea worms is bewilderingly complex to the human eye, and Miner, with his flair for teaching, developed an arbitrary color key for Childs to work on—black for nerves, chrome yellow for digestive tracts, etc., which resulted in modeled replicas of startling clarity for public instruction. "Thus our artists," Miner has remarked, "are the organ keys upon which the symphonies of popular exhibitions are played."

Eleven-ring circus

Miner is never at a loss to invent some pardonable "improvement" on Nature. Nor is he reluctant to accept the suggestions of his aides-de-camp along these lines, though strict adherence to naturalistic detail is inevitably the order of the day and Miner will tolerate no newfangled "impressionism." Cramming 30-odd tons of coral into a 35′ x 30′ x 12′ space and having it look like sea bottom demands a little compromise somewhere—the miracle is, it's so slight. Indeed that goes for all the features in Miner's show, which is really not a three- but an eleven-ring circus, owing to the fact that his department is responsible for all but one of the twelve phyla (major groups) into which the entire animal kingdom is divided.

In 1909, Doctor Miner was placed in full control of the exhibition work in Darwin Hall, wherein he had been a participant for some time. Under his direction, work on the alcove models of all twelve phyla was pushed forward and the window groups begun. The latter—seven in number—represent not only the first pioneer attempts to create three-dimensional, life-like groups of the humble marine organisms, but the most successful achievements to date in the interpretation of the intimate relationship between organism and environment along our shores.

Long before blueprints and drawings, diagrams, and charts, could be handed over to his adjutants, Miner had to collect all the data together with hundreds of specimens on the coasts of Maine, Massachusetts, and Long Island. This Hall is a triumph of visual instruction, and student, layman, and specialist alike have profited by visiting its cool alcoves. The fact that Miner was working on the microscopic Rotifer Group and the huge Coral Reef Group at the same time caused him to comment on the Gulliver-like psychological somersaults which he was compelled to perform in the course of an ordinary day's work. It also stimulated him to pen his philosophy of size:

"Size is an important factor to many people. An elephant is imposing because of its bulky stature, and when met in the wild state in the jungle, it appears dangerous to men and a

Continued on page 256

*Doctor Lucas later became Director of the American Museum.

†*See also* D. R. Barton, "The Art of Herman Mueller, Glass Blower," Natural History, April, 1938, p. 299; "Master Miniature Builder," (George H. Childs), *ibid.*, September, 1938, p. 145; "The Man Who Came Back," (W. H. Southwick), *ibid.*, January, 1939, p. 55.

YOUR NEW BOOKS

EARTH'S HISTORY • MODERN INDIANS • SIERRA SOJOURN
PEATTIE'S SELF-PORTRAIT • PLAGUE ON US • MINERALS
CHEROKEE MARTYR • HAWAIIAN MYTH AND HISTORY • BIRDS

RIVER OF RUINS

- - - - - - by Louis J. Halle, Jr.

Holt, $3.00

RIVER OF RUINS is a travel book. It is an account of travel in the forests of the Petén district of Guatemala and the state of Chiapas in Mexico. There is an abundance of adventure and hardship, but there is nothing conventional in this pattern of incident and scene. Louis Halle has a deeply cultivated mind, and he can write the king's English. The result is a book which combines vigorous and humorously burly adventure with an infinitely charming intellectual reaction.

Mr. Halle and his friend Tom Gladwin set forth to visit this little-known part of Middle America to seek ruins and collect birds. They found the ruins, but the insects prevented their amassing ornithological specimens. Thus, to the record of adventure Mr. Halle has added not only the fresh impressions of a field naturalist regarding the flora and fauna of the region, but also the unsentimental and unromantic accuracy of a historian when describing the ruined cities of the Maya.

River of Ruins is a distinguished addition to the growing corpus of books on Latin America. It is especially important in that it brings the literary approach to a field dominated by flatulent journalese and desiccated technical writing. I cannot recommend too warmly *River of Ruins.*

GEORGE C. VAILLANT.

BIOGRAPHY OF THE EARTH, ITS PAST, PRESENT AND FUTURE

- - - - - - - - by George Gamow

Viking, $3.00

DOCTOR GAMOW, Professor of Theoretical Physics at George Washington University, and author of *The Birth and Death of the Sun* has produced a work that is unique among the popular accounts of earth history. Most authors of books upon this subject devote an opening chapter to the problems and theories of the origin of the earth, and immediately turn to the discussion of the later eras where the sequence of events and the evolution of life is well-known and documented. Doctor Gamow has completely reversed this emphasis, one-third of his book is devoted to the origin of the planets (including the earth) and to the "birth" of the moon. Only one chapter (less than 40 pages) is devoted to life on the earth, and more than one-third of this chapter is concerned with the problems of the origin of life itself. The entire paleontologic record is summarized in about eighteen pages. The remaining pages are concerned with the internal constitution of our planet, with the origin and evolution of the continents, and with a discussion of the future of the earth and the solar system.

It is this reversal from the usual distribution of subject emphasis that makes this work valuable and important to the student of earth history and to the well-informed reader. Doctor Gamow, a theoretical physicist, has contributed to research on problems of the solar system, and because of this scientific interest is admirably equipped to discuss the theories and problems of the earth's formative years. And this discussion is a very real contribution. Unfortunately, however, Doctor Gamow is not a paleontologist, and the pages devoted to the fossil record contain many errors. Most of them are not of great significance, but they are, nevertheless, most regrettable in a work which otherwise is so valuable.

H. E. VOKES.

THE ROAD OF A NATURALIST

- - - by Donald Culross Peattie

Houghton Mifflin, $3.00

MR. PEATTIE'S most recent volume is something less than an autobiography and something more than a collection of essays on nature, and yet it forms a coherent whole. The non-biographical text shows us the author's thoughts, which are as much a part of the man as the briefer paragraphs about his life. Each digression falls naturally into place in relation to the particular epoch of the author's career that brings it into view.

Thus, a short review of the life of the young naturalist, Robert Kennicott, is a logical corollary of the Peatties' return to live at Kennicott's Grove. The story of the fearful crossing of Death Valley by the forty-niners finds an entry with a visit to the Mohave Desert, as does a discussion of the rôle of the Pronuba moth in the fertilization of yucca flowers.

There are many such side journeys; in fact, they form the bulk of the volume. There is the story of Michaux's discovery of the little plant, *Shortia*, lost again for 99 years and a day, when it was discovered by Professor Sargent. There are comparisons of the vast evergreen forests of the West with the hardwoods of the East, and impressions of the life of the intervening prairies. There is note of the once vast flights of passenger pigeons, of the California redwoods, of the persecution of the Pacific sea otters, and of the activities of the eggers on the Farallones. There are the stories of Coronado's search for Quivira, and of C. V. Riley's pioneering in the science of economic entomology. There is a chapter on the evolution of nature writers, their place in the scheme of things, and their relationship to the research scientists on whom they must depend for the facts they popularize. Through it all runs the author's philosophy of life.

So, although we are told only scattered bits of personal history, and these not always chronologically, in the end we have a picture of the author drawn by his own hand, against his chosen background,—a self-portrait rather than an autobiography.

JOHN T. ZIMMER.

PLAGUE ON US

- - - - - - - - by Geddes Smith

The Commonwealth Fund,

41 East 57th St., New York, N. Y., $3.00

IT is a pleasure to recommend Geddes Smith's book, *Plague on Us.* In recent years, there have been a number of popular and semipopular volumes on the vast subject of the valiant fight of man against the agents of infection. Many of these books were written in an over-spirited manner in hope of engaging the attention of the reader in what the writers must have originally considered a dull subject, otherwise they would not have deemed necessary the "injections" they supply. But Geddes Smith, whose attractive literary style for some reason reminds us of the *Education of Henry Adams,* has gathered together a vast fund of information concerning the infectious diseases and how they are spread, in a way that engages the attention of the reader from first to last. Heretofore complicated subjects, such as the mechanism of the fight of the human body against invasion by disease-producing agents, have been simplified by Mr. Smith's sheer charm of writing.

The how and why of epidemics, much of which still remains a deep mystery, is explained so clearly that even one without any previous training in medicine will be in possession of the pertinent facts as far as they are known. Therefore, *Plague on Us* can be read with enjoyment not alone by the intelligent layman but also by those who are preparing to specialize in the field.

Mr. Smith has taken pains to record

fully the sources of his information, and a complete Index adds to the value of this attractively published volume. He has been painstaking concerning history of his various subjects. It seems unfortunate, therefore, that although yellow fever is brought to the attention of the reader on several occasions, no acknowledgment is made of the pioneer work of the modest Cuban physician, Carlos Finlay, who was the first to lay before us the theory of the mosquito transmission of this disease, which he did in 1881. Moreover, the idea of possibly conferring immunity by allowing mosquitoes to bite mild cases of yellow fever and then healthy persons is wrongfully credited to Gorgas apropos of Reed's work (1900), when in reality it was first advanced by Finlay in 1881 and again in 1895.

MORTON C. KAHN.

DANA'S MANUAL OF MINERALOGY (Fifteenth Edition)

- - - - - Revised by C. S. Hurlbut

Wiley, $4.00

THE fifteenth edition of Dana's *Manual of Mineralogy*, revised by Dr. C. S. Hurlbut, is a complete revision of the older text. In this book will be found a discussion of the *origin* of the 197 minerals described, a contribution which makes the *Manual* outstanding among books for beginners in mineralogy. Nowhere else will so much information about the occurrence and associations of the common minerals be found. Study of mineral occurrences eliminates nine-tenths of the amateur's confusion, showing that at a given type of locality only a few minerals with generally similar appearances will be found. Thus, 100 minerals are eliminated, and determinative tests made for but one or two.

The needs of the collector are twofold, he must learn about his minerals and he must have confidence in his authorities. Too many books are written by other amateurs who lack the background of experience and fundamental knowledge. Here is one which is unimpeachable. J. D. Dana, the author, and W. E. Ford, the earlier reviser, were foremost authorities; and the present reviser, Dr. C. S. Hurlbut, Professor of Mineralogy at Harvard University, carries on the tradition most creditably. For the amateur and the student the book may be considered an essential tool, unequalled by any other and occupying a niche of its own. This revision of an old work should not be neglected by collectors for newer but far less valuable books.

F. H. POUGH.

TWENTIETH CENTURY INDIANS

- - by Frances Cooke Macgregor

Putnam, $3.00

THERE is gradually growing in North America an appreciation of our first settlers, the Indians. A steady stream of nontechnical books has flowed into the market, the good outweighting the indifferent. Many of these excellent volumes are heavily illustrated since we need a visual understanding of peoples who have left no readily accessible literature.

Mrs. Macgregor has produced a most important book, which describes the present and future of the Indian without nostalgia for their past. Her own sensitive and strong photography lends force to the points she makes in her text, both of which are stamped with the seal of approval of no less an authority than Dr. Clark Wissler.

Mrs. Macgregor emphasizes the contemporary position of the Indians and the problems they face to survive in our modern world. The reservation life, imposed by the whites, at first tended to reduce their numbers, but in the last half century has enabled their population to increase. However, the various types of social order and material culture which were adequate for the Indian's existence under pre-Columbian conditions, have become largely transformed into a livelihood submarginal in terms of white standards. Mrs. Macgregor, in photograph and text, drives the point home that economic conditions, which would melt our hearts when endured by whites, are rather far above the lot of many of our Indian groups, sequestered under the loving care of the Great White Father.

We know that the zoological park and the arboretum do not answer the needs for conservation of natural resources. The Indian Bureau is beginning to work out means for conserving the human resources of our Indians and to depart from the zoo technique of the old-line reservation. Mrs. Macgregor has set forth the plight of the modern Indian without wailing and gnashing of teeth. She has pictured the fortitude of the Indians who maintain an unfaltering way of life in adversity. Despite the gloomy cast of this review, her book presents a lively, even charming, view of our modern Indians. *Twentieth Century Indians* should take its place among the foundation books for general knowledge of our Indian tribes and cultures.

GEORGE C. VAILLANT.

PUEBLO INDIANS OF NEW MEXICO

- - - - - - - - - - by David Hare

Distributed by William Salloch, 344 East 17th St., New York, N. Y., $36.00

DAVID HARE, a well-known artist-photographer of much skill, has prepared a portfolio of his own photographs in natural color. The subjects chosen are Indians of eighteen different pueblos of New Mexico, ranging in age from an infant to a centenarian. No Pueblo Indian is shown in a Plains Indian headdress, nor even in the ceremonial costume of his own people. Each is shown as he is today in the everyday European clothes that he has adopted from the white man. The only things to remind one of the old-time, pre-Spanish costumes are in some cases the headdress and a modest array of beads and other jewelry.

These are photographs of Indians with emphasis on the Indian as a human being. The photographs were not made by the well-known kodachrome process, but, as Mr. Hare explains, from direct color separations with no intermediate process. They are dye transfers from gelatine matrices, and each print is an original photograph and not a reproduction. The prints are about ten by thirteen inches in size, and are mounted on mats of thirteen and one-half by seventeen and one-half inches. The attractive paper of the covers of the portfolio was made especially for this collection of photographs. Very appropriately, it is an adaptation of Indian pottery designs.

These are the best photographs in natural color of people that this reviewer has ever seen. When one looks at the face of one of these Indians, he can hardly keep from exclaiming, "That is not a photograph—that is human skin!" Beads and turquoises are unbelievably realistic! And the collection is made much more interesting and valuable by an analytical Introduction written by Dr. Clark Wissler, Curator of Anthropology in the American Museum. The Library of the American Museum is fortunate in having a set of these superb and unique pictures.

CLYDE FISHER.

SIERRA OUTPOST

- - - - - - - by Lila Lofberg and David Malcolmson

Duell, Sloan & Pearce, $2.50

A FEW people, but very few, can record observations concerning wild animals they have known intimately without becoming maudlin or anthropomorphic. Mrs. Lofberg manages to avoid such foolishness with a fair amount of success, and while she had pet names for each animal, she points out that this was out of respect for the personality of each creature that she came to know in her secluded mountain home.

Her book is a delightful, factual account of events that took place in the Sierras of Fresno County, California. Mrs. Lofberg spent nine interesting years at Florence Lake, 7,300 feet above sea level, where her husband was an engineer engaged on a hydroelectric project. Armed with a copy of Chapman's bird guide and an intelligent interest in the reptiles, birds, and mammals, the Lofbergs established the highest year-round birdbanding station in the Biological Survey, enticed numerous mammals into their "yard," and all in all gleaned much from their Sierra sojourn. Woven into the account of their hardships in a camp cut off completely during the winters from the nearest towns are observations on birds, woodchucks, squirrels, chipmunks, white-footed mice, skunks, coyotes, and timber wolves. Accounts of the several coyotes they watched so carefully contain information that trained observers have failed to record, and there are sound observations on the balance of nature that gradually became restored after the construction gang the first year had destroyed the equilibrium locally by killing many of the larger predators.

Despite its factual reporting, *Sierra Outpost* is thoroughly good reading. There is little foundation for a few speculations, such as that concerned with the supposed mating of a coyote and a timber wolf, but Mrs. Lofberg makes no pretense of being a trained observer with a scientific background. Her modesty is in pleasant contrast to the writing in many books on the market that seemingly were written to glorify the author; she has been neither effusively sentimental nor spectacular, and for the most part her interpretations have been accompanied by cautious qualifications. The caliber of the book is greatly improved as a result.

C. M. Bogert.

Within the Sound of These Waves

- - - by William H. Chickering

Harcourt, Brace, $3.00

In these days of fast-moving and terrifying world events, an increasing number of authors are turning to write of remote periods of history, or of small or little-known people. By limiting their theme to such small groups as the history of the Hawaiian islands, they are developing a new sort of escape literature, replacing that kind which used to be written around the Noble Savage, the Noble Red Man, and various colored shadows of the South Seas.

Within the Sound of These Waves is a very good example of this new type of writing, combining quite careful research into old historical sources with an exceedingly romantic treatment of the past of Hawaii, as the Hawaiians once described it in their myths. Although the author's purpose is not explicit, the book does actually give, by the ease with which it slips between telling of ancient myth and historical king, a very good impression of the way in which the past and the present, the Gods, their heroic descendants, and those Hawaiian chieftains who encountered the first white voyagers, were probably linked together in the native mind. The details of the visit of Captain Cook and his murder by the natives have been looked up with care, and the scene is related with spirit and a good deal of first-hand comment from the diaries and reminiscences of the members of Captain Cook's company.

So, by giving a gay and rapidly-moving selection from Hawaiian mythical history, followed by an equally gay and somewhat documented account of early historical days in Hawaii, the book manages to give a feel for the islands and their type of sense of the past.

Margaret Mead.

Elias Boudinot, Cherokee

- - - - by Ralph Henry Gabriel

University of Oklahoma Press, $2.00

Romance, tragedy, grim realism, and religious intolerance characterize this story of two lives,—the youth, a Cherokee Indian, the girl, a sincerely religious Protestant of Connecticut. The Indian youth is educated and well-conditioned to the white religious culture of the time, to the end that he becomes a religious leader among his own people; the girl is the daughter in an old white family noted for their religious zeal. They fall in love at the beginning of the story. The girl is fanatically religious, feeling a call to go among the Indians as a missionary and the bride of this young Cherokee. The family and the community are horrified, attempt to force the girl to desist, and resort to a mass meeting in which her own brother burns her effigy, with the result that she is more determined than ever to follow the dictates of her heart and the mandates of her religious conviction.

Yet this is not fiction but plain, fully documented history. Elias Boudinot and Harriet Gold are real persons. They begin their mission on the Indian Reservation, become influential, live normal, happy lives, yet are involved in the terrible tragedy of the Cherokee nation,—the wife to die a natural death, the husband to be assassinated as a martyr to his conscience.

The author is a historian of note, able to write history as if it were fiction. Our readers desiring a striking chapter in the social history of New England and the South should consider this volume, for the statements are accurate and the social interpretations justifiable. Further, the book is written in a pleasing artistic style.

Clark Wissler.

By Light of Sun

- - - - - - - by Elsie Symington

Putnam, $2.00

This is not a how- or what-to-do book on gardening, though there is no doubt that the author is well-versed in the art. Rather, it is a treatise on the richer and more abundant life that is attained through intimate association with mother earth. Here is the inquisitive mind of the true lover of nature, always seeking for whatever revelations the Creator of all growing things is willing to impart. The autobiography is richly informative, noble in conception, and very absorbing. Not only is it well worth reading, but also rereading, for it passes on to the reader a philosophy of life and the serenity of spirit which reward those who live close to the soil.

There are a few illustrations, to be exact three in number, done in woodcut. They are very good in draftsmanship and composition, and are in keeping with the spirit of the narrative, adding much to its attractiveness. Would that there were more of them, for the book is worth it.

Laurence Blair.

Birds in Your Backyard

- - - - - - by Virginia S. Eifert

Illinois State Museum, Paper-bound, 60¢

This book has the tang of originality. The page biographies contain the local and general information one expects to find in a work of this scope, but there are also descriptions of appearance, voice, and characteristic traits, presented with a freshness of expression evidently born of intimate acquaintance with the living bird.

The author's brush rivals her pen. Her 95 full-page drawings are lacking in detail, but, in some exceptions, they are animated by that essence of individuality that makes a successful portrait. For good

Continued on page 252

HUNTING DINOS WITH THE CAMERA

University of Utah photograph

Photograph of a large dinosaur where it fell

By CHARLES H. COLES

Chief Photographer, American Museum of Natural History

STRADDLING the border between Utah and Colorado lies Dinosaur National Monument. A sharp upthrust of Jurassic-Triassic sandstone has laid bare the bony remains of ancient beasts in this desolate region. To protect these valuable deposits from the marauding hands of souvenir-hunters, the United States Government has drawn this area into its protective custody so that only duly accredited scientific organizations may remove specimens. The rangers on guard are only too happy, however, to show visitors the petrified remnants of these ancient inhabitants of our country. A small museum at the rangers' headquarters displays a large number of odd bones left by several scientific expeditions.

Dinosaurs in the rock

Photographing the partly exposed specimens in the rock is by no means easy. When an expedition is at work, there may be sections of a skeleton sufficiently well excavated to enable the interested spectator to see a considerable portion of the bony structure of one animal. Generally a paleontologist will work in and around bones that bid fair to yield a more or less complete skeleton intact, even though buried entirely in the rock. If the skeleton lies with its length parallel to the surface of the rock, the chances are pretty good that at some stage in the excavating a well-defined outline of the dinosaur may be seen and pictured. Do not assume, however, that a whole dinosaur or even a major part of one, may be seen at the Monument at the present time. No expedition is working there now, and consequently only small fragments are visible.

Taking pictures of these fragments presents many difficulties because of the similarity in texture and color of the bones and the surrounding rock. Only because the bones protrude slightly above the rock surfaces and so form shadows when the sun falls upon them is it possible to photograph the specimens. Outlining the bones with chalk to make their edges more apparent will help greatly. Our two eyes can detect these weathered-out bones because of their ability to "read in" the illusion of depth, but a photograph does not show this third dimension. The use of shadows, chalk, and perhaps a pointing finger included in the picture, will locate and outline the fossil remains.

Photographs in color do not reveal the bones any better, since they are almost the same color as the rock.

Fossils in the Bad Lands

The Bad Lands of South Dakota contain a large number of fossil deposits of the Tertiary period, which came just after the decline of the dinosaurs. This year the American Museum of Natural History sent an expedition under the leadership of the late Dr. Walter Granger to collect specimens of fossil mammals. Kodachrome still photographs as well as motion pictures were made of some of the expedition's activities, to be used for educational purposes.

The intense brightness of the Bad Lands is due both to the clear, dry air and to the very light color of the hardened sand. So dazzling is the reflected light that the needle of a photoelectric exposure meter bounces clear off the upper end of the scale. Obviously the meter is of no use under these conditions.

To render the instrument serviceable, a piece of card from a film carton can be fastened to cover half the photoelectric cell window, thus reducing the light intake to half its value. The needle now falls back to a usable section of the scale. The difficulty here is that all readings must be doubled before translating them into terms of diaphragm setting and shutter speed, and, of course, the dial calculator of the meter accommodates no such high light values. The solution is to place a 2x yellow green filter over the camera lens and just forget to compensate for it. The meter is then read as it normally is. The filter compensates for the card on the exposure meter.

Color photography

It is a good rule to make use of the meter readings for exposures on black and white film but to ignore them for Kodachrome exposures. In the filming of the expedition's activities, the photoelectric exposure meter would have had us use a lens aperture of f:22 at 1/25th second for Kodachrome. Actually, the minimum possible exposure for daylight Kodachrome seems to be 1/25th second at f:11. Less than this will result in too dark a transparency. So, screwing up his courage, the photographer set his motion picture lens to f:11 and shot the scenes in color. The films turned out perfectly exposed; and still Kodachrome exposed in the same manner turned out equally good.

Here also the specimens are about the same color as the sand. In one place dozens of shells from fossil turtles are seen. Casts of the bodies of the turtles lie beneath the shells, although no skeletal remains are in evidence. Pictures of the shells present no problem because of their size and clearly defined shapes. Though some shells have weathered into fragments, many of them are still intact. Photographing these from the shadow side emphasizes their outlines. Pictures made with the sun behind the camera show practically no differentiation between the sand background and the light-colored shell.

Because the excavated skulls of some of the larger four-footed animals are rather delicate, they have to be held together for shipment by shellacking to them pieces of thin rice paper. In order to obtain surface details, the pictures were made before this operation was begun, for the rice paper covers and obscures all faint contours. Taking advantage of glancing sunlight, the photographer was able to bring out hardly noticeable undulations by slightly exaggerating them. It is preferable in all photography of this type to set the specimen upon a background differing in color sufficiently to produce contrast. Just wetting the sand around the specimen will darken the background enough to produce the desired effect. In this way the outlines of the object are well defined.

The stay-at-home photographer who is lucky enough to find fossil remains not too far from his own doorstep and the traveling filmer who is privileged to visit our country's great storehouses of prehistoric bones will both find in fossil filming a challenge to their ingenuity and photographic skill.

Continued from page 249

measure the accessory vegetation is usually named, thereby adding to the information value of the book.

Mrs. Eifert writes from Springfield, Illinois. Her locale is defined by her title but, in effect, the area covered includes Sangamon County. An Introduction states her point of view and offers advice to beginners. An Appendix is a calendar-diary which, week by week, carries us through the bird life of the year. In a word, this book is a distinct contribution to the illustrated literature of ornithology and should win immediate recognition for its author-artist as a successful portrayer of bird life.

F. M. Chapman.

WE FOLLOW THE WESTERN TRAIL

- - - - - - - by Ruth Wheeler

Macmillan, $2.00

WANDERLUST at some time in life generally gets into the veins of most mortals. Prehistoric life as revealed in rocks often brings on this urge to be off, plants reported from out-of-the-way places will bring the same reaction in others, while many will respond to the lure of the promise of solitude. From Mrs. Wheeler's book, *We Follow the Western Trail,* the indication would seem to be that the whirr of bird wings, or the possibility of finding opportunities for photographing bird activities, was the magnet that drew her into the open. The theme, which at times is a little sentimental, is mostly about her experiences having to do with birds of the West coast.

Probably the ornithologist will find her recordings of the nesting habits of rosy finches of the Sierra Mountains her greatest contribution to science. Her most dramatic description will be found in the chapter pertaining to the immense havoc wrought by forest fires.

Naturalists who have been intrigued by California's ever-changing contours and diverse forms of life, will find that Mrs. Wheeler strikes many a responsive chord in this account of her answer to the wanderlust call.

Farida A. Wiley.

FOUNDATIONS OF BIOLOGY (Sixth Edition)

- - - - - by Lorande Loss Woodruff

Macmillan, $3.75

MANUAL OF BIOLOGY (Sixth Edition)

- - - by George Alfred Baitsell

Macmillan, $2.75

DOCTORS WOODRUFF and Baitsell of the Osborn Zoological Laboratory at Yale have reissued these estimable works in new editions, which bring the respective texts up to date in every respect. In these supplementary volumes, the student will find thorough grounding in the science of living matter, presented in a manner that is a signal credit to both publisher and scholar.

INFORMATION TEST

A few informational high spots that may be gleaned from this month's NATURAL HISTORY

Correct answers on page 256

1. What precious stone can you make an amethyst resemble, and how?

2. Amber is
- (a) Fossilized resin of prehistoric trees
- (b) A derivative of ambergris
- (c) The same as meerschaum

3. Kohl is
- (a) One of the world's oldest cosmetics
- (b) The trade name for black diamonds
- (c) Anthracite that has been prehistorically struck by lightning

4. The early fishes that gave rise to all the land animals developed legs so they could
- (a) Escape from their enemies
- (b) Gain new food supplies
- (c) Stay in the water

5. The body cells of a mouse are approximately the same size as those of an elephant.

True.......... False..........

6. Kangaroo rats can live without drinking any water because
- (a) From birth to death they lose none of their original bodily fluids
- (b) They manufacture water from their dry food
- (c) They absorb rain through their pores

7. Because he can exist both on land and in the water, the amphibian is Nature's closest approach to the perfectly adapted organism.

True.......... False..........

8. Does the yolk of a hen's egg eventually develop into the chicken's body, while the white becomes the feathers?

9. The largest topaz in the world weighs
- (a) one-quarter ounce
- (b) one-quarter pound
- (c) one-quarter ton

10. If you saw the tracks shown in the photograph below, what animal would you say had passed?

WHAT PASSED BY? An unusual photograph submitted by John M. Lofton, Jr., of McClellanville, S. C. If the picture itself does not tell you, see Answer to Question 10, on page 256

NATURAL HISTORY TRAVEL GUIDE

THE SOUTHWEST

Guaymas

Guaymas is situated opposite Lower California in the northwest sector of the Mexican mainland, and is one of the principal resort towns on the Gulf of California coast. Both commercial and game fish exist in abundance in this region. Other recreational facilities are outlined in the advertisement below.

Arizona

Among the sights of interest to NATURAL HISTORY readers touring this locality are the large Papago Indian Reservation just southwest of Tucson, and the San Xavier Reservation immediately to the south. National Monuments and government-protected forest lands stud the entire state of Arizona, of which the northeastern corner is given over to the Grand Canyon National Park. Subscribers may gain some idea of the breath-taking grandeur of the southwestern desert scenery by referring to Josef Muench's magnificent "Skyscrapers of the Desert," a photographic story of Monument Valley, which appeared in last month's NATURAL HISTORY. The hobbyist interested in places of archaeological or fossil-hunting significance will find hereabouts an embarrassment of riches, rivaled only by the extent and variety of the natural wonders in which this section abounds. Arizona is full of historical interest, from its southwest corner where the Devil's Highroad (soon to be described in NATURAL HISTORY) still lives up to its record as one of the most dangerous thoroughfares ever traveled by man, to the Hopi and Navaho country in the northeast.

California

Southern California possesses less spectacular canyons than Arizona, but for devotees of natural history the Salton Sea Migratory Bird Refuge, numerous small Indian Reservations, and the Joshua Tree National Monument all deserve prominence on a list of things to see in the Southwest. In NATURAL HISTORY's selection of rare trees, California had a greater variety of them than any other state in the Union, nor is there any other spot in our country that can equal the range of altitude between Mount Whitney and Death Valley. The latter, contrary to its forbidding reputation, is a winter playground of the first rank. East of San Francisco is the world-famous Yosemite Valley, while to the north lies the Sacramento Migratory Waterfowl Refuge.

 Continued from page 193

SIRS:

In return for the enclosed check will you please send your magazine NATURAL HISTORY . . . as a birthday gift. . . .

I might say in passing that I am still but a beginner as one of your subscribers, yet so instructive and interesting is your publication that I feel certain our acquaintanceship will be long and profitable. It is consoling to know that at least one publication is not racked with hysteria.

THOMAS D. BOWMAN.

Rydal, Pa.

* * *

SIRS:

Please send me one each of the following charts: "Cycle of Life," "S.O.S. for a Continent," and "Beaver House," for which I enclose 20¢.

If they are half as good as the Magazine they must be *good,* and, therefore, worth having.

WITMER S. HUNT.

Forest Park, Ill.

* * *

SIRS:

The reader of NATURAL HISTORY will recall the splendid illustrations which accompanied the article on termite architecture by Dr. Alfred E. Emerson in April, 1937. As we are becoming more Western Hemisphere conscious, it might be pointed out that Panama possesses some of the finest termitaria in the world.

The smaller termite "houses" are apt to be hemispherical, resembling somewhat an overturned round-bottomed kettle. But they may form about and conform to the shape of any core structure, such as a crooked fence post; and as they grow larger, may become more acutely conical, like a huge inverted funnel.

Some of them with rather flaring bases measure more than 30 feet in circumference. The taller ones are as high as the combined height of two average men.

The inside of one of these "air-conditioned" mounds is a disappointment to the amateur, who has labored hard to cut into it. All that he sees is a cross section of many tortuous and ramifying galleries of small bore. Usually there has been an exodus of the occupants at the approach of the hacking tool, and the few soldier termites that form the rear guard are scant reward. But the expert termitologists may find the galleries of great interest. Examining these mounds of *Amitermes foreli* Wasmann on May 11, 1935, Doctor Emerson found more than a dozen other kinds of termites living in their runways, some of them new species!

The national highway enables one to get a creditable view of the termitaria without getting out of the car. In the dry season when the growth is not high, one can see small to medium-sized mounds from near Panama City all the way to Aguadulce (about 130 miles). Here they reach their greatest development within about two miles of the city. Closer inspection can easily be had by driving off the road or walking less than a mile.

GEORGE O. LEE.

Canal Zone Junior College,
Balboa, C. Z.

1 The smaller termite mounds in Panama are apt to have a rounded shape.

2 —but they may form about any core structure such as a crooked fence post and take their shape from it.

3 As they grow larger, they become more acutely conical.

4 In height they range to eight and ten feet, or more. Carefully measured in conjunction with the Canal Zone Junior College field biology class, the flaring bases of the largest ones proved to be more than 30 feet in circumference.

5 Many of the termite "houses" slope off center. Evidence of compass orientation was at first suspected but this is not the case. Possibly local factors such as the direction of the wet season rains determine the direction of the building.

6 A cross section of one of the mounds reveals many tortuous and ramifying galleries, from which most of the occupants have departed except for a few soldier termites that form the rear guard.

DO NOT MISS

From the whole broad realm of Natural Wonders

BIG

● THE FAMILY TREE OF THE DINOSAURS—a special feature of next month's NATURAL HISTORY Magazine, showing for the first time in one pictorial display all the main types of dinosaurs and their family history down to their extinction 60 million years ago.

LITTLE

● A HOUSE OF BUBBLES—a brilliant series of close-up photographs revealing pictorially for the first time in history how the tiny froghopper builds its almost microscopic home.

HOT

● THE DEVIL'S HIGHWAY—the epic story behind a road in the United States on which more than 400 persons have perished from heat and thirst, the last of them within the past few months.

COLD

● WE LIVE IN AN ICE AGE—proving that we have not emerged from the last glacial period and that it is an even guess whether palm trees may grow in Alaska or continental glaciers once again descend, to bury our civilization a mile deep in moving ice.

ON YOUR RADIO

Programs of the American Museum and Hayden Planetarium, Fall and Winter, 1941-'42.

SUNDAYS over the Mutual Broadcasting System from 9:30 to 10:00 A. M.

This Wonderful World. Questions and answers on nature subjects, and discussion of Museum exhibits brought before the microphone.

•

SUNDAYS over the Columbia Broadcasting System Network from 1:30 to 2:00 P. M.

This Is the Life. Discussion of the life history of Man in various lands, based on exhibits in the anthropology halls of the American Museum.

•

WEDNESDAYS over the Columbia Broadcasting System Network from 9:15 to 9:45 A. M. (Central Time: 2:30 to 2:55 P. M.; Mountain Time: 9:30 to 10:00 A. M.; Pacific Time: 1:30 to 2:00 P. M.)

Lands of New World Neighbors. The dramatic story of men and events that are the fabric and fiber of New World exploration and expansion.

•

FRIDAYS over the Columbia Broadcasting System Network from 3:45 to 3:55 P. M.

Americans Map the Skies. The story of the growth and development of astronomy in America.

A MODERN GULLIVER

Continued from page 246

creature to be avoided. On the other hand, beings which are so small we can scarcely see them, appear insignificant, or if they are of such microscopic size that they are invisible, are often ignored entirely. Yet all the elephants that have ever lived in the jungle have done far less damage to the human race than the microscopic parasite of malaria has accomplished in a single epidemic.

"We seem important to ourselves because of our intimate knowledge of mankind, derived from the evidence of our senses. Niagara and the Grand Canyon seem huge to us. Yet the telescope reveals among the stars wonders of such magnitude that, in comparison, our earth dwindles to an insignificant speck and the human beings upon it shrink to the dimensions of microscopic germs.

"Therefore, size is relatively unimportant. The most significant factor is life, which is of the same nature in microscopic organisms as in ourselves."

Honors

Doctor Miner's expeditions have taken him from New Brunswick to the West Indies where he joined other Museum colleagues in the historic effort, sponsored jointly by the American Museum and the New York Academy of Sciences, to carry out a concentrated biological survey of Porto Rico and the Virgin Islands, while other expeditions took him down to the Lesser Antilles to collect material for the Pearl Divers Group.

Always popular with his colleagues and associates, Doctor Miner is ever in the vanguard of general activities. In fact, the Curator of Living Invertebrates never lets the dignity of his position interfere with his good fellowship at Museum social affairs. And he inevitably figures prominently on committees. He is Chairman of the Committee on the Popular Publications of this institution, and has represented the Museum at several scientific gatherings in other cities.

For many years he has served the New York Academy of Sciences in various capacities and is now winding up his second term as President. "There won't be any third term," he says with a twinkle. "The constitution doesn't allow it." Many additional honors have deservedly been bestowed upon him including an honorary Doctorate of Science from his old Alma Mater, Williams.

Since he is already at work on the part played by the continental shelf in the life of marine animals, we may expect new projects of public education to be forthcoming from his expeditionary activities, which will undoubtedly be as brilliantly conceived and supervised as those already standing as monuments to his name.

BLITZED BIRDHOUSE

PRIORITY meant nothing when a swarm of social wasps decided to take over this wren house on the campus of Keuka College, Keuka Park, New York. Nor did they spare the photographer, R. E. Hart, who was given a warm reception when he took this unusual picture

FLOWER SHOW

The Flower Show of the New York Horticultural Society will be held this year from November eighth to tenth at the American Museum of Natural History. Members of the Museum are cordially invited to attend this exceptional exhibit.

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.

Answers to Questions on page 252

1. An amethyst can be made to resemble a topaz, by heating it. See page 231
2. (a) Amber is the fossilized resin of prehistoric trees. See page 205
3. (a) Kohl is one of the world's oldest cosmetics, used by women of the East to darken their eyes. See page 206
4. (c) So they could stay in the water when their pools dried up, forcing them to crawl overland to reach other ones. See page 239
5. True. The body cells of a mouse are approximately the same size as those of an elephant, but there are far fewer of them. See page 223
6. (b) They manufacture water from their dry food. See page 233
7. False. The amphibian is "jack of two trades" but master of neither. He is not a particularly good performer in water, yet must remain near it. See page 240
8. No. The yolk supplies nourishment for the growing chick embryo, which is protected from drying by the white and the shell. See page 242
9. (c) The largest topaz in the world, which is on display in the American Museum of Natural History, weighs over one-quarter ton—596 pounds. See page 231
10. The tracks shown in the photograph reveal that a large turtle has crossed the sand, in this case a loggerhead weighing about 300 pounds. The picture was taken at Murphy Island, 50 miles northeast of Charleston, S. C. Marine turtles of three species range northward to New England coastal waters, but they come up on the beach only to deposit their eggs. Only the loggerhead is known to breed as far north as the Carolinas.

December **NATURAL HISTORY** 1941

Family Tree of the Dinosaurs • We Live in an Ice Age

South Sea Life • Capturing Sharks Asleep • Wasps

VOLUME XLVIII, No. 5

FIFTY CENTS

THE COVER THIS MONTH

Were they polished by man, by the elements, or by dinosaurs?

The singular thing about the beautiful stones on the cover of this issue is that they were apparently polished while inside of dinosaurs. Dinosaurs have been accorded much popular attention but their use of these stones is a phase of their life that has been given little public notice. These specimens are from an extensive collection belonging to Betty Beck Roberson of Worland, Wyoming, who has collected dinosaur gizzard stones for several years. The Kodachrome photograph for the cover was taken by Stan Kershaw of Cody, Wyoming, and is probably the first photograph of these remarkable objects—certainly the first in color—ever presented to the public.

As many as 112 of these gizzard stones were found actually within the body cavity of one dinosaur discovered by the American Museum in Mongolia. Quantities of others frequently lie scattered in the rock beds where dinosaur bones are common. Their abundance indicates that certain of the dinosaurs swallowed the stones in considerable quantity to aid in the digestion of their food, particularly the dinosaurs lacking effective teeth. The churning action of the swallowed stones helped to grind up the plant food upon which these dinosaurs lived, just as stones similarly swallowed by chickens today assist in their digestive problem. Dinosaur stones are discussed more fully by the celebrated dinosaur-hunter, Barnum Brown, on page 294 of this issue.

The collecting of dinosaur "jewels" has been popular in certain sections of the West since scientific expeditions familiarized local residents with their existence. But in order to achieve a fine collection, one must walk or drive many miles over badland outcrops during certain favorable seasons of the year, and must hunt through hundreds of quite ordinary gastroliths scattered over the gullies in order to find a few which are perfect and beautiful.

LETTERS

SIRS:

. . . The covers of NATURAL HISTORY are a sort of appetizer for what is to follow. And let me say here that I've never been disappointed in the meal that follows the appetizer. I read it from cover to cover.

MARY M. PERKINSON.

Pawnee, Okla.

* * *

SIRS:

. . . Your magazine is the best of its kind. I enjoy reading it to the last page because of its interesting and informative contents. As long as I am able I shall subscribe to it.

DAVID STEFANYE.

Bronx, N. Y.

* * *

SIRS:

For five years I have been a subscriber to NATURAL HISTORY, and ever since reading the first issue I received, describing the African Hall in the American Museum, it has been my ambition to see it. Last month my wife and I realized that ambition. We spent the whole day, from the time the Museum opened until the guards swept us out, seeing the place. We were so busy we didn't even have time to look for the Member's Room to take a rest. Needless to say, it came up to all expectations; never was a day so well spent. You certainly have a wonderful place, of which you can be justly proud.

I have thoroughly enjoyed nearly all the issues of the Magazine. Of course I am disappointed once in a while, but I realize that what doesn't interest me interests others, and these disappointments are few and far between. I especially wish to compliment you on the beautiful covers you have been having lately. I say this as one whose hobby is photography and who would almost rather take pictures than eat. Also, I especially enjoyed in the October number the article and pictures of Monument Valley. The more such, the finer.

ERNEST B. RIECK.

Albany, N. Y.

* * *

SIRS:

. . . I am enjoying NATURAL HISTORY immensely. The articles are fascinating and the photographs superb. My hobby is birds, and with your publication and the Audubon magazine, my interest has never a dull moment.

RUTH H. RUSCH.

Peekskill, N. Y.

* * *

SIRS:

Once more I am writing to order some of your lovely covers. The calendars I made of them last year were so warmly received that I plan to make more for this Christmas. . . . Your magazine is a cheerful spot in a sad world. Keep up the good work!

THELMA BRACKETT.

Concord, N. H.

Continued on page 304


EVERY EXTRA LEAF IN THE TABLE
AND FAR
TOO MANY GUESTS
FOR CHRISTMAS DINNER!

NATURAL HISTORY

The Magazine of the American Museum of Natural History

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

VOLUME XLVIII—No. 5 ☆ ☆ ★ ☆ ★ ★ DECEMBER, 1941

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S A M O A

By TRUMAN BAILEY

From Three Lions

EONS ago in what is now poetically called the South Seas, a group of volcanoes erupted from the floor of the deep and formed the archipelago of Samoa. For centuries lava poured down the sides of these mountains-in-the-sea, depositing a rich igneous soil, from which, encouraged by the moist, even-tempered climate, arose a riotous paradise of verdure.

At some remote time a band of sea-wandering Polynesians discovered these plenteous islands and, augmented by other voyagers from time to time, cultivated thereon a simple but exceptionally happy way of life. Some surviving aspects of this life are recorded on the following pages.

The native inhabitants of these islands are among the finest and purest Polynesians and are noted for their cleanliness, dignity, mental capacity, and physique. They are fortunately on the increase, because laws prohibit foreigners from buying their land.

Thus the Samoans have survived better than many others the age of imperialistic exploration, which disrupted native life in so many parts of the world. Several major powers have had a part in determining the status of Samoa. In 1900 Britain traded off its interests, leaving six of the islands to the United States, eight to Germany. A few days after the declaration of World War 1, a New Zealand expeditionary force occupied the German islands, and these are still held by that dominion under a League of Nations mandate. The United States holds the other six islands, where three native Governors under an American Commandant-Governor administer the territory in conjunction with County and City Chiefs.

(Left) A SAMOAN BEAUTY wearing tapa cloth, made from the bark of the paper mulberry. Today this costume would be worn only on special occasions. The Samoans are noted for their sea-faring qualities. The small outrigger canoe, or *pao pao*, below, is used in the lagoons and along the reef. Larger canoes and longboats are used for the open sea. In clear weather the mountains are visible from far out to sea, for some rise to over a mile

(Above, left) In the manufacture of tapa cloth, strong native teeth strip the bark from the saplings of the paper mulberry

(Above) After a soaking in sea water, the rough exterior is scraped from the white inner bark

(Left) Heavy mallets of wood are used to beat the remaining bark out into thin sheets

(Below) These sheets are then appliquéd together with breadfruit paste into an even piece of the desired size

(Above) THE THIN PIECES of beaten bark are placed over a carved board, and the design is rubbed into each layer, —as a rubbing is made of a coin

AFTER THE PATTERN has been transferred, the tapa is finished with additional painting which is applied with a brush. Colors used in this process are made from herbs, berries, and earth

(Right) DEMONSTRATING one use of the tapa, this genial Samoan is properly attired for a ceremonial feast or other important event symbolizing the old life

(Above) SAMOANS build their houses sturdily without the use of nails. The tough fiber from the husk of the coconut, braided into a cord, is used to lash the framework together. The builder often achieves beautiful designs by the way in which he wraps the cord

(*Right*) THE LADY OF THE HOUSE looks her best when she enhances her natural beauty with a floral headdress, a form of adornment in which the lovely girls of Polynesia achieve many ingenious effects.

(*Above*) STRINGED INSTRUMENTS were introduced to the islands by foreign traders but have come into such general use that they are inseparable from Samoan life

HEAVY STORMS of the hurricane season necessitate a strongly reinforced structure. The Samoan house is usually constructed in sections. The owner may move in when only the central unit and one end have been built, finishing the other at his leisure

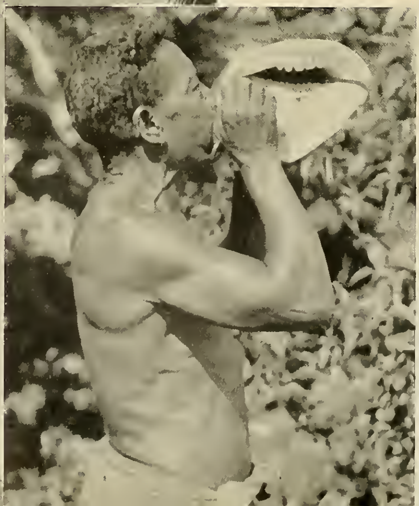
FEW HOMES are better suited to their climatic conditions than those of the Samoans. Almost circular in form, they allow free ventilation from all sides. During sudden squalls, which are frequent, mats somewhat similar to Venetian blinds are let down. Here they may be seen drawn up under the eaves. The house is thatched with coconut fronds or sugar cane

THERE ARE NO WHARVES on many of the Samoan islands, so that one must ride through thundering surf to reach the shore. At left the natives are seen unloading copra on the beach at Luma, on the island of Tau

(Left) COPRA is dried coconut meat, the oil from which is used extensively for soaps and explosives. The coconut palm has been a mainstay of the South Sea Islanders for centuries, and the young Samoan early learns to climb the tree to harvest the green fruit. Coconut meat is the basis of many Samoan recipes. The water inside the coconut provides a delicious beverage, while the husk, beaten into strands and braided, furnishes the cord used in house construction and in many other ways. Aside from what the natives use, American Samoa exports annually about 1100 tons of copra

(Left, below) SHELLS AND DRUMS are used to call the men from the plantations in the hills. A blast from this huge shell can be heard for a mile or more

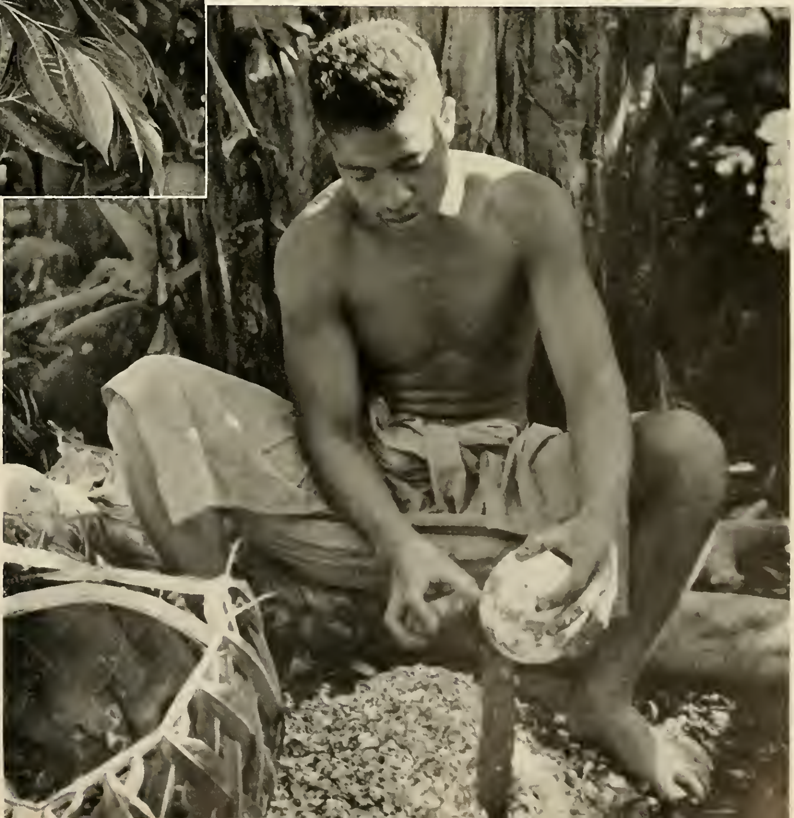
(Below, right) THE MEAT of the coconut is frequently ground up and heated with a hot rock. The warm meat is then squeezed to extract the juice. This juice thickens into a delicious, custard-like substance when cooked with greens, fish, or chicken



(Right) TABLE ETIQUETTE in the South Seas does not require silverware or dishes. Fingers replace knife and fork, and a green leaf serves as a plate

(Below) BREADFRUIT is another staple food of the South Seas. So important is this plant to the islanders that the leaf and fruit are favorite motifs in native design

BREADFRUIT is roasted over a fire, much like a chestnut. Before eating, the blackened husk must be removed, as shown at the foot of page. The basket represents another use of the coconut palm



THE PAPAYA, whose juice has become increasingly popular in this country for its flavor and digestive properties, grows abundantly in the Samoan Islands and achieves great size *(above)*

SAMOA'S warm tropical rains are ideal for fern growth. The fronds below were over eight feet long

(Above) THIS YOUTHFUL SAMOAN holds a fish spear he is scarcely large enough to handle. These spears, with their heavy prongs and long shaft, weigh ten to fifteen pounds, so that great strength and dexterity are needed to manipulate them while swimming

(Right) SCANNING the clear waters from a ledge of rock, the fisherman can spot his quarry many feet underwater. Then he throws the spear with great force and immediately follows it into the water, for he must retrieve the spear to bring his catch safely to shore

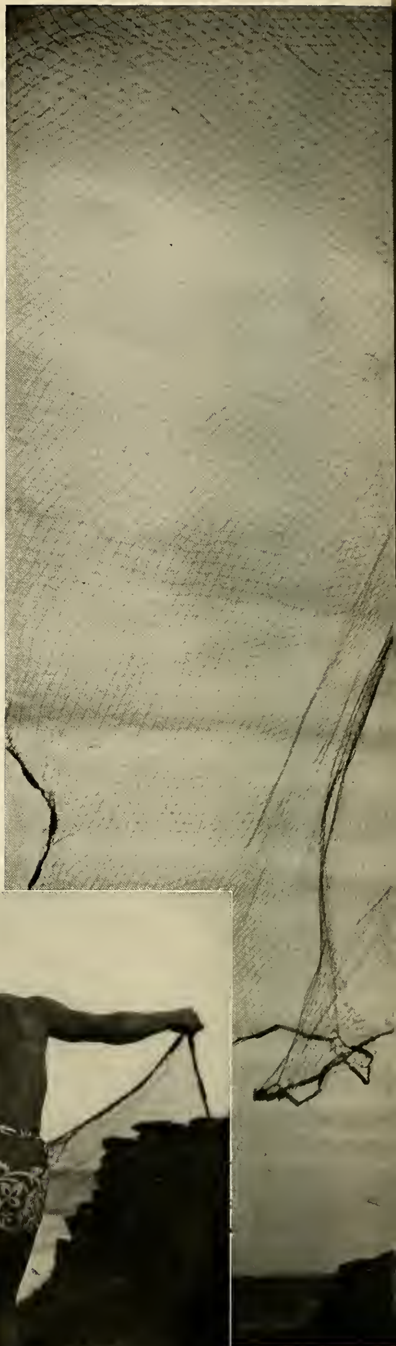
BACK ON THE ROCKS he removes a *poge* from the barbs of his spear, a delicious fish which abounds along the reefs of Samoa

SAMOA

(Above) Expert hands fashion a throw-net, which is used in one of the world's most picturesque methods of fishing. All the knots are tied by hand. Formerly native fibers were used, but today cotton line is procured from the trading stores

While operating the net from the coral ledges, great care must be taken in gathering and arranging it, lest it become tangled or torn on the rough rocks

Fifteen to 30 feet of circular net is an awkward bundle in the hands of a beginner, yet net-throwing is a popular and practical sport in the islands



THE NET is thrown with a circular motion so that it spreads out like a parachute. The weighted edges sink to the floor of the sea. Then the fisherman must dive into the surf, gather the edges together underwater, and haul his catch ashore. Sometimes a single throw will net as much as 200 pounds of fish

Bring 'em

THE ENRAGED TIGER SHARK lashes the sea to foam as he fights capture with all the fury of his 400 pounds. He is one of the fiercest deepwater fishes, but his worries will soon be over, and he will wake up comfortably installed in his new home

(Right) THE WEAPON has guards which prevent too deep penetration or serious injury to the shark. From the tiny holes in the point, jets of anesthetic are discharged into the fish's tissues

back *ASLEEP*

By Andre La Terza

Voracious tiger sharks are captured alive for scientific study by means of a new hypodermic harpoon

At the famous Marine Studios in Florida, where visitors from all parts of the world can observe and study the creatures of the deep in glass-windowed tanks, fish experts have encountered difficulty in capturing and transporting big dangerous specimens from the sea. To solve the problem, a new instrument was developed by the late Dr. G. Kingsley Noble of the American Museum of Natural History and Count Ilya Tolstoy, grandson of the novelist. This is a steel-pointed spear which pierces the animal and, with power supplied by ordinary soda siphon gas, anesthetizes it. So effective is the instrument that in 60 seconds a 400-pound monster is rendered unconscious and can be transferred from ocean to oceanarium without injury to himself or to his captors.

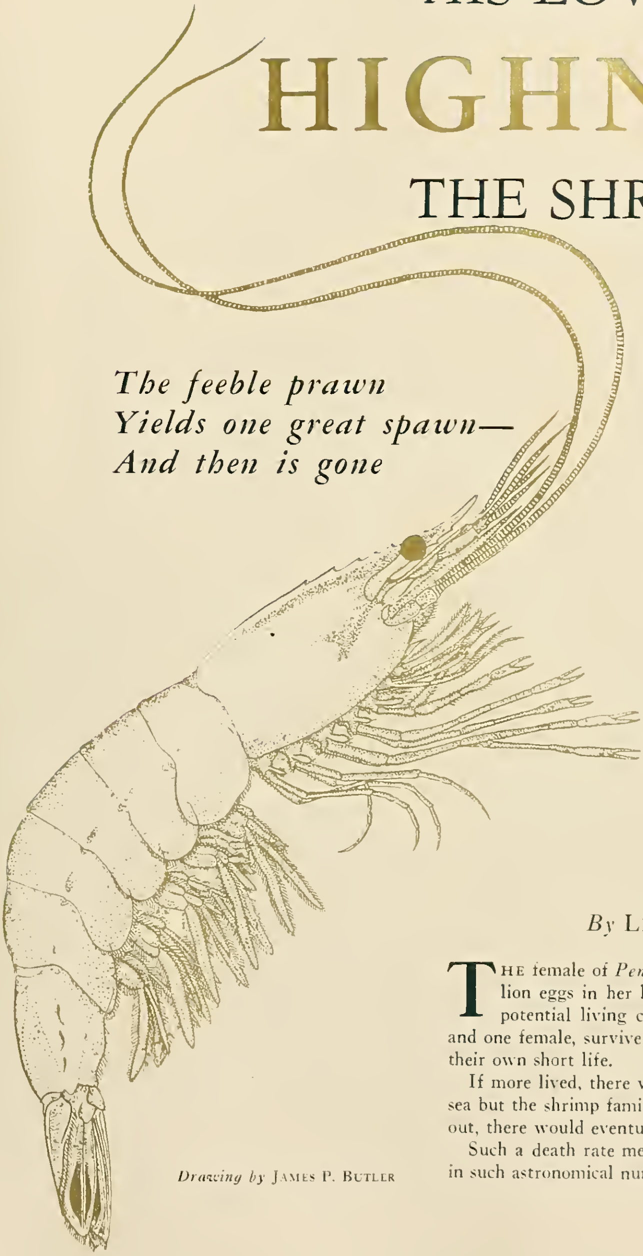
Count Ilya Tolstoy poises the harpoon. A split second later the anesthetizing dart will drive into the tiger shark

(Left) HARMLESS, the huge fish is lowered into a small receiving tank en route to the oceanarium. He has suffered no injury, save possibly a broken tooth or two, which is of no consequence, as he can grow new ones. If he shows signs of waking up, he will receive a second injection

(Below) A WATER-FILLED CANVAS CRADLE hoists the unconscious shark from the boat onto a trailer bound for Marine Studios. He will stay "out" for about three hours

(Below) SAFELY INSTALLED in his new home but still groggy, the shark is nursed back to consciousness by a diver. To keep the fish from drowning, the diver must actually guide him about underwater, forcing water through his gills. When the shark wakes up, the diver makes a quick exit

HIS LOWLY HIGHNESS THE SHRIMP



Drawing by JAMES P. BUTLER

The feeble prawn
Yields one great spawn—
And then is gone

By LEALEN E. MARTIN, JR.

THE female of *Peneus setiferus* lays half a million eggs in her lifetime. Out of this mass of potential living creatures only two, one male and one female, survive, on the average, to complete their own short life.

If more lived, there would soon be nothing in the sea but the shrimp family; if less than two averaged out, there would eventually be no descendants.

Such a death rate means nothing when they exist in such astronomical numbers. Though only two live out of 500,000, nevertheless *Peneus setiferus*—the chief variety of the commercial shrimp—maintains a business which, when its products of one year are consumed, has taken in upwards of fifteen million dollars.

Shrimping itself is an occupation that dates back no one knows how far. Probably it has been going on since primitive man's curiosity led him to the edge of a lake or stream where he first saw the elusive little creatures.

Yet history is curiously reticent about the shrimp. He appears on Phoenician and Grecian coins and on Egyptian temple walls, so he was undoubtedly common. Aristotle observed and recorded members of the shrimp family. Then, 2100 years later, Linnaeus, the great naturalist, clarified and added to the bit of knowledge. In all the intervening centuries, mention of any crustacean is scant, and of the shrimp it is almost nonexistent.

The very name "shrimp" has always been a synonym for insignificance. But who knows that today the shrimp ranks third largest among U. S. seafoods, exceeded only by salmon and sardines?

For all that, the recorded information is like Mother Hubbard's cupboard. Many of the thousands of varieties of shrimp must have been caught from early times. Despite this, despite its picturesqueness, and despite the fact that—with the possible exception of whaling—shrimping has always been the most widespread fishery in the world, the shrimp is *still* something unknown.

Biologists think that the industry today is near the limit of possible production under present catching and handling conditions and that greater intensity of fishing will not make an appreciable increase in the catch. There are just so many shrimp in the ocean. The catch limit has been approached. When it is touched, more boats will only mean less average catch per boat, unless new shrimping grounds are found. Further, such discoveries are now considered unlikely, for the Fish and Wildlife Service has explored pretty thoroughly along both Gulf and South Atlantic coasts.

How old?

In addition to finding him, there is another problem that Mr. Shrimp poses—the question of his life span. No one has ever seen a shrimp that lived longer than one year, although many a veteran shrimper will tell you: "Man, sure they live for years. Why, way out I seen great big, old fellows, crusted over. Musta' been five, ten, maybe even fifteen years old."

Maybe he did see some aged crustaceans, but they weren't the common commercial variety of shrimp, *Peneus setiferus*, which makes up over 95 per cent of the catch. In contrast to many of his relatives on the roomy crustacean family tree, *Peneus* is a short-lived, tender soul.

For example, he's nothing like the brine shrimp, *Artemia*, which you'll find in the Great Salt Lake region. For *Artemia* represents life in its toughest form and is almost indestructible. Embryos have been subjected to prolonged liquid air baths at —310° F. without harm. They can live without oxygen for at least six months.

Then there are deep sea shrimp that light up; others that climb trees; some that weigh as much as three pounds; and still others so tiny that they can pop up through cracks in the floor. Odd as it seems, this actually happened in suburban New Orleans a few years ago. Housewives, startled at the strange migration, thought the tiny creatures were fleas and vigorously applied insect powder.

This is by way of showing the infinite variety of the shrimp family and not to hint at close kinship with *Peneus*.

The latter, which has many enemies, is extremely sensitive to changes in environment and perishes if they are unfavorable. Starvation gets many of his brothers and, being cannibalistic, he eats some himself.

In delicate balance

The short life span is the bane of the industry, for shrimp are dangerously vulnerable to overfishing. If one year's class of prawn is seriously depleted, Nature's delicate balance is upset. Then it will be nearly impossible for the fishery to return to its former abundance.

Incidentally, shrimping is unenviably unique in this vulnerability, for it is the only major fishery dependent upon creatures which live only one year. In the case of halibut, salmon, oysters, haddock, and other fish, depletion of any one year's offspring is not as vital a handicap to the continuance of the species. All these live several years, and the next season's spawning may take up the slack.

Shrimp, on the contrary, would disappear from the face of the earth if all those born in any twelvemonth were to be annihilated prior to the spawning season. There would be none left to carry on the race. Of course this wouldn't happen, but dangerous reduction of the supply in any given locality is entirely possible.

Biologists know this and admit that there are many unsolved mysteries presented by the fitful fliptails. Part of the trouble is that fewer and less accurate statistics have been available than are needed by researchers. Another part is that in this realm scientists are pioneering. The mass of research into the lives of other creatures of the sea is worth little as a parallel for procedure. Moreover, there is difficulty in studying these crustaceans. Learning their characteristics through raising them in a laboratory is impossible, beyond hatching the eggs and studying embryos.

Their movements

For shrimp, though their name has been a synonym for insignificance, move no insignificant distances during their life. If they are restricted in these movements they die. It's a part of their life urge, brought about by weather changes, water changes, and a host of other things. There's no studying them under ideal conditions. Biologists must go to the sea and learn there what they can.

The common shrimp, known also as lake shrimp, prawn, and by various other names, spawns throughout the spring and summer in the open sea or gulf, beyond the three-mile limit and any State's jurisdiction. As soon as the young are hatched and passing through the larval stages, they begin those mysterious moves which are part of their life force.

The young move into the warmer shallow waters, their nursery. Then, as they grow, they move toward larger bodies of water. July finds them beginning to show up in the offshore fisheries. By the end of September they form the chief portion of the commercial catch, as immature shrimp.

Cold weather sends them into deeper waters offshore, where it is warmer. With spring and still warmer waters offshore, they reveal an increased growth rate. Food is more plentiful. They become adults. They spawn. And then they die.

At least, from all existing evidence this is their fate.

The Fish and Wildlife Service is pretty sure that they can't live longer than a twelvemonth, though it will require several years and much more experimental work to settle this question absolutely. No reward is offered for a shrimp over twelve months old, but anyone who can produce a specimen and prove its age is fairly certain of a lot of acclaim.

You can't tell age, by the way, from the size or structure, from the number of feelers, or from anything like that.

The story of shrimp is not complete without a closer glance at the shrimp investigations of the Fish and Wildlife Service, for by their careful, exhaustive work many of the mysteries are being solved. One of the chief forms of the investigations is the tagging of shrimp in order to study their life-cycle, migratory habits, growth rate, decrease through fishing, and the fate of the adults.

Tagging consists of placing small numbered disks on young shrimp, then releasing them to wander where they will. Fishermen are paid fifty cents for each of these recovered in their nets. They must give the approximate location where the drag was made and the date. Thus the growth and traveling habits are learned. Thousands of shrimp have been tagged and released, and thousands found and returned. One even came from Indianapolis, where it turned up in someone's salad! Most of the tagged ones don't travel quite this far, though distances of 300 miles between point of release and capture in a number of instances indicate that they do get about.

The search for shrimps

Another phase of the work carried on by the service is the dragging or sampling of the entire ocean floor from shore out to a depth of 600 feet, to determine where shrimp dwell and what types of areas they most commonly inhabit.

During one such dragging, in 1938, the greatest single shrimp fishery was found, a comparatively small, concentrated area located in the Gulf of Mexico off Morgan City, Louisiana. Out of this ground, first proved by the Fish and Wildlife Service dragging experiments, 200 trawlers now take as many as 90,000 barrels of big shrimp each year.

Carrying the tests further in 1939, the Service's experimental vessel *Pelican*, explored other parts of the area from the Mexican border to Carrabelle, Florida. Later the Service did the same on the South Atlantic coast to the northern limits of that shrimp fishery. On the Gulf alone, the trawl was dragged over 1200 miles of ocean bottom.

Among the valuable facts learned was that there no longer seemed to be any undiscovered concentrations of shrimp. The investigations also revealed that bottoms composed of sand, shell, or coral, do not provide suitable habitats for shrimp.

Though much has been learned, the job is far from done, says Milton J. Lindner, head of the Service's shrimp investigations. Several years and many more thousands of tags will be needed to obtain even part of the knowledge that Mr. Lindner and his associates feel is indispensable.

In other words, no one has yet really known the shrimp, though this creature is one of the best known sea dwellers.

THE PRIVATE LIFE OF A WASP

By CARL G., PHILIP E., AND PAUL A. HARTMAN

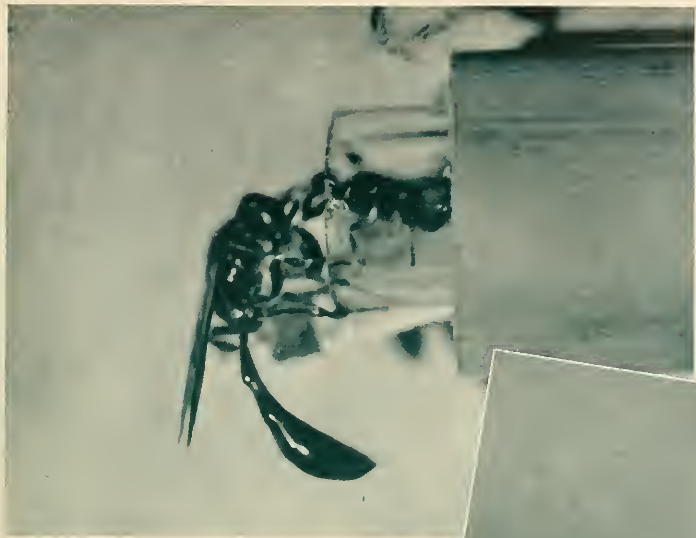
Many of Nature's most interesting processes take place in ocean depths, underground burrows, or secret crannies,—hidden from human eye. To witness these, the observer must frequently match the ingenuity of the creature itself, who has survived oftentimes through its ability to escape the attention of possible enemies while carrying on the vital cycle of reproduction. A fascinating example of this is the private life of Madame Trypoxylon and her husband.

Ordinarily the cycle pursues its curious course in some crevice of your window sill, an abandoned burrow, or other unnoticed nook. Many persons have tacked bamboo tubes to their window sills, just as you might fasten a wren house to a tree, to see the wasps pass in and out and watch the female carry spiders and pellets of mud. But until recently what went on inside was in part obscure. When glass tubes are inserted in the bamboo ones, however, Madame Wasp scarcely retains as much privacy as the proverbial goldfish.

The following series of photographs taken by Carl G. Hartman and his sons, who are probably the first to photograph this wasp by the glass tube and bamboo method, reveals that Madame Wasp is a past mistress in the task of providing for a family and a generation she will never live to see.

Before Madame Trypoxylon can create life she has to take it,—or rather she has to find a victim and reduce it to sort of suspended animation. The victim is an orb-weaving spider, which she skillfully paralyzes with a single jab of her stinger, so that it will remain fresh food for the young. On one spider in each chamber she lays an egg, as illustrated below.

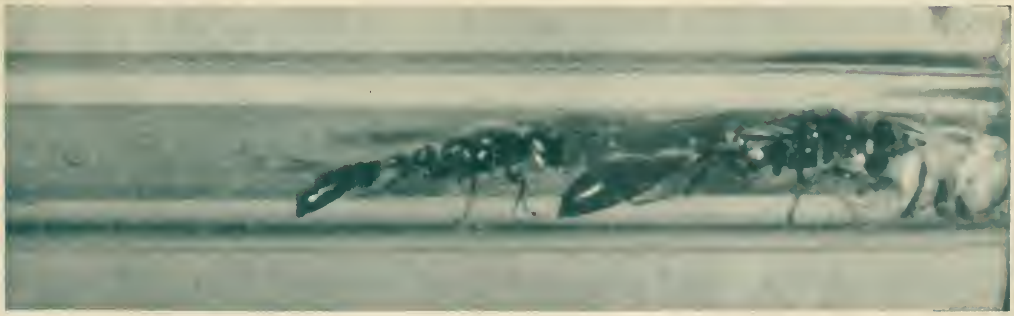
1 **ON SPIDERS paralyzed but not killed, Madame Wasp lays her eggs, thus providing fresh food for a generation she will never live to see**

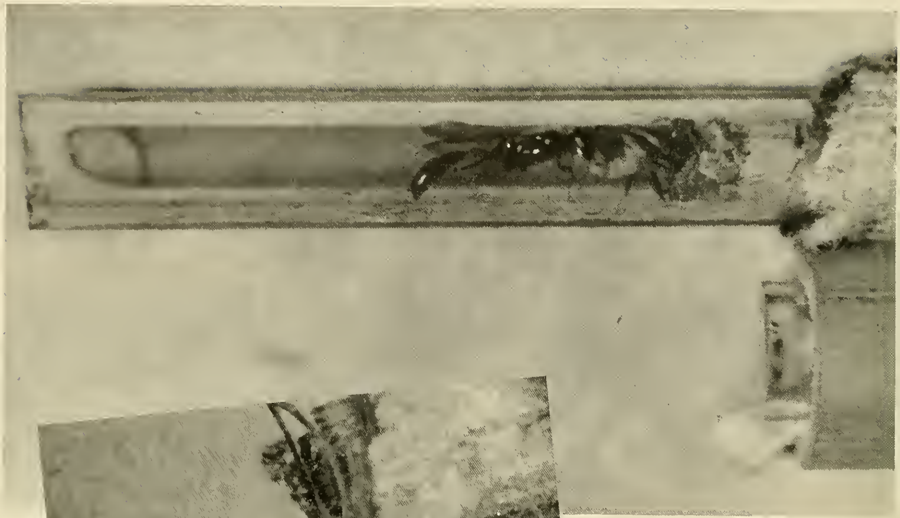


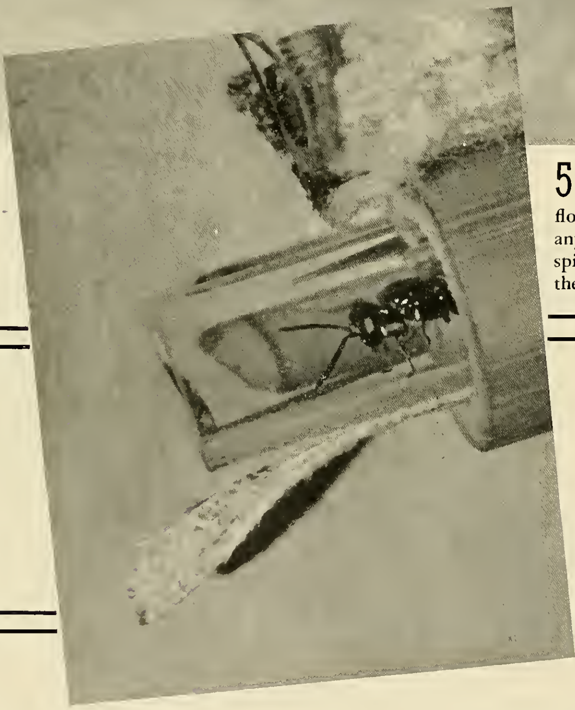
2 BUT FIRST Madame Wasp must bring the "sleeping" spider to the tube, which the observer has provided for her. At left, she is seen alighting with it at the entrance and being met by the male

3 THE MALE mounts the female at the entrance and rides into the nest pickaback. The glass tube has been inserted in the bamboo one, from which it may be withdrawn so that the observer can see and photograph what is about to happen inside

4 BRINGING the spiders one at a time, Madame Wasp pushes them into a compact mass, while her mate sees that the job is well done







5 *(Above)* When she departs, he tolerates no littering up of the floor with spiders. He at once does any necessary tidying, jamming the spiders back into the farther end of the tube

6 Then he returns to stand guard at the entrance, continually vibrating his antennae alertly

The male is a good-natured ne'er-do-well, who cannot fare forth as his mate can, saber in hand, as it were, to stab the prey. But he guards the nest faithfully against cuckoo flies and wasps which are always present to lay their own eggs on the collected larder. And he gives his wife a glad welcome when she returns from her frequent trips abroad for provender and building material.

After about four or five spiders have been brought in, which may be a half-day's work, the female lays an egg on the last one, which is always large.

THE egg-laying is quite a ceremony. The female is too large to turn around in the tube, so she turns around outside and backs in. After a period of pumping movements of the abdomen, the egg emerges and is laid across the back of the abdomen of the spider, affixed by a sticky secretion.

In sealing the nest shut from the outside, Madame Trypoxylon uses dry mud mixed with a secretion of her crop diluted with water. One wasp had a private quarry to which she was seen to come on every sunny day for six weeks, to roll up pellets of mud. Madame Wasp's husband cannot handle mortar, so it is for her to do all the necessary work of sealing the combined tomb and maternity ward.

7 WHEN THE LAST EGG is laid, Madame Wasp walls the nest shut with a mud partition. The photographs at right show both ends of the tube sealed shut. The nail was used by the observer to fasten the tube in place

8 *(Above)* WHEN THE NEST has been filled and sealed, the clear glass tube can be removed and studied with a magnifying glass under good illumination. The photograph shows the tube partitioned into three cells, one empty and each of the other two occupied by a large grub well on the way to wasphood

THUS Madame Trypoxylon has provided for the future of the new generation. When frost arrives the senile parents die. The grubs and pupae become dormant and remain so until the summer heat awakens them to the duty of reproducing as their parents did, and indeed their ancestors for millions of years past.

The activities of Trypoxylon can be observed widely throughout much of the world.

GEM FOR DECEMBER

By Frederick H. Pough

Acting Curator, Geology and Mineralogy,
The American Museum of Natural History

Savages the world over have prized the turquoise, while its fame for beauty and magic resound through the ages. Lapis lazuli is an attractive alternative

(Below) Persian Lapis has gone east as well as west, to be worked by the Chinese in some of their delicate carvings

(Above) A VEIN of turquoise cuts through the matrix rock. From Los Cerrillos Mines in New Mexico

FROM the dawn of civilization, turquoise has played an important role in the lives of primitive peoples throughout the world. No important turquoise deposits are known today that do not show traces of having been worked by prehistoric man. The American Indian, the Aztec, the Egyptian, the Persian, and the Tibetan, all valued turquoise as one of the more precious materials.

This is easily understandable, for turquoise is an opaque mineral, one which depends for its attractiveness upon color, rather than upon brilliance and transparency. Primitive peoples did not facet and polish as we do today, and quite naturally the bright color of opaque stones had a greater appeal. This partly explains the wide use of opaque quartz gems,—bloodstone, jasper, sardonyx, and carnelian—, as well as turquoise and lapis lazuli (the latter, an alternative gem for December).

Turquoise is easily worked by primitive methods but does not take the polish of the harder stones. It is a phosphate of aluminum and copper, and owes its blue color to the copper it contains. Turquoise is one of the few gems whose color is chemically bound in the material; most are colored by impurities. The name comes from the French word for Turkish, probably because people referred to the gem as coming from the East, from Turkey. Orientals still prize it highly and have a proverb, "A turquoise given by a loving hand brings happiness and good luck." Shylock in *The Merchant of Venice* was seriously grieved at the loss of a turquoise ring which had brought him good luck. There is a tendency for blue stones to become greenish, because turquoise is a soft and rather porous gem, readily absorbing oil and dirt from the skin. Such a change was thought by some to be a sign of impending evil. Much old Navaho jewelry reveals this aging.

Spanish conquistadors found turquoise to be highly valued by the Indians of the Southwest. The mines at Cerrillos, New Mexico, which are among the largest deposits in this country, were actually operated by the Spaniards for a number of years. Kunz describes visiting the locality and observed that the Indians sold the small pieces at the rate of twenty-five cents a mouthful,—for there it was stored as they worked. That was in 1890. No doubt the Indians would ask more today. Fine blue stones are the most prized. Bits of brown or black matrix are often cut with the blue as an attractive foil. But turquoise is easily imitated, and the purchaser should be wary.

Many a stone which the ancients referred to as turquoise was undoubtedly lapis lazuli, December's alternate. This is also a blue opaque mineral but has a far richer, deeper, bluer color. The finest quality of lapis, a complex silicate of sodium and aluminum with some sulphur, almost invariably contains small flecks of iron pyrite. Pliny likened lapis to the night sky studded with stars.

This fine gem was of great importance as a pigment. Until recently lapis lazuli was the only source of the artist's ultramarine. Fra Angelico used this finest blue pigment, and his work is still famous for its lovely blues, five centuries after his death. Ultramarine was made by crushing hand-picked fragments of pure lapis lazuli. Because lapis was the most expensive color, azurite—a copper carbonate—often replaced in part the genuine lapis. This substitution would pass unsuspected for many years but was always revealed by time, for azurite can change to green malachite. Blue skies painted with inferior pigments became in time an unnatural green. Only ultramarine was permanent,—until a synthetic product of the same composition was introduced to take the place of the precious lapis.

The principal source of the highest quality lapis lazuli was the remote fastness of Afghanistan, a region surrounded with legends and terror. The stone containing the masses of blue lapiz, often in twelve-sided crystals, is still quarried by ancient methods. The rock is heated by fires, and water is then thrown over it, cracking loose large slabs. Other sources include Lake Baikal and Chile, but the quality in these localities is lower.

Lapis lazuli, under the name turquoise, was believed to be effective against the sting of scorpions and reptiles, and to prevent accidental death. About 50 A.D. Dioscorides recommended that lapis should be drunk for internal ulcerations and for growths in the eyes, and said that the stone would even glue broken membranes together. Later it was thought to be a cure for melancholy.

The name means blue stone. Therefore, the confusion between the two blue stones—turquoise and lapis lazuli—is not surprising. We may accept them both as the jewelers' choice of birthstones for December. But one might wish that for so cold a month a more warmly colored stone had been selected.

THE RISE OF THE Dinosaurs

By ERICH M. SCHLAIKJER
Assistant Professor of Geology and Paleontology, Brooklyn College

"Leaping Lena," humble forerunner of creatures that could nibble leaves "four stories" above the ground, gave little promise that her race would rule the earth for 140 million years

At right, THE 75-FOOT "THUNDER LIZARD," representing the Golden Age of Dinosaurs, looks back 50 million years at a pair of early dinosaurs only a yard long

Drawing by ALASTAIR BROWN

BIG bones, little bones, all strung together and supported by wires, bolts, screws, and curling pipe—60 or 80 feet of it. Why, it's the biggest thing in the biggest hall in the Museum—yes, in any museum. It's a dinosaur, or "terrible lizard," as the word is usually translated from the Greek.

Even a hundred years ago these ungainly looking things were called dinosaurs. Not all of them, however, are so big or so terrible. This name, though of little scientific standing, is used for the greatest and most diverse group of animals on record. Some were small—no bigger than a jack rabbit and very meek in appearance; others, in fact most, were quite terrible looking. They came into existence 200 million years ago at the beginning of the Mesozoic era, or Age of Reptiles, spread over the whole earth, and then vanished after 140 million years of triumph.

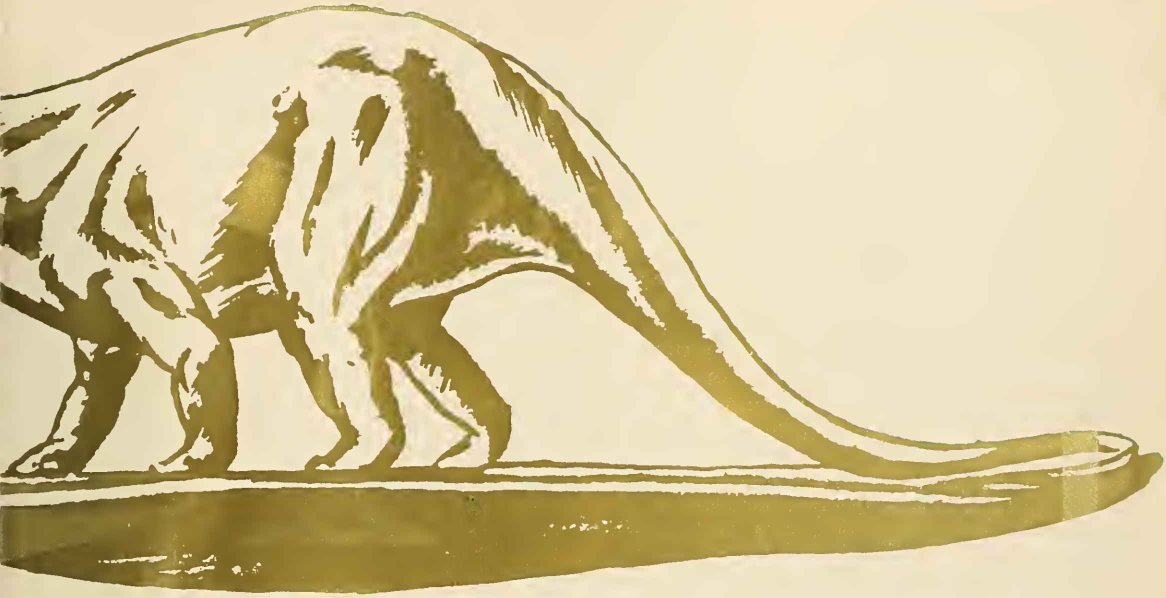
One hundred and forty million years is a long time for any group of animals to rule the world, but the dinosaurs were by far the most abundant and diversified land-living creatures throughout all that time. The life span of any group depends on its ability to cope with the vicissitudes of a changing environment. "Change with me or you die," is environment's command to all life. Because the dinosaurs were plastic they could change, and they evolved into bigger, and so far as they were concerned, better forms. But it was this very demand for change that led them into the inevitable pitfalls of overspecialization, and when the greatest of all climatic changes the reptiles had ever seen came at the close of the era, they could not meet the new demands.

At the beginning of the Age of Reptiles, the earth was still in the grip of one of the most effective revolutionary periods in its history—the so-called Appalachian Revolution. On every continent, mountain building and erosion, with the deposition of vast blankets of debris under semiarid climatic conditions, were the order of the times. In North America, relentless compressional forces had formed a great chain of mountains along the eastern seaboard from Nova Scotia to Alabama, of which our present Appalachians are the mere roots. When these forces gave way, the earth's crust snapped and broke all along the eastern flank of this chain, forming a lofty series of blocks and deep basins. This took place in the early Triassic period—so named because in Europe the extensive rocks laid down during that time are clearly separable into three distinct units.

Throughout the later part of this period, the block mountains were gnawed away by erosion, and the basins gradually became filled with debris—deposits which attained a maximum thickness of more than 20,000 feet. Great sheets of molten rock then forced their way up into these deposits and escaped here and there to form lakes of seething lava. These eventually cooled and were buried under more blankets of fine muds.

By the close of the Triassic, this great interior area, flanked by the high ancestral Appalachians on the west and by less lofty mountains on the east, was a nearly featureless plain. That its climate was arid is revealed by the prevalence of mud cracks, indicative of long periods of drying, also by the "desert red" color of much of the deposits, and by other evidence. There were local areas, however, where the climatic conditions were more acceptable and where life was fairly common. Fishes were abundant in the permanent lakes. And the presence of many fossil ferns, cycads, etc., shows that the humid localities were densely clothed with vegetation.

It was in these more favorable places that tiny,



primitive, crocodile-like reptiles and some of the first dinosaurs lived. Fossil remains of these are extremely rare, but their footprints in the rocks are numerous. It seems strange that so many footprints and so few bones have come to light. Probably the regions most suitable for the reptiles were close to the mountains in higher, cooler, wetter places, which have since been worn away by the elements. From these places, the reptiles wandered over the great inhospitable mud flats, leaving the impressions of their feet "on the sands of time." Only an occasional straggler died by the wayside, and it is his bones that we find.

In western North America the setting was not so uniform. Narrow arms of the sea occupied parts of the Pacific Coast region throughout the period, and in these narrow troughs, thousands of feet of marine sediment were laid down. At times, an arm of the sea would extend inland several hundred miles, as far as western Wyoming or even to western South Dakota. As these retreated, streams from the near-by surrounding mountains followed them carrying mud and silt. Our greatest deposit of such continental material laid down in this period extends from Utah to western Texas and in some localities is over 4000 feet thick. The plants and animals likewise were similar to those then in the east. Also, the fossil logs in the Petrified Forest of Arizona tell us that lofty evergreens clothed the uplands of that time.

Nor was all quiet on the western front of North America in regard to volcanic activity. The whole coastal area was peppered with volcanoes that belched forth clouds of ash. Thousands of feet of erupted material make up most of the Triassic rocks of certain islands on the southwest coast of Canada.

Such were the conditions in the world when the dinosaurs were born. But what are dinosaurs? What was their ancestry?

In size they ranged from twelve inches to 80 feet long—or just about one-third of a city block. In the beginning they all walked on their hind legs, and some kept this method of getting around, becoming more and more highly specialized in it. Others became thoroughly adapted to walking on all fours. Still others did a little of both. The skeletons of some were lightly built and bird-like. These were fleet-footed runners—at first flesh-eaters, later herbivorous. Some of the early flesh-eaters evolved into enormous destroyers of life—the Panzer division of the Age of Reptiles. There were gigantic forms that were at home both on land and in water. Others had horned heads or were heavily armored.

The dinosaurs are indeed so diverse that it is difficult to name features common to all. When we think in terms of an 80-foot *Brontosaurus* or a gigantic *Tyrannosaurus*, what we mean by a dinosaur seems perfectly clear. But some of the first types were almost indistinguishable from some members of another very generalized group of reptiles, the Pseudosuchia ("false crocodiles"), which lived in the same period. The evolutionary change from this group to the dinosaurs was so gradual that it is only in minor details that the two can be separated.

One of these borderline cases had hind legs over twice as long as its front ones. For popular purposes let us call this little animal Leaping Lena, for leap it certainly did, and the diminutive Lena is fitting for an animal that was only a foot long. Its scientific name, *Scleromochlus*, is more difficult to remember. The fossil expert examines the shoulder and hipbones in his effort to tell whether an animal is a dinosaur or not. Leaping Lena had no collarbone (clavicle) or interclavicle—characteristics of the "false crocodiles" that went before. And its hip joint, though incompletely preserved, seems to have had an opening where the thighbone of the leg hinges—a feature that distinguishes almost all dinosaurs—instead of a closed socket. From what is known, Leaping Lena has about an even chance of claiming the title "dinosaur."

While many of the early dinosaurs resembled one another, the group as a whole can readily be divided into two separate lines, distinguishable by the form of the hipbones. These two groups, or orders, have been named to indicate a comparison with lizards on one hand and birds on the other, Saurischia and Ornithischia respectively. In addition to the hip, various other parts of the skeleton, particularly the jaws, teeth, and skull, show distinguishing features. The point is that the two groups, while they are collectively called "dinosaurs," evolved independently from two different lines of "false crocodiles."

Of the first dinosaurs, the Saurischia, or the ones with the more "lizard-like" hipbones, were the more abundant. Their evolution in the beginning was much more rapid than that of the other group, and by the close of the Triassic period they had evolved into three main lines, which continued down to the very close of the Age of Reptiles. These three main lines may be called the Lightweights, the Meat-eaters, and the Land-and-water dinosaurs. *(See chart, page 288.)*

The first Lightweights (Coelurosauria) are the most primitive dinosaurs known. Their skeletons are very delicately and lightly constructed. They all walked on their hind legs, although in one of the earliest from North America the front legs may have shared some of the weight of the body. Their hind legs, especially the lower part, were conspicuously long and slender. Their skulls were equipped with relatively large eye sockets, and many had small teeth of the type adapted for cutting flesh.

Fox-sized dinosaurs

Various types of Lightweights have been discovered ranging in size from no bigger than a small fox to six or eight feet in length. One which seems to make a good grandparent for all the rest is the little animal named *Saltopus,* which roamed the semiarid plains of what is now Scotland. In life he was no more than three or four feet long. His little skeleton has all the features one would expect to find in the ancestor of the later members of this fleet-footed group of dinosaurs, whose evolutionary development, like that of the Meat-eating dinosaurs, became more and more progressive until near the close of the Age of Reptiles.

The Meat-eaters (Carnosauria) are not so named because they were the only dinosaurs that ate flesh but because as a group they were better designed for a carnivorous life than any other and because their members became the most destructive flesh-eating machines of all times. They were the most efficient Panzer unit ever invented. Some, especially the earliest ones, were quite small, but others attained a height of over 20 feet. There is some difficulty in separating some of their earlier members from the Lightweights.

The Meat-eaters all walked on their hind legs, and their front legs were very much smaller, becoming in the later more specialized forms nothing more than meat-hooks. Their grasping hind feet were bird-like. All had big heads with large, dagger-like teeth, the edges of which were serrated, or saw-like. The largest teeth on the side of the mouth were always towards the front.

True Meat-eaters are known to have lived in what is now South Africa and North America, and though not especially abundant, were well established. The one called *Paleosaurus* ("ancient lizard"), which lived in the Old World, seems to have been very near the starting point of all the later forms. This beast was about ten feet long and was already adapted for walking on his hind legs. His skull was deep, his teeth were specialized for cutting, and his hands were of the grabbing type, with large curved claws on the ends of the thumb and the next two fingers.

The most abundant dinosaurs in Triassic times, were the forerunners of the third group, the Land-and-water forms. They were very widely distributed over the world, having been found in North America, the British Isles, Europe, and southern Africa.

Grandfather of the giants

They were small to medium-sized dinosaurs which usually walked on their hind legs, although some spent part of the time on all four. They had long necks and small heads, and their small, pointed or spatulate teeth were still best adapted for eating small reptiles, fish, or soft-shelled invertebrates. Some may also have been partially herbivorous. An eight-foot creature called *Thecodontosaurus* is the earliest known form and is also the most primitive. That is why he makes a good ancestor for all the rest, and for the later giant sauropods. By the close of the Triassic some had become specialized and had departed from the trail of evolution leading to the later giants. *Plateosaurus* ("oar lizard") is one of these—a clumsy animal that got to be 20 feet long. He is known from a number of fine skeletons which were preserved when the animals died in desert regions of prehistoric France and Germany and were covered by wind-blown material.

These dinosaurs are important because they were the most abundant dinosaurs of the Triassic and because they gave rise to the sauropods—the most plentiful group of the next geologic period, some of whose members became the largest of all land-living animals.

Coming to our other main division, we find that the ornithischian dinosaurs, or those with bird-like hipbones, were much slower on the evolutionary pickup than were the types we have just discussed. Almost no trace of them has been found in the first period in the Age of Reptiles—only one fragmentary skeleton, found in Colorado, and footprints indicating three other forms. But they must have been quite varied and widely distributed by then, because at the very begining of the next geologic period their remains show definite specialization into two distinct lines.

The second phase in the rise of the dinosaurs took place in the Jurassic period, which gets its name from the Jura Mountains between Switzerland and France, where marine rocks of that age are some 3000 feet in thickness. Gibraltar, too, stands out today as a great block of Jurassic limestone that had accumulated on the floor of the sea and was brought to the surface by later fracturing of the earth's crust. Thick Jurassic deposits also occur in India, Australia, southern Africa, and South America.

In North America not a grain of Jurassic rock is to be found anywhere east of the Mississippi River. This great region was being worn down, not built up, throughout the period. Just the reverse was true on the west coast, where sediments accumulated in the long, narrow seas that penetrated inland. In what is today the Rocky Mountain region, conditions were different. A vast trough-like lowland was present, with a long, narrow mountain chain to the west. At first this basin was wind-swept and arid, but as time passed, warm shallow waters came creeping in from the north, ultimately reaching as far south as northern Arizona. Just to the south, arid conditions continued to prevail, and vast deposits of wind-blown sands were piled up. Towards the close of the period, the land tilted up, and great meandering streams flowed sluggishly eastward across this region, spreading out a blanket of muds and sands over an area of 100,000 square miles.

Lands of plenty

Along Jurassic streams such as these, on the margins of seas, and in the swamplands densely clothed with vegetation, the dinosaurs evolved abundantly. There were many other forms of life, too,—flying reptiles, turtles, lizard-like creatures, and crocodiles. More than a thousand different kinds of insects—flies, moths, cockroaches, termites, etc.—are known to have lived there. Primitive mammals became more and more numerous, and the first birds appeared. The seas swarmed with invertebrate life. Some coiled mollusks reached a size of six feet across. Schools of great porpoise-like marine reptiles swam along the shores of every continent.

In these surroundings, the dinosaurs began making their first real evolutionary splurge. The Lightweights became more abundant as time went on. Their best-known representative was a creature that stood about two feet high at the hips and was over seven feet from nose to tip of tail. His name, *Ornitholestes,* means "bird robber"—because at his christening it was erroneously thought that his long, curved foreclaws were suitable for catching primitive reptile-like birds. Closer inspection shows no bird-in-the-hand for *Ornitholestes,* for his much elongated and very compact hand probably couldn't have held a bird even if one had flown right into it. He could have eaten birds though, because his small carnivorous teeth were well adapted for such work.

The true Meat-eaters also became more abundant and more widespread during this period. There was little danger of extinction for these marauders in the lands of plenty. They grew to be nearly 40 feet in length and were well able, with their grasping claws and knife-like teeth, to take on even the largest of the giant dinosaurs, called sauropods.

One of the nastiest of these creatures was the North American *Allosaurus,* whose main diet probably consisted of sauropod steaks. Evidence of his slaughterous feats is written on the remains of a large sauropod found in Wyoming. The spines projecting from the backbone of this victim had been bitten off, and the teeth marks match the teeth of *Allosaurus.*

The Land-and-water dinosaurs, or sauropods, are perhaps the best known to the general public. After all, once you see an animal 80 feet long it's difficult to forget it. Not all were as big as that, however,—some were only 40 feet long. The sauropods were by far the dominant group of the Jurassic period.

Not only were they distinctive in their great size, but they were all short-bodied, long-necked, long-tailed, small-headed, literally almost brainless individuals. One of the largest had a brain no bigger than a man's fist. But these creatures were equipped with an additional "brain" that was twice as large as the real brain and was located in the spinal column in the hips. It wasn't really a brain but a sort of relay-station to transmit to headquarters what was going on behind.

The sauropods walked on all fours, that is, when they walked. It is questionable whether they came out on land at all, because the limb joints were of cartilage instead of firm bone. That a 30- or 40-ton animal could support all his weight on such limbs seems unimaginable. It was more likely that they spent all their time in the shallow water along the shores of lagoons and lakes, walking over the muddy bottoms where at least part of their weight was supported by the water.

Stones to aid digestion

Their heads were relatively small and had peg-like or spoon-shaped teeth wholly unadapted to eating flesh but very serviceable for gathering vegetation. They didn't have to eat as much as one would think, however, since their metabolism probably was low. The type of teeth shows that they could not have chewed their food. What they swallowed was taken care of by their gizzard-like stomachs and stomach-stones, or gastroliths *(see cover and page 294).*

The bodies of these huge creatures were covered with skin having a surface of small, low tubercles, set close together, but arranged in no regular pattern. Discovery of this was made in 1934 by Dr. Barnum Brown when the American Museum-Sinclair Expedition collected parts of some 20 skeletons from the Howe Quarry near Cody, Wyoming.

Quite a number of different kinds of sauropods have been found. The oldest known member is called *Cetiosaurus,* which means "whale lizard." *Cetiosaurus* is, of course, unrelated to the whales, but is a whale of a big dinosaur, for in length he was around 50 feet. He is a genuine sauropod, though in structure rather a primitive one. He makes, therefore, a good structural ancestor for nearly all the later Jurassic forms.

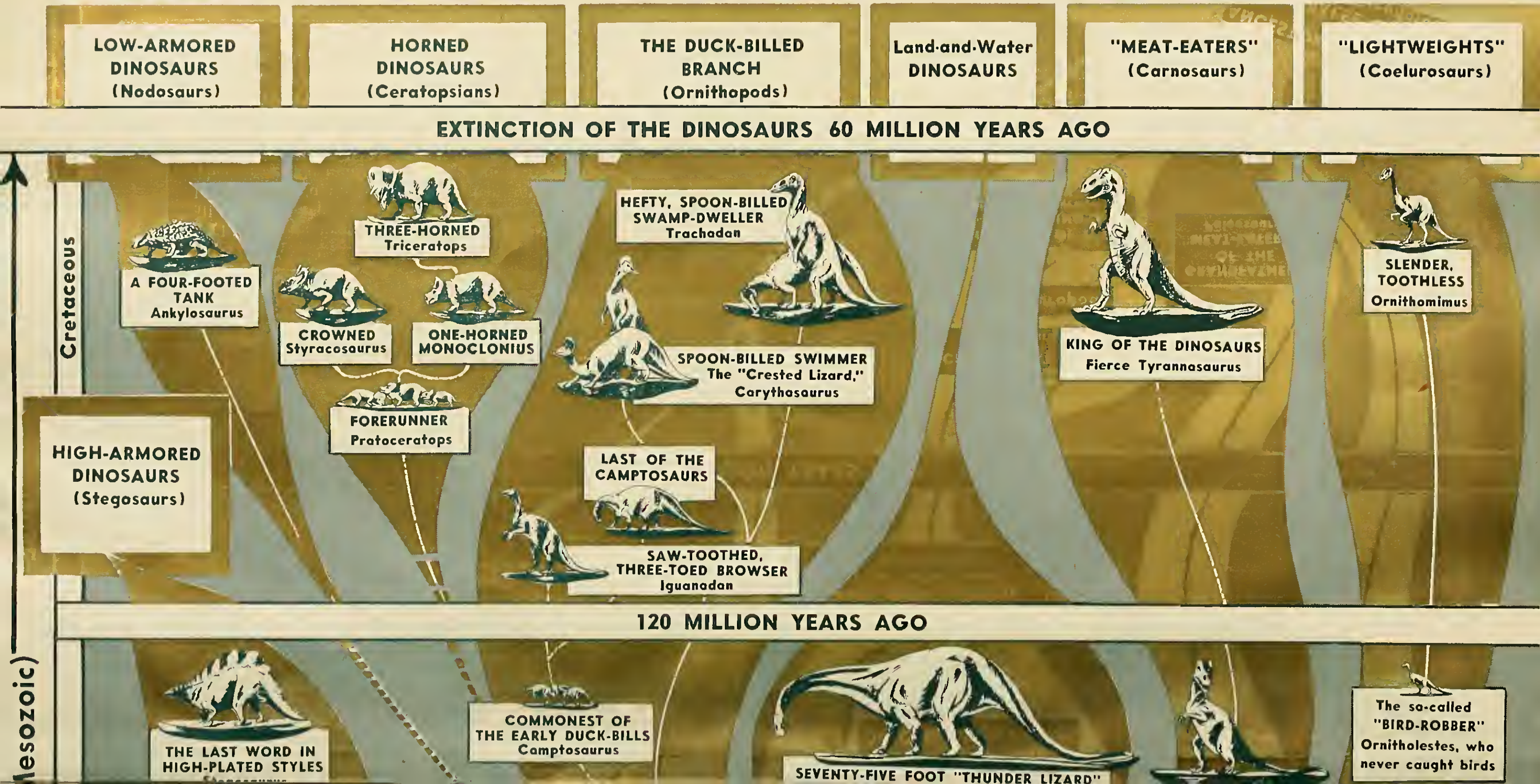
One of the most familiar of later sauropods is the "Thunder Lizard" (*Brontosaurus*). He got to be around 75 feet in length, but the long "whiplash" ending of the tail accounts for ten or twelve feet of that. He stood about fifteen feet at the hips.

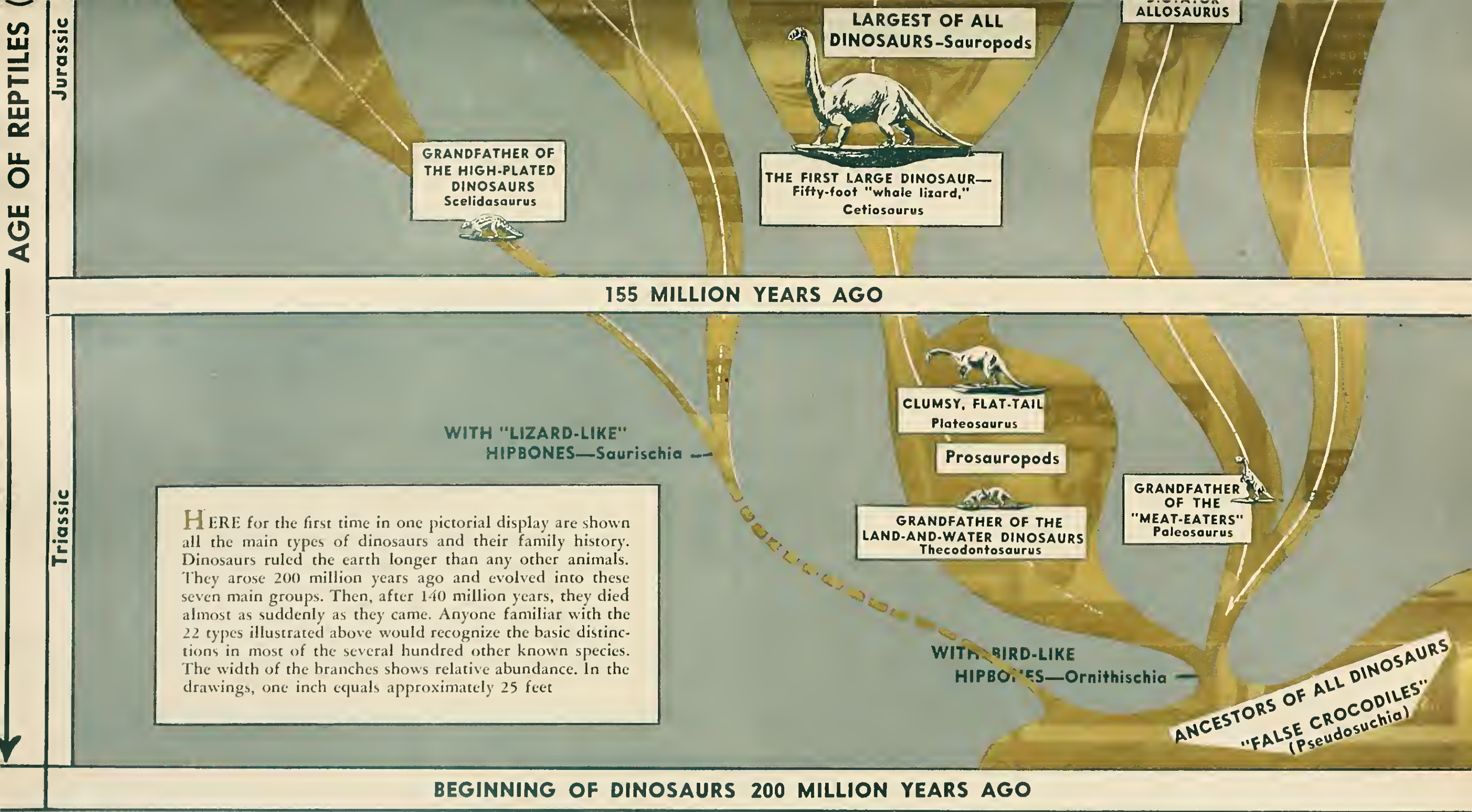
For sheer bulk, the champion dinosaur is *Brachiosaurus,* a native of both North America and eastern Africa. Portions of several skeletons—one rather complete—of this spectacular giraffe-like beast are known. The skeleton is mounted in the Berlin Museum. This specimen shows that the tail is short, but

Continued on page 303

Family Tree of the DINOSAURS

By BARNUM BROWN *and* ERICH M. SCHLAIKJER

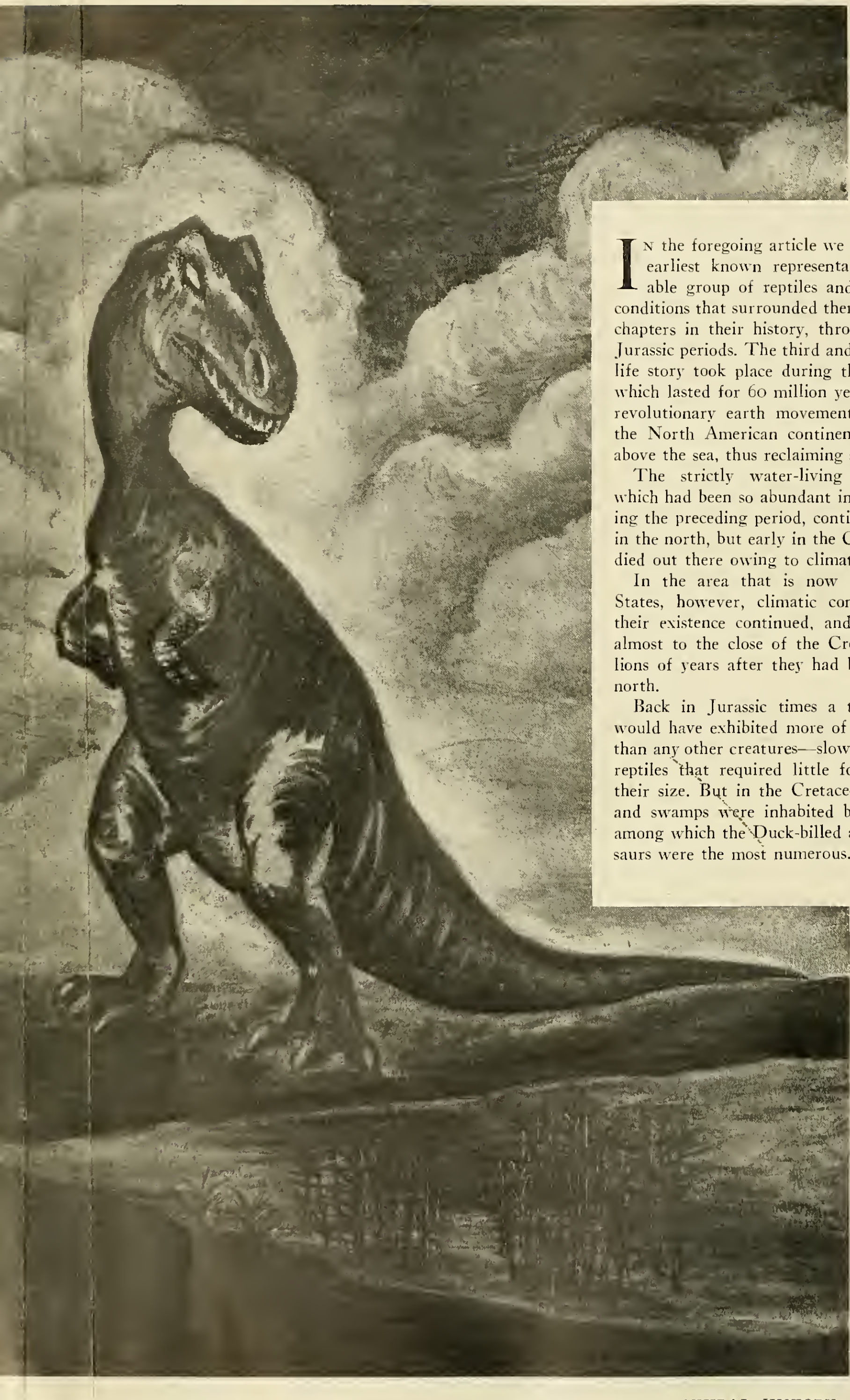




HERE for the first time in one pictorial display are shown all the main types of dinosaurs and their family history. Dinosaurs ruled the earth longer than any other animals. They arose 200 million years ago and evolved into these seven main groups. Then, after 140 million years, they died almost as suddenly as they came. Anyone familiar with the 22 types illustrated above would recognize the basic distinctions in most of the several hundred other known species. The width of the branches shows relative abundance. In the drawings, one inch equals approximately 25 feet

Drawn by
Alastair Brown
from models by
Georgia Mary Whitman

THE



In the foregoing article we have seen some of the earliest known representatives of this remarkable group of reptiles and have envisioned the conditions that surrounded them during the first two chapters in their history, through the Triassic and Jurassic periods. The third and final chapter of their life story took place during the Cretaceous period, which lasted for 60 million years. During this time revolutionary earth movements caused portions of the North American continent to rise still higher above the sea, thus reclaiming submerged areas.

The strictly water-living sauropod dinosaurs, which had been so abundant in North America during the preceding period, continued for a short time in the north, but early in the Cretaceous period they died out there owing to climatic changes.

In the area that is now the southern United States, however, climatic conditions favorable to their existence continued, and there they persisted almost to the close of the Cretaceous period—millions of years after they had become extinct in the north.

Back in Jurassic times a typical lakeside scene would have exhibited more of these huge sauropods than any other creatures—slow-moving, cold-blooded reptiles that required little food in comparison to their size. But in the Cretaceous period the glades and swamps were inhabited by more varied types, among which the Duck-billed and the Horned dinosaurs were the most numerous.

Tyrant king of the dinosaurs, *Tyrannosaurus rex.* This largest flesh-eating animal that ever walked the earth had a sharp nose for blood and carrion, but the days of his rule were numbered

Drawing by Alastair Brown

LAST DINOSAURS

By Barnum Brown*

Curator of Fossil Reptiles, The American Museum of Natural History

It was the era of spectacular armaments, but even Dictator Allosaurus and the four-footed tanks went down before world conditions with which they could not cope

The beginning of the Cretaceous period marked the advent of a highly diversified plant life. Whereas the only type of flowering plants known in the previous two periods were the cycads, the landscape now developed a flora almost as varied and abundant as it is today. Undoubtedly this change in the vegetation influenced the diversification of dinosaurian life during the Cretaceous period.

It is impossible to speak of dinosaurs—a great order of creatures which existed for so many millions of years—without becoming philosophic. They were one of Nature's greatest experiments—a bold venture along new lines. Various forms were tried out, under various circumstances; but after 140 million years, all were thrown into the discard. "All?" you may ask. "Might not some explorer discover descendants of the dinosaurs living today in some hidden corner of the world?" The thought is a romantic one, but I am sorry to say the chances are nil.

Most extinct creatures have left some living descendants or not too distant relatives that give definite clues to their peculiarities and habits, but the dinosaurs left none. As we know them today they suddenly appeared in the Triassic period, 200 million years ago, and they as suddenly ceased to exist near the close of the Cretaceous, 60 million years ago. Our real knowledge of the group goes back only 100 years, when footprints were first found in the Connecticut Valley and were thought to be the tracks of Noah's raven. Since then hundreds of skeletons and incomplete remains of dinosaurs have been classified and exhibited in museum halls, yet every active institution has in its storerooms countless specimens—single bones, fragmentary bones, and teeth—as yet unclassified, of doubtful identity, or entirely new. Many of these, insufficiently understood and too doubtful to bring to light, will remain unpublished until we can learn more definitely of their relationships.

Dinosaurs are so remote from the experience of most people that perhaps the best way to make these dry old bones come to life is to examine the equipment with which Nature endowed them, and to see them perform. If we can see what made the wheels go round, instead of merely pigeonholing them with names and classifications, we may know better what it would have been like to be a dinosaur.

Several hundred species of dinosaurs have been determined; yet we know that these represent only a fraction of the once numerous population. It is indeed a poor season when an expedition does not uncover one or more new species. Realize that all of the combined exposures of dinosaur-bearing rocks represent only a tiny percentage of the accumulated sediments laid down during dinosaur days. Where the dinosaur-bearing beds are being weathered away, each rain may expose specimens previously covered. So we search the same areas year after year and find new specimens. Classic fields will continue to reveal new forms as erosion goes on. And new beds are continually being discovered.

In favorable places dinosaur footprints are found in great numbers, and they are so varied in form that only a few general types have been identified as belonging to creatures whose skeletons we already know. Literally thousands of tracks have been found in the Triassic rocks of the Connecticut River Valley, representing a great many distinct forms. Yet only twelve species of dinosaurs are known by incomplete skeletons from these same rocks.

The rarity of dinosaur bones in this welter of tracks is one of the great mysteries of the past. Possibly it is to be explained on the grounds that the bones were too delicate for preservation in these particular sediments. In spite of their size, the bones of living dinosaurs were probably as delicate as are those of our present-day salamanders. As fossils, the large bones of dinosaurs are extremely heavy, but most of the weight is made up of rock that fills the cavities in the bones—cavities once filled with air. Changed to stone as they are now, it is difficult to appreciate their original lightness and fragility.

In other places, where dinosaur remains were mingled with great masses of vegetation, the skeletons probably were destroyed by humic acid generated during the changes brought about in the formation of coal. Notable examples of this kind were found by the American Museum-Sinclair Expedition of 1937 in the coal fields of Wyoming.

Few skeletons of young dinosaurs

Another mystery connected with dinosaurs is that we find so few bones and skeletons of the young as compared with the vast number belonging to adults. There are only a few cases on record where we can say definitely that the individual was a young animal of a kind known by adult skeletons. Water was necessary for the bones to become fossilized, and it was also essential in the life of the vast majority of dinosaurs. Even semiaquatic creatures of today, such as turtles and crocodiles, lay their eggs away from water. And it has been satisfactorily determined that the egg-laying dinosaurs deposited their eggs in sand

*For a biographical sketch of Doctor Brown, please turn to page 308.

A DINOSAUR TREASURE GROUND

Drawing by Erwin Christman

(Above) A DINOSAUR that looked like an ostrich: *Ornithomimus,* one of the last Lightweights. This toothless animal, which departs so widely from the popular idea of a dinosaur, was about 6 feet tall and may have lived on crustaceans

(Below) GIZZARD STONES. Various kinds of dinosaurs probably swallowed stones which served to grind their food. Here a large number of small stones can be seen among the ribs exactly as found in a small dinosaur in Mongolia

AMNH photo

Photo by Barnum Brown

A DOZEN FINE DINOSAURS have been taken out of this one area, 40 miles southeast of Billings, Montana, on the Crow Indian Reservation. Dinosaurs are found where rock edges are exposed along steep slopes. Such exposures represent only a tiny fraction of the total beds laid down during the time of the dinosaurs. Yet it is a poor season when an expedition does not return with one or more dinosaurs new to science

THE OLDEST unaltered animal substance known: skin at least 120 million years old. The left-hand piece shows the actual skin of a dinosaur. The other two, though less spectacular as examples of preservation, both give a clear impression of the surface texture. Sectioned under a microscope, the skin shows a structure similar to the shed skin of a living snake or lizard. Other dinosaurs had distinctive skin patterns like some of our modern reptiles

Photo by American Museum-Sinclair Dinosaur Expedition of 1934

away from water, where they were hatched by the heat of the sun. If the very young died, perhaps they died where there was no mineral-bearing ground water to fossilize their bones.

Other forms, such as the large sauropods, probably gave birth to living young. Among this group there are more specimens that probably represent young animals. The great number of individual remains found together in favorable places and in definite growth stages indicate multiple births as in living reptiles.

How long did dinosaurs live? We can only guess. Their growth and development was probably rapid in spite of their sluggish habits and small consumption of food.

The oldest unaltered tissue

Our efforts to discover what these creatures were like in life are, of course, hampered by many obstacles resulting from the millions upon millions of years separating us from them. But we are fortunate in knowing even the texture of their skin in some cases. Among the huge long-necked, long-tailed sauropods, a section of tuberculated skin pattern was found on a single leg bone in England; and in the great Howe Quarry in Wyoming we found isolated loose patches of skin impression all over the quarry—indeed, impressions not only of the skin pattern but the actual skin substance itself. This has been sectioned and studied under the microscope, and it shows a structure similar to the shed skin of a snake or lizard. This is the oldest unaltered animal substance known, approximately 140 million years old. The surface of this skin is composed of small, low tubercles or bumps, the size of a pinhead, not overlapping as in the scales of fishes or snakes or in the mosasaurian (marine) reptiles. There is no evidence of a definite pattern, nor can we be certain which type of animal this skin covered. But as most of the remains were of barosaurs, the skin in question presumably came from these sauropods—animals that were 50 feet long and twelve feet high, with heads a foot long and brains that weighed an ounce!

Our knowledge of the skin of the Duck-billed dinosaurs—the most numerous of the Cretaceous dinosaurs—is much more specific. We have every authority for saying that the different species could be distinguished by skin pattern as clearly as are the different genera of modern lizards. Many specimens are preserved with the skin impressions immediately overlying practically all parts of the body. So completely do the skin impressions "clothe" two bodies that they have been called mummies, although no part of the actual skin substance was preserved.

Among the Duck-billed dinosaurs, the different areas of the body had different skin patterns—tubercles of characteristic size and shape. Large rosettes were distributed in rows down the belly and upward over the back, with the individual tubercles larger and more uniform in general character over all the tail surface. This wrinkled skin was evidently so tough that when the carcass was covered with soft silts during burial it resisted decomposition for a long time while the silts were hardening, thus forming a clear-cut impression. Later the skin substances decomposed and the impressions were preserved with exact fidelity as to form and pattern. In other species we find uniform impressions without pattern development. At present we are of the opinion that the crested Duck-billed dinosaurs lacked definite pattern arrangement and that some of them may have been variously colored like modern lizards. Probably this group lived for the most part in the water. Sometime in the future when a sufficient number of Duck-billed specimens have been recovered it will be possible to assign definite skin designs to the various species and to identify the creature by them even as we do now by skeletal features.

Among the Horned dinosaurs of the same period several specimens have been recovered with patches of skin impression preserved, and in these forms there is also a definite series of rosette-like patterns on the sides of the belly.

The Low-armed dinosaurs, such as *Ankylosaurus* ("stiff lizard"), were huge, slow-moving armored "tanks," some of them fifteen feet long, five feet high, and six feet wide. The back and sides of these animals were covered with rows of plates running crosswise and lengthwise like those of modern alligators and crocodiles. An epidermis or outer skin, which was similar in form and pattern, covered these plates. Plates of smaller size, varying in form and size so as to permit movement, covered the belly and legs. This numerous and varied group of dinosaurs resembled enormously enlarged, drawn-out "horned toad" lizards.

Gizzard stones

Chickens and other gallinaceous birds swallow stones which serve the purpose of grinding their food in the gizzard or pro-stomach. Some extinct animals such as plesiosaurs regularly followed this same practice, and there is no doubt that certain types of dinosaurs also swallowed stones. A skeleton of an orthopod dinosaur from Mongolia now in the American Museum has 112 stones preserved within the body cavity. With another specimen—one of the large sauropod dinosaurs of the type of *Barosaurus*—seven highly polished stones were preserved with the vertebrae, and it is practically certain that these stones had been in the dinosaur's body when it died.

In some fields where dinosaur skeletons are numerous, as in the Lower Cretaceus beds of Montana, we find literally thousands of highly polished stones that probably were regurgitated by dinosaurs after the stones became rounded and therefore no longer useful as grinders. None of these highly polished stones were found in the body cavities of skeletons from the same beds. We did, however, find such stones while excavating one of the skeletons, and they show the same high polish as those found exposed in the surface layers. In another place where a great number of skeletons were found together, in the Howe Quarry of Wyoming, there were 64 well-polished stones under the shoulder blade of one of the large skeletons.

These are a few examples in which the implication is quite conclusive that some sauropods, as well as other types of dinosaurs, had the habit of swallowing stones as an aid in digesting food. Our difficulty, however, is to explain the high polish found on the supposed stomach stones (gastroliths), because among the modern birds, hard objects such as glass are etched rather than polished in the gizzard. In our opinion the polishing took place by some unknown process in the alimentary canal of these dinosaurs. The highly polished stones are invariably found in rock layers that contain dinosaur skeletons and they are not found elsewhere.

The teeth of dinosaurs shed much light on their feeding habits. Some dinosaurs like *Ornithomimus* ("bird mimic") were actually toothless and they may have fed upon crustaceans. Those that fed exclusively on flesh were provided with sharp, dagger-like teeth, some of which were smooth on the borders, others serrated.

As among many living reptiles new teeth were grown to replace those broken or lost throughout the life of the individual. The plant-feeding Horned dinosaurs shed their teeth and replaced them with new ones as soon as the enamel-surfaced crowns wore off.

Two thousand teeth

In other groups like the plant-eating Duck-billed dinosaurs, the feeding habits were evidently quite different, since they were provided with a highly complicated tooth system. Some of them had more than 2000 teeth at a time, arranged in the jaws like rows of cartridges in a gun-clip. The teeth were all curved and had enamel only on the outside of the upper teeth and the inside of the lower teeth. Thus the enameled surfaces acted as the blades in a pair of scissors for sectioning the food. As the enameled surface wore down, new teeth came into place at the cutting edge, and the worn roots functioned as a grinding surface. This complicated tooth arrangement must have served a specific purpose, and it seems probable that these animals fed on some highly siliceous kind of plant like "horsetail" rushes, which were abundant during the Cretaceous period.

We marvel at the comparatively small brain in all of these huge creatures. Some of the largest bodied sauropods had the smallest brains, and none could have exceeded ten ounces in content—only about one-fourth the size of a man's.

Casts of the brain cavity have been made from several kinds of dinosaur skulls. Even the semicircular canals, the "balancing organs," have been determined, and in a few cases we have explored the pituitary cavities. It seems probable that dinosaurs as a race were hyperpituitary cases. This, in a measure, may account for their great diversity in form and sizes.

The brain cast of *Tyrannosaurus rex*, "tyrant king," the largest land-living, flesh-eating creature that has ever lived, shows a well-developed fore and hind brain and abnormally large olfactory lobes. This would indicate that some of the carnivorous dinosaurs at least, depended largely on their sense of smell when searching for food, and that they were carrion feeders as well as killers.

Dinosaurs were more plastic than any group of living or extinct creatures of which we have a definite record, and their capacity to meet changing conditions may account in part for their long existence. Most lizards of today can regenerate a new tail if they lose the original one—but there will be no bone in this replacement. The long-tailed sauropod dinosaurs, however, could regenerate not only the soft tissue of the tail but the tail bones as well. One of the sauropod specimens found in the Howe Quarry at Shell, Wyoming, demonstrates this ability, for 21 vertebrae at the end of the tail were "replacements." Several other similar examples of regeneration were found in this quarry.

What happened to the dinosaurs?

Dinosaur remains are found practically over the entire world, but these animals did not get up and travel from one section to another as mammals do when seeking a change of environment. We picture their migration as a slow, gradual dispersal and encroachment into favorable bordering regions—a movement comparable to wavelets where a stone has been thrown into a pond.

The dinosaur race perished all over the world at approximately the same time, near the close of the Cretaceous period. There has been much speculation as to the cause of their extinction, and several untenable theories have been advanced:

1. It has been suggested that a series of sudden cataclysms such as volcanic outbursts may have exterminated them. But many of the latest survivors died too far from volcanic regions for vapors or even wind-borne ashes to have harmed them.

2. Another supposition is that mammals—progressive newcomers on the earth—might have destroyed the eggs of the dinosaurs. But many kinds of water-living dinosaurs undoubtedly gave birth to living young and were safe from predatory land creatures.

3. Finally it has been argued, that the climate became too hot for the dinosaurs. Modern reptiles, to be sure, cannot stand extremes of heat,—but the plant life at the time of the last dinosaurs does not indicate such temperatures.

The best explanation of the extinction of the dinosaurs follows other reasoning. Dinosaurs had become highly specialized creatures. The plant-eaters were restricted in their feeding habits to certain types of vegetation. When, through regional elevation toward the close of the Cretaceous period, lakes and swamps were drained and plant life changed or became scarce, plant-eaters died out locally, and the carnivores went with them. For they could not migrate rapidly enough to new, favorable places or adapt themselves to a radically and rapidly changing environment.

After all, why should we criticize any group of animals for giving the earth over to other creatures after 140 million years of supremacy? They were amazing creatures, to say the least, and the mysteries still surrounding them will continue to give zest to one of the most absorbing branches of scientific exploration for many years to come.

Glaciers are becoming increasingly important in the study of our changing climate; and "glacier hunting" is a popular sport yielding valuable information. In the background, an icefall is seen where the "river of ice" pours over a steep slope; in the foreground, a crevasse. (Olympic Mountains, Washington)

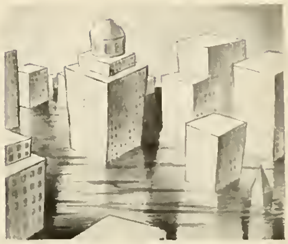
All photos by the author

WE LIVE

IN AN ICE AGE

By Weldon F. Heald

Five new glaciers have been discovered in California, where no ice existed when the big trees were young. Will continental glaciers one day bury our civilization a mile deep in moving ice, or will existing glaciers melt to flood all our coastal cities under 164 feet of water?



Drawings by Ray de Lucia

The glacial period is still with us. One-ninth of the world's land surface is covered with moving mantles of ice, from a few hundred to several thousand feet thick. Today more than six million square miles of ice are actively grinding, scouring, and carving the surface of the earth.

Of course, this is less than half the amount of ice 25,000 years ago at the height of the last great glaciation. But Nature's air-cooling system continues to function. It is only a little less efficient than it was in those far-off frigid days.

We are living during an unusual time in the earth's history. Our present weather is stormier, colder, and more violent, than normal. Fossil records left in the rocks from past ages show that there have been long periods of mild climate, lasting millions of years. It is the usual thing. But these uncounted eons of genial warmth have been broken occasionally by relatively short ice ages when the climate was even colder than it is today. At least four times the world has been overwhelmed by huge continental glaciers. The first ice age of which we have any record occurred in the Huronian period, a billion years ago. The latest, in the Pleistocene, happened so recently that no one can be certain that it is over.

So these are soul-stirring times—not only politically but geologically as well. Perhaps the excesses of one are caused by the other. Such cold interludes are probably trial periods during which all life makes rapid advances, only to sink back into sloth and extinction when the whole world once more becomes a steaming hothouse comparable to the African Congo today.

Man is a child of the ice age. His rise to dominance has occurred during a time of vigorous climate. We are all intimately, though mysteriously connected with the coming of the ice, and we may go the way of the dinosaurs when the last glacier melts some thousands of years hence.

If glaciers are so important to us, so closely related to our revolutionary advance, we ought to know something about them. Where are they? What causes them? Are they increasing or retreating? If we lived in Switzerland or Norway the answers would be easy. Glaciers would be familiar daily sights. But to most of us in the United States glaciers, icecaps, and permanent snow fields are thousands of miles distant.

Glaciers hold secrets which cannot be solved in a lifetime. Although they have been studied for over 100 years, even today experts are not in complete agreement about the mechanics of moving ice. Enough heat has been generated in scientific arguments on the subject to melt several polar icecaps.

The same natural laws govern all glaciers,—from continental ice sheets thousands of square miles in extent to pygmy glacierets covering a few acres. In the United States, glaciers are limited to the high mountain ranges of the West. They are mostly small, wasted remnants of once magnificent ice streams, but they show in miniature all the characteristics of moving ice bodies.

There remain many unsolved problems about the movement of ice, but the fact that it does move furnishes us with the best definition of a glacier: a permanent reservoir of snow, replenished each winter and drained by a slow, continuous movement of its compacted snow and ice to lower elevations.

Glaciers form wherever more snow falls each winter than is melted away the following summer. Let us take an example: a high mountain peak in a snowy region. Winter storms pile snow on this peak while blizzard gales whip it into huge, curling drifts. The summer sun melts most of the snow, but perhaps the largest drift lingers through the autumn as a foundation for the succeeding winter's storms. So each year more snow is added to the accumulations left over from preceding winters. If the snowfall remains relatively constant the drift annually becomes deeper and covers a larger area.

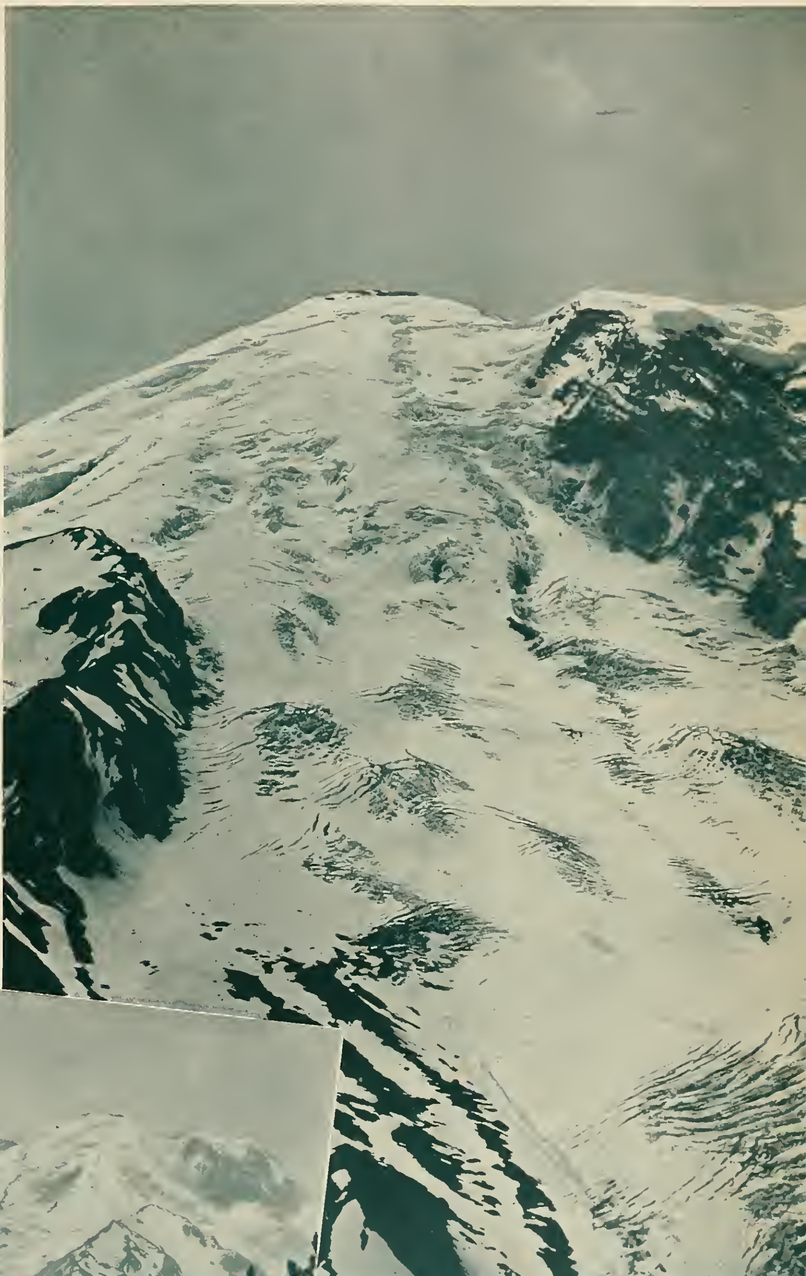
Through repeated thawing and freezing the drift turns into granular snow called *névé* (pronounced nay-vay'). This word, like most terms relating to glaciers, is borrowed from the French.

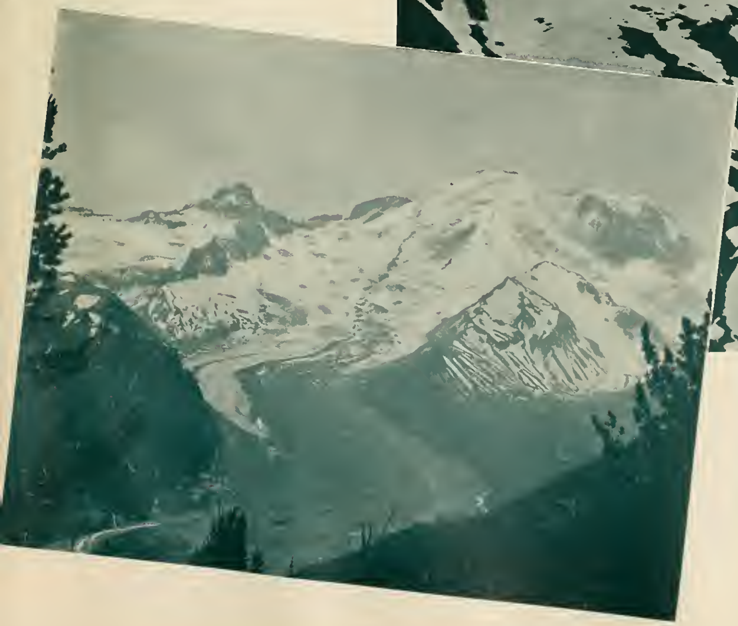
As our snowdrift deepens year after year its weight becomes so great as to compress the older layers on the bottom into ice having a crystalline structure. This is the critical point when a snow field becomes a glacier, because névé by itself does not move continuously, while crystalline ice does. Scientists have puzzled for many years over Nature's snow-into-ice conjuring trick. They haven't

At left, A MOUNTAINEERING PARTY can be seen exploring a remote glacier in California's Sierra Nevadas, one of five new glaciers discovered by the Sierra Club three years ago. The large crack above the climbers is called a *bergschrund*, a feature formed where moving ice pulls away from the snow field above

GLACIERS form when more snow falls each winter than is melted away each summer. Sholes Glacier, at right, is in the only region on earth where winter snowfall is so heavy that glaciers form wholly below tree line—our Pacific Northwest

(*Right*) THE "RIFFLES" in this vast surface of ice can be likened to the rapids in a stream: they reveal rough places in the bed of the glacier. This is the upper four miles of Winthrop Glacier, one of 27 rivers of ice that pour down the sides of mighty Mount Rainier





(*Left*) EMMONS GLACIER, the largest in the United States. Its lower third is covered with piles of rock, called moraines. These deposits, excavated by the moving ice, enable geologists to map the location of glaciers which vanished ages ago found all the answers yet. But microscopic study of actual ice crystals forming in snow-ice under artificial laboratory pressure has solved many problems that were once controversial.

When our growing snowdrift becomes thick enough, the lower ice layers begin a slow downhill movement. Pressure from the snow and ice above under the force of gravity starts the entire mass in motion. How thick it must become in order to "flow" continuously and become a true glacier is another unsolved problem. An estimate of 150 feet has been given, but it probably depends somewhat upon the steepness of slope and smoothness of bed.

Moving ice acts like a viscous fluid, such as molasses or tar. So our newly born glacier flows majestically and relentlessly down the mountainside a few inches or a few feet a day. It obeys the laws of moving liquids: conforming to its bed, rounding corners, churning past obstructions, and pouring over cliffs in slow, frozen cataracts of ice.

Although the glacier as a whole acts like a moving fluid, the ice itself retains all its well-known ice-like characteristics. It is brittle, easily split,—but broken parts have the ability to freeze together again and may even be remolded into different shapes under melting and pressure. Therefore our glacier's surface is rent, riven, and cracked where it passes over a rough bed, smoothing out once more when it reaches even going.

A river of ice

We begin to see how much a glacier resembles a river. Hundreds of *crevasses,* or deep cracks, break the surface into frozen riffles and rapids. Areas of tossed and broken ice splinters, called *séracs,* pour over the steep places like waterfalls. Smooth stretches correspond to quiet pools and ponds.

But our glacier is like a river in other ways. It moves more rapidly in the center than at the sides, faster at top than at the bottom. It flows continuously from the névé field at its head. Our ice river can no more separate itself from this source than a stream of water can desert its spring. Like a river the glacier is dependent upon a constant supply—when that ceases, it dies.

If the snowfall on our mountain peak remains about the same, a point is eventually reached at a warmer, lower elevation where the descending ice melts away each summer as rapidly as winter snow replenishes the névé reservoir. Here is the glacier's terminal or "snout." A good sized stream of melt water drains it, usually issuing from an arch in the ice. The water is milky because of glacial silt in suspension. This pulverized "rock-flour" is an indication that the glacier is actively grinding, scouring, and shaping the bed over which it passes.

The terminal will remain at the same point as long as the supply of new snow at the head equals the melting at the foot. When the climate becomes cooler or the snowfall heavier, the glacier will continue to advance down the valley to still lower elevations, possibly combining with other glaciers to bury the land in a new ice age. When the weather moderates or the snowfall lessens, the front of the glacier will retreat toward its head, perhaps eventually melting away completely. The size of our glacier is determined by a delicate balance between winter snow supply and summer melting.

The largest glaciers and icecaps are thousands of feet thick. It can be imagined what revolutionary changes these ponderous masses weighing millions of tons cause as they move over the landscape. It is because moving ice does such a thorough job of scratching, leveling, and excavating that the former extent of glaciation can be traced so easily. When glaciers melt away they leave their "fingerprints": steep-walled mountain basins, or *cirques,* usually containing chains of lakes; U-shaped valleys, often descending in giant steps; scratched and polished rock; scoured and leveled land stripped of all soil.

As these moving bodies of ice excavate their valleys, they carry down enormous quantities of rock, which they dump at the terminals. If a glacier terminal remains for some time at the same place, rock piles accumulate around the end and sides of the lower tongue. These terminal and lateral *moraines,* sometimes several hundred feet high, are left when the ice finally retreats. They show us the exact outline as well as the former extent of the glacier that made them.

From a study of moraines, cirques, scratches, and polished rock, accurate maps of former glaciers can be made in regions where there is now no ice. Artists are enabled to paint pictures of ice-burdened mountains and valleys as they actually appeared thousands of years ago. Such things stir our imaginations. They help us not only to visualize a familiar landscape as it was in past ages but also to understand why it looks as it does now.

Glaciers in retreat

On the whole the glaciers of the world are in retreat today, those of North America perhaps fastest of all. In sections of our West the retreat has become almost a rout. Many smaller glaciers have lately disappeared completely, while others have so wasted and shrunk as to be almost unrecognizable from photographs taken 20 years ago. If Nature doesn't rush fresh reserves of snow and cold to the glacier front, the ice battle will be lost. The glacial period in the United States will soon be a thing of the past.

In recent years the National Park and Forest Services together with western mountaineering clubs have been systematically recording data about our remaining glaciers. They take annual measurements, make surveys, collect photographs, and write yearly reports. The results are sent to the International Committee on Snow and Glaciers, whose Washington branch, headed by the eminent geologist, François E. Matthes, is a section of the American Geophysical Union. The Committee welcomes additional information from whatever source and is glad to receive photographs and descriptions of glaciers from individuals. Every little bit helps, for ten questions about snow and ice spring up for every definite answer.

The Sierra Club of California is taking a census of glaciers in the Sierra Nevada. Glacier hunting has become a popular sport on summer mountain trips. In 1939, five hitherto unknown or unreported glaciers were added to the list. The ice bodies of the Sierra are small, but it is their smallness which makes

ATTENTION FOCUSES on the Sierra Nevadas of California as a region offering much insight into climatic changes. Above is seen the largest glacier in that area, beautiful Palisade Glacier, covering several square miles in the protecting shade of 14,000-foot peaks. The ice tongue reaches nearly to the lake but is buried under rocks excavated from the headwall. California had no glaciers 4000 years ago, when over half a million cubic miles of ice now frozen in the world's glaciers lay melted in the sea. But California's glaciers are barely holding their own. Like Dana Glacier below, many of our western "glacierets" hang in the balance between moving ice and stagnant snow. Which way they turn may indicate whether we are leaving the Ice Age or entering a new one

them so important. Most of them have recently retreated until they are at the critical stage of delicate balance between névé field and true glacier. They would be the first to respond to minor changes in climate. And it is the present glaciers of the Sierra Nevada which hold the key to the past glaciation of the West.

Through a world-wide study of glaciers and the traces they leave behind them, geologists discovered that the last, or Pleistocene, glaciation was not one continuous period of refrigeration. There were four cold waves with nonglacial intervals between, some of them much warmer than the present. The first and most severe of these Pleistocene cold waves occurred 700,000 years ago. The fourth is not over yet. We are in a cool spell today—a sort of "little ice age."

More ice than 4000 years ago

The glaciers of the Sierra Nevada have proved especially helpful in checking and plotting these variations in climate since the last ice maximum. François Matthes was the first to realize that the present-day California glaciers are not remnants of Pleistocene glaciation. Those huge ice streams melted away completely about 4000 years ago. Mr. Matthes pointed out that the raw, new moraines of the present glaciers, many of them containing stagnant ice, have no connection with the larger moraines some miles down the valleys, which are obviously several thousand years old. This led to the theory that there has been a recent resurgence of glaciation on a small scale.

The related observations brilliantly check Mr. Matthes' deductions. Owens Lake, a desert body of water without outlet, on the east side of the Sierra, was tested for the amount of salinity or mineral salts it contained. It was found that the present salt content would take roughly 4000 years to collect. Borings showed that the lake inherits no salinity from the much larger Pleistocene body of water, since those ancient salts are buried under sediments on the modern lake floor. Therefore, there must have been a warmer, more arid time about 4000 years ago, at the time when Owens Lake dried up. This was the period when all glaciers disappeared from the Sierra, for today they are much too small to withstand any further warming or drying of the climate. Correlations like this make a scientist's life worth while.

But the neatest independent corroboration of Mr. Matthes' theory is brought to light by a study of ocean levels during past glacial stages. The amount of ice now covering the land is equivalent to about 4,300,000 cubic miles of water, according to R. L. Daly. This ice, if released through melting, would raise the sea level 164 feet. By the same authority the volume of ice at its maximum was enough to have lowered the oceans 246 feet below their present level.

Old ocean levels

Did they leave any record at that level? Fortunately, Hawaii, Samoa, and other volcanic islands of the Pacific rise from an ocean floor which has probably remained stable for millions of years. Ancient sea levels can plainly be seen on these islands. The story told by these strand lines of the Ice Age and the succeeding period exactly checks with land observations made in glaciated regions. The lowest level, now over 200 below the sea, made during the maximum glaciation, comes within a few feet of Daly's mathematical estimate of the amount of water removed from the ocean and locked in the ice fields.

Since then there have been several fluctuations above and below the present sea level. But the most interesting to us is a strand line shown by marine fossils to be about 4000 years old. Does it corroborate Mr. Matthes' theory about Sierra glaciers? It does absolutely! The ocean at that time was 25 feet higher than it is now. This means that 4000 years ago there were 655,000 cubic miles of water in the ocean that are now locked on land in the form of glacial ice. Since Sierra glaciers are now barely holding their own, we can be certain that there was no ice in California 4000 years ago, which is not so great a time when we realize that trees living then survive today.

Ocean levels, glacier observations, and climate all tell us that we are living in an ice age. In the western United States, Mount Rainier, Baker, and other high peaks of the Pacific Northwest still carry huge, sprawling rivers of ice; the Olympic and Cascade Mountains glisten with hundreds of ice fields; the Rockies and Sierra Nevada yet shelter numerous glaciers.

Is the ice age drawing to a close? Will our climate continue to moderate until palm trees grow on Alaska's shores? Or is it possible that continental glaciers will descend upon us once more, burying our civilization a mile deep in moving ice? The odds are even. No one knows what causes an ice age nor what makes it disappear. It is a good bet either way. But the chances are that you will not be here to collect on that distant, future day when *your* guess turns out to be correct.

THE RISE OF THE DINOSAURS

Continued from page 287

the animal is still 75 feet long. A unique feature of this dinosaur is that his front limbs are longer than his hind ones, which together with a terrifically long neck made it possible for him to nibble comfortably at leaves 40 feet above the soles of his feet!

A large number of other well-known sauropods living at that time were all thoroughly overspecialized for an aquatic or semiaquatic life in humid climates. Nearly all of them died out at the close of the Jurassic, when earth movements drained their lakes and marshes and the climate became more arid. Survival was possible only for those few lucky ones that lived where the old conditions prevailed. They continued on into the next geologic period, and a few managed to survive to the very end of it, when all dinosaurs gave up the ghost.

The plant-eating dinosaurs that dwelt on land in Jurassic times were the descendants of the earlier ornithischian group already mentioned, which now became more important. There are four main branches of these: the High-armored, the Low-armored, the Horned, and the Duck-billed dinosaurs. The Family Tree on pages 288 and 289 shows when they evolved and how they are related. They were rare at the beginning of this period but branched out considerably towards the end.

The Duck-billed dinosaurs, quite obviously, had bony duck-like snouts. Some of these dinosaurs, especially the later ones, got to be very large. They all walked on the toes of their hind feet, although certain ones occasionally touched the ground with their hands. The whole skeleton of these animals was massive. The head was relatively large and was equipped with numerous teeth of the chopping type. *Camptosaurus* was the most common and widespread representative of the Duck-billed group at the end of the Jurassic.

The High-armored dinosaurs or Stegosauria got away to a good start at the very beginning of the Jurassic and became a typical feature of the landscape during this time in the earth's history. The earliest one we know, *Scelidosaurus*, had several rows of tubercles and keeled plates along the back, and a row of fairly large vertical plates down along the top of the tail. But his coat of mail wasn't nearly as fancy as that of his descendants, who really went in for decorations. The stegosaurian style-setter was *Stegosaurus* himself, typical of North America late in this period and of occasional occurrence in England.

Stegosaurus got to be 30 feet long, had a little head and a short tail. That little head of his had very little in it, but like the sauropods, he had a second "brain" in his hindquarters—and what a "brain"! In some it was 20 times larger than the regular brain up forward.

A double row of large plates projected along the middle of the back and onto the tail, at the end of which rose two pairs of long spike-like spines. Of what service these ornaments were to the animal is not certain. Many suggestions have been made. It has even been proposed that they might have acted as a sort of roofing or self-invented shade to protect the reptile from too much sunlight when forced out of the abundant vegetation. They certainly were a protection against attack when dictator *Allosaurus* and his crew took on *Stegosaurus*. And the spines at the end of the tail must have been very effective ankle-busters in combat. Gaudy and homely as these structures seem to us, we may assume that they were attractive to a stegosaurette back in the Jurassic jungles. Furthermore, it must have taken a shrewd Meat-eater to spot one of these creatures with its big, and probably greenish, leaf-like superstructure, half-hidden in one of those Jurassic marshes or in the bush along one of the lakes.

By the end of the Jurassic period, the dinosaurs had risen to unquestionable ascendancy. But the Age of Reptiles was not yet over, and with further environmental changes in store for them, the dinosaurs were destined to have an even greater evolutionary development. With the closing of the period, the earth once again began to tremble. And in their effort to meet new environmental conditions, these most sensational animals of all time entered upon some of their most surprising adventures in the remaining 60 million years of the Age of Reptiles.

Be sure to read "The Last Dinosaurs," by Barnum Brown, beginning on page 290.

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Continued from page 257

SIRS:

I am probably one of your youngest subscribers, but I enjoy NATURAL HISTORY Magazine extremely much. I also subscribe to the *Junior Natural History* Magazine, and like that too. I save every copy I receive of both magazines. I notice particularly the articles concerning gems, and hope that they may continue.

REED P. ANTHONY, JR.

P. S. I am twelve years old.
Greenwich, Conn.

SIRS:

I enjoyed very much indeed "Attorney for the Insects," the life history of Frank E. Lutz. . . . LOUIS D. HUNTOON.

Pleasantville, N. Y.

* * *

SIRS:

I am very proud indeed of the step I took several months ago in placing before you my Associate Membership application blank. . . .

NATURAL HISTORY Magazine alone is worth many more times the membership fee, with the privilege of receiving such valuable information of this great world and the natural history therein contained.

I have always been very much interested in the American Museum of Natural History, in the developments it has made for the taxidermist's world. I became acquainted with the Museum's work through the book *Taxidermy and Zoological Collecting*, by the late William T. Hornaday.

Again in closing let me say NATURAL HISTORY Magazine is a world of interesting education. I shall always be proud of your great institution, the work it is carrying on, and last but not least, I am more proud to have a Membership with the organization, which I intend to keep *always*.

Burlington, Colo. RAYMONO BEY.

SIRS:

. . . The Magazine makes a splendid Christmas present—thank you.

Troy, N. Y. E. W. GOULD.

* * *

SIRS:

. . . The October issue of NATURAL HISTORY arrived Friday. You should see the waiting list. It grows and grows. I have one fellow who is copying that chart, "Grandfather Fish and His Descendants," onto a big sheet of paper so that he can have his own copy of it.

No. 3395.

In a New York prison.

SIRS:

. . . I have secured four members during the past year, each of whom feels that I have done him a favor . . . NATURAL HISTORY is the one magazine that I literally read from cover to cover.

San Diego, Calif. H. K. RAYMENTON.

* * *

SIRS:

I have just finished reading Doctor Romer's very interesting article on "The First Land Animals." In his discussion of the egg-laying habits of the amphibians he makes the statement that "all amphibians must return to the water to lay and fertilize their eggs."

On page 35, Part II of Schuchert and Dunbar's new edition of *Textbook of Geology,* a similar statement is made. "The amphibians were never able to improve on this habit and so, throughout the ages have returned annually to the water to spawn."

A year ago our class at the University of Michigan Biological Station collected the eggs of the salamander *Plethodon cinereus* on land! After checking in the late Doctor Noble's *Biology of the Amphibia,* I find no mention of their

Continued on page 312

SIRS:

Since their formation is something of a riddle, I thought your readers might be interested in these highly irregular stalactites called helictites. They are formed of the same material as the more familiar stalactites and stalagmites—carbonate of lime—, and their rate of growth is thought to be about the same, perhaps one cubic inch a century.

As for their habit of twisting and turning in every imaginable shape, all that can definitely be said is that certain factors are *not* the cause, such as wind currents, faster or slower flows of water, seasonal changes, or grains of sand or silt in the fluid forming them. It has even been a question whether they grow at the free end or at the base. Lyman C. Huff of the University of Chicago, who has produced artificial helictites, states that the ones in his experiments grew at the free end. He also concludes that, if natural helictites are formed in the same way as artificial ones, they assume their crooked shape as a result of the chance orientation of the crystals at the growing end.*

The photographs shown here were taken in Wyandotte Cave, Indiana, one of whose passageways is said to contain more of these curious helictites than any other known cave avenue in the world.

Evansville, Ind. GEORGE F. JACKSON.

* In the *Journal of Geology,* August-September, 1940.

WINTER COLORS IN KODACHROME

By Charles H. Coles

Chief Photographer, American Museum of Natural History

Photo by the author

WATCH YOUR EXPOSURE IN WINTER: your meter will serve you well only if you give it your best photographic judgment

Kodachrome for white snow? Of course. Winter is no time to pack away the color camera. The brilliance of freshly fallen snow, the sparkle of ice on the trees after a sleet storm, the scintillations of frost crystals—all can be caught and registered faithfully with color film.

A snow scene in color can be a simple or a difficult subject, depending upon the contrasts of light and dark. Usually the scenes most easily recorded are those in which the contrast between the lightest and the darkest parts of the picture is comparatively small. The tonal scale that the color film is capable of rendering properly is limited, and this presents difficulties for contrasting subjects.

Direction of light

By carefully selecting the direction of light, the photographer can often control the contrast in his snow picture. Ordinarily, when no snow is on the ground, the lowest contrast is usually obtained by working with the sun behind the camera, its rays falling directly upon the subject. Any shadows that are cast by the objects in the picture fall behind the objects themselves so they do not show. The color film must include only the brightness range of the objects themselves; it does not have to pick up detail in the shadows.

But with snow on the ground, the shadows reflect so much light from the sky that they are sufficiently bright to come within the exposure range of Kodachrome. Since they are illuminated by light from the blue sky, they turn out a bright blue in the finished color picture. That the shadows are actually blue in color is not generally noticed but if they are observed carefully this fact will be substantiated.

In taking winter sports scenes, the Kodachrome-user is beset with the problem of contrast between the dark togs and the white background. More exposure will brighten up the person's face, the snow, and the sky to the point of overexposure. Better results are obtained by selecting skiers, for example, with lighter colored outfits, but the best skiers unfortunately seem to wear the dark suits. In commercial advertisements, you will notice, skiers do not wear dark blue suits. Dark garments are conspicuously absent; bright mittens, caps, and jackets enliven the picture.

The bright surface of sunlit snow presents a practically uniform reflection of white light when the sun is behind the photographer. But by turning so the sun is at one side or the other, the photographer will catch the surface texture and waves that relieve the monotony.

Some of the finest pictures of snow have been made with back lighting, i.e., with the sun directly in front of the photographer. With this light direction, the crystalline surface of the snow literally sparkles in the picture. Shadows of small branches and rocks will add interest to the scene.

However, back-lighted pictures are by no means easy to take, because it is difficult to prevent the sun from shining directly into the lens. If the sun's rays as much as touch the lens, streaks and flares will practically ruin the picture. Two ways are open to the picture-maker to circumvent this problem. A deep lens shade may prevent the rays from entering the lens, though if the sun is fairly low, this will usually prove ineffectual. It is then a good idea to ask someone to hold his hat about four feet in front of the camera in such a way as to prevent the sun from shining into the lens. But keep the hat out of the picture!

Perhaps a better way of shielding the lens is by finding a tree with an overhanging branch to frame the view you are photographing. An evergreen makes an effective frame. The sun, concealed behind the tree, will no longer shine into the lens, and the picture will be improved by the dark border.

Exposure

Exposure meters of all kinds are notoriously inaccurate on all bright landscapes. And with snow, the meters are even less reliable. Photoelectric meters usually indicate woefully short exposures for views in which snow is prominent.

The reason that the photoelectric meter goes so far wrong on snow is not difficult to understand. The trouble is in the basic assumption that all subjects have an equal amount of light and dark, and that the average of the light reflected from a scene is the same as that from an object of average brightness. Snow is by no means a reflector of average brightness. If the exposure meter were read on the snow and the indicated exposure given, the snow would be reduced to the brightness of this theoretical average—a rather dark tone. In Kodachrome the snow would turn out a dingy purplish blue. More exposure is obviously needed.

Kodachrome is limited to a brightness range of about four to one if good color is to be obtained. In other words, the brightest object should not reflect more than four times as much light as the darkest object. Therefore, we want snow to record at the upper end of our brightness range, because nothing else in the picture will be brighter. To accomplish this, all we have to do is to point the meter directly at the snow and read our exposure. The camera should then be set one stop larger than the meter reads. A more convenient way is to set the film speed dial to half the film speed figure and take the reading on the snow directly. Kodachrome has a Weston speed of eight for the outdoor film; so the meter is set for a film speed of four and readings made directly on the snow.

Filters

Under normal conditions, no filters are required when taking pictures on a sunny day. Kodachromes made in the shade on such a day, however, will come out far too blue to look well. A Wratten 2A filter will correct this blueness with no loss in speed. This filter will also improve pictures made in cloudy weather.

With these few not too complicated techniques in mind, the color fan may ride his hobby even when the snow falls. He will find his winter Kodachromes as full of sparkle as the pale greens of spring, the brilliant hues of summer, and the russet of fall foliage.

Father of the Dinosaurs

Barnum Brown is today widely acknowledged the number one dinosaur hunter of the world and the greatest authority on their life and times. Yet hardly any form of organic life, living or dead, has been neglected in his 50 years of exploration all over the world. Diplomat, oil geologist, and scientist, his career is one of the most fascinating in the annals of the American Museum

By D. R. BARTON

WHEN, if, and as, gasless Sundays take their not altogether welcome place in the American way of life, they are bound to cause manifold repercussions, not the least curious of which might possibly be some lessening of popular interest in dinosaurs. As most automobilists know, the connection between the sauropods of the Cretaceous and our modern motor fuel was established for all practical purposes by the Sinclair Refining Company. For a number of years now, patrons of their service stations have received free booklets and stamp collections illustrating the history and development of the dinosaurs in surprisingly entertaining fashion, without sacrifice of accuracy.

Responsibility for the accuracy and partial responsibility for the whole scheme lies with Dr. Barnum Brown, Curator of Fossil Reptiles in the American Museum. Through these pamphlets which he edited and wrote he has answered the questions of millions of children and adults throughout the country, becoming as it were the much honored and sought-after Mr. Bones of the dinosaur show. The first issue consisted of a run of 24 million stamps. They were gobbled up in 48 hours. There followed a printing of 72 million more all of which have now been distributed. Indeed, except for a few of the larger cities, the booklets are in standard use throughout the country as secondary and elementary school texts in fossil reptiles. This is an audience of such breath-taking dimension that no other naturalist can well boast of its equal.* And millions have been added through the current showing of Walt Disney's *Fantasia*, in the making of which Doctor Brown was a consulting specialist. Yet, though his written word and directing influence have spread far and wide, he has kept himself very much in the background. This is largely because dinosaurs and their contemporaries are the moving passions of his life, and he regards himself simply as the agent of their recovery, restoration, and interpretation to the end that they may contribute to the general knowledge of life on earth. The 200 specimens on exhibition in the American Museum and the countless others awaiting assembly in the laboratory are almost all in some measure the fruit of his labors. He calls them lovingly his children, and in his own eyes at least they all have the vivid color and movement of actual living creatures.

Kaiden-Kazanjian Photo

BARNUM BROWN

The Man

Considering the difficulties of securing the specimens and their analysis, it is probable that no other department of the Museum has made such tremendous strides as has Fossil Reptiles under Brown's leadership. When he first came to the Museum in 1897, fossil reptile bones were considered of little "osteological importance" by many of the officials, largely mammal men, of that time. It was felt that the accumulation of such bones in sufficient number to work them out on a systematized, zoological pattern was beyond the realm of possibility. Brown's record of the last 45 years has all gone to prove that they were mistaken. He went out into the field and showed that the bones *could* be gotten, that by patient application they could be gotten in sufficient numbers, and finally that they could be systematized. From the mere handful that had been described up to the 1890's the number of dinosaur species has now risen to approximately 5000, many of which resulted directly or indirectly from Brown's expeditions. He has worked in nearly every major geographical area except Australia, Japan and the South Sea Islands. He has been to Europe both in a diplomatic capacity and as an explorer, and has used all forms of transportation (except the submarine) from human labor to the airplane. Moreover he has perfected and in many cases actually invented many of the modern methods of extracting fossil material from its matrix, and of analyzing it in the laboratory.

Born in Carbondale, Kansas, with a prosaic surname, he owes the distinctive alliteration of his full name to a small brother who was impressed by circus posters for the great P. T. Barnum. It was a provisional choice, but as time went on no one could think of a better one. And it turned out to be a singularly fitting appellation, for though Doctor Brown has never gone to the extremes of his great namesake, he has nevertheless put on one of the greatest animal shows on earth even if all its participants have been dead these 60 million years or more.

Barnum's development was the next thing to a straight line. Before he was much beyond the toddling stage he began a serious collection of fossils which gradually outgrew various rooms in the house and was finally relegated to the laundry building.

*Doctor Brown and the American Museum are therefore indebted to the Sinclair Refining Company for its public educational campaign on the Age of Reptiles, as well as for added scientific knowledge gained from specimens collected through expeditions financed by them.

These fossils were not bones but sea shells. Sea shells in Kansas? Yes. Until about 60 million years ago much of that state lay under the ocean, and before that time parts of it had acquired a layer of coal. Late in the nineteenth century the coal was mined, and during these operations the sea shells appeared.

His parents encouraged him in this absorbing hobby, but they never suspected that he would eventually make a name for himself at essentially similar tasks. When he went to Kansas University, it was with the idea of studying civil engineering; but at the University, Brown met Professor Samuel W. Williston who at that time was one of the big men in paleontology. It was a red-letter day for Brown and a happy occurrence for Williston. The latter was a fine hand at finding and identifying specimens but no great fist of a digger. Conversely, Brown had the patience of Job, doubled and redoubled. A born collector, he quickly became a master of fossil extraction and filled a sizable lack in Williston's professorial life. Their Jack Sprat relationship continued in this symbiotic manner for many years to come.

Early Museum days

When young Barnum arrived in New York in 1897, he had a scholarship to complete his graduate studies at Columbia, and a part-time job with the Museum. Associated with President Osborn, he immediately plunged into expeditionary work of a most ambitious character.

One morning in 1899, Osborn called him into his office at nine o'clock and said, "Brown, can you go to Patagonia with the Princeton party? The boat sails at eleven o'clock and you will probably be away a year and a half."

"That's rather short notice, Professor, but I'll be on that boat," said Brown.

This expedition, accompanied by Brown for the American Museum, explored 800 miles of previously untraveled pampas. Brown was able to gather a large collection of prehistoric mammal skeletons for the Museum, and when at the end of a year the Princetonians had had enough, Barnum was just getting his second wind. With three pack horses he made a solitary tour of Patagonia's bleak Atlantic coast chipping out fossils with his favorite tools—a prospecting pick, crooked awl, and whisk broom. His appetite for bones now whetted to a keen edge, he made up his mind to circumnavigate Tierra del Fuego after finishing work in Patagonia. This was not just for the ride but to see what that dismal island might have to offer the science of paleontology. His hired cutter came to grief, however, when a storm swept into Spaniard Harbor and capsized her.

Brown's experience with the ways of the sea had been chiefly confined to picking up sea shells of the Carboniferous period, and since salt water had retreated from Kansas many millions of years before his birth, he never had the opportunity to learn to swim. No whit daunted, he seized a broken hatch cover and floated to shore while the crew reached the same destination clinging to barrels. The next three weeks were spent in a gold miner's camp, after which a coastal schooner picked them up and carried them around Cape Horn and eventually to France—which was about the last place in which Brown ever expected to wind up an expedition to Patagonia.

This episode, which took place in his twenty-sixth year, reveals two significant characteristics of Barnum Brown's nature: (1) in common with some of history's greatest explorers, he likes to do things his own way—and, whenever feasible, alone; (2) there are few personal risks he is unwilling to take once the scent of a valuable specimen assails his peculiarly sensitive nostrils. Today he is older and wiser, but essentially little changed. At the age of 60 he lost his grip sliding down 40 feet of rope into an extinct volcanic crater in New Mexico and came within an ace of dashing himself to smithereens all because he wanted to see if there were other specimens where the mummified remains of an extinct sloth had been discovered. He did not find other fossils but he did get a pair of hands rasped and battered into mincemeat. In fact his hands always seem to rush in where angels fear to tread. One evening in India, the arrival of a snake raised quite a rumpus about camp, but Brown, thinking instantly of a good herpetology item, snatched up the serpent and discovered only when it was pickled in alcohol that he had been holding a king cobra.

Yet Barnum Brown is no reckless exponent of derring-do, and for a man whom circumstances have drawn into the cauldron of international affairs, his appearace is the most misleading imaginable. Of medium height and weight, his grave, sometimes melancholy countenance might remind one of a Presbyterian divine; but when you note the gold-chained pince-nez and the sparkle of the eyes, you can easily believe that his face may have been the winning of many a poker game. It is not too difficult to believe that he likes to put up his own buffalo berry preserves—which he does. To learn also that he is much in demand as a ballroom dancer well-nigh staggers belief, and certainly goes to show that the surface severity is merely thin veneer. Indeed, "everybody," to quote one of his colleagues, "is crazy about him. When he comes back to a summer digging grounds, local residents meet the train in droves and fight to see who gets him in their car."

Diplomacy

During World War I he was called in by the Treasury Department as an expert geologist to work out defense tax rates for the oil industry. Incidentally, much of the ensuing legislation is expected to be revived in the present emergency.

He resumed the more glamorous exploratory activities in 1923 when he took up fossil-hunting in the eastern Mediterranean during the Greek-Turkish War. Up to this time his career had been hectic, to say the least. He had left the Museum temporarily to accept a geological commission from the Anglo-American Oil Company to determine whether there was any petroleum in Ethiopia. There wasn't. But there were lots of other and — to Brown — more interesting things. By instinct an indefatigable, not to say voracious, collector, he lost no time rifling the kingdom of the Lion of Judah of its least marketable natural wealth. Vertebrate fossils were not especially plentiful, but there was an abundance of the earlier invertebrate variety, together with swarms of insects, lizards, and snakes, all of which were very much alive until Brown got his hands on them. He dispatched the whole job lot to the American Museum wherein they now comprise one of the world's outstanding collections in the invertebrate paleontology, herpetology, and entomology of Ethiopia. There followed the Indian expedition, of which we shall hear more anon, as well as incidental work in Arabia and the Sudan.

Fresh from these triumphs, Brown argued an archaeologist-wary Greek government into letting him exhume fossils amid the ruins of ancient Hellas. This was a fruitful quest, especially on the island of Samos where he bagged a great variety of mammal remains and one of the largest fossil birds ever found in the Mediterranean.

But Museum work was interrupted when his two other "bosses" clamored for his services more or less simultaneously. The oil company wanted him to interview Mustapha Kemal with a view to making some important commercial arrangements. At the same time, the United States Government asked him to see if he couldn't find out why the Greeks were being systematically peppered with British-made ammunition despite the fact that Great Britain openly backed them against the Turkish adversary.

With one eye cocked for signs of contraband explosives, the other alert to any natural history items that might come to light along the way, and his mind busy with the problem of properly approaching the redoubtable Mustapha on that oil matter, Barnum Brown made for Ankara, undaunted by a few Turkish shells that geysered uncomfortably close to the American destroyer which had carried him across the Dardanelles. Asked how he fared on this complex mission, Doctor Brown replied that the oil transaction was successfully consummated. And the ammunition leak? "I secured the information they wanted." And did he collect anything for the Museum in Turkey? "No," he said testily, "I couldn't find the time."

Five Years afield

Just before this press of international affairs, however, Brown had accumulated many treasures for science in the course of a junket that kept him from his native land for five long years. Not that this was a leisurely undertaking by any means. Though Brown dislikes hot countries, the exigencies of his profession oblige him to work in them, which he does with tireless energy. And for a good reason. "Playing a lone hand has had disadvantages as well as advantages. I very quickly discovered," he says, "that when I stopped, the whole expedition stopped."

This human failing he found to hold true all over the world, however much other expeditionary problems might vary. And vary they did in proportion to the quality of local equipment and, perhaps even more cogent, to the astonishing diversity of social customs.

Recollecting his Ethiopian trip, Brown remarks that, "a mule caravan with black servants is like an appetite; it continually grows and is difficult to curb." Nor were the patriarchal potentates any easier to handle. To smooth the way, Brown presented a diamond necklace to the Queen and a diamond wrist watch to the high priest, and an electric light plant for the palace. "On a broiling hot day, in full evening dress, astride small mules, and sheltered by umbrellas, our party proceeded to the palace like a triumphal procession. The streets were thronged with white-clad natives, and our attendants cleared the way by brushing them aside with whips. On reaching the palace our gifts were presented with great ceremony, after which we were told that in a few days we would receive the necessary paper that would permit our caravan to travel over the distant country. The days lengthened into two months of patient and ceaseless daily trips and interviews with the authorities until they were compelled to deliver this important permit, which was, of necessity, our first step in the investigation. This document, by the way, is written in Amharac and starts with: 'By the Grace of God I am well—how are you? etc.' Quaint in diction, but, nevertheless, of the utmost importance to us; for on reading it, all villagers supplied our every want and made it possible to travel where otherwise traveling would have been impossible."

Hindustan

On a slope of India's Siwalik Hills it was 115° in the shade when Brown was faced with the task of transporting a mammoth and a mastodon skull weighing 800 pounds each to an ox-cart road fourteen miles away. Not even mules were available here. A veritable Ptolemy, Brown directed his Hindu porters to shoulder the immense burdens, and marched them down to the trail. It is a tribute to his generalship that everything arrived safe and sound in New York some months later.

India yielded also the complete specimen of a tortoise which stands four-and-a-half feet high and carried a ton of soup meat when alive. Ardent conservationists, viewing the specimen in the Museum, like to think how this ancient titan might turn the tables on the wildlife-slaughtering motorist of today. Try hitting 2500 pounds of turtle and watch the Fords go bye-bye, or, as Brown facetiously remarks, hit 2500 pounds of turtle with a Ford and watch the car turn turtle!

It was in the Siwalik Hills that Mrs. Brown, who has accompanied her husband on many of his more recent expeditions, ran afoul of the Hindu religion. While shopping in the village, she chanced to cross the threshold of a storekeeper during lunch hour. The tradesman instantly jumped up and pushed her out of the shop. Mrs. Brown was unhurt but considerably nonplused and thoroughly indignant. She pried her husband away from his fossil of the moment, and aided by an interpreter they lodged a heated protest to the head man of the village, threatening to manhandle the shopkeeper. The head man could only assume that the latter had gone out of his wits—for a Hindu to lay hands on a white woman is, speaking mildly, pretty bad—, but when things were finally straightened out it developed that Mrs. Brown had really given him rather severe provocation. Ignorant of the complex religious taboos of the country, she had inadvertently thrown a female shadow across his lunch, automatically defiling the food. The poor fellow couldn't afford to have his second helping spoiled, too, and accordingly flung discretion to the winds and tossed the substance of the shadow into the street.

Pack rat

However, it is not often that Mrs. Brown gets into a scrape of this sort, and her presence on his expeditions has won for her paleontological consort at least one accolade that would not otherwise have been his. The Divorce Reform League recently named Barnum Brown as one of the five best husbands in America, an honor he shares with such assorted luminaries as the late Lou Gehrig and Franklin Delano Roosevelt.

The morning after he completed his five years' exploration of Africa and the Near and Far East, Brown stepped into the elevator at the ground floor of the Museum. Another curator glanced up from his newspaper, murmured, "'Morning, Brown," and started to resume his perusal of the headlines, then looked up again and said cautiously, "Been away, haven't you?" But this is not unusual in an exploratory institution, where it sometimes seems that only the individual himself could keep track of whether he is coming or going.

Although Barnum Brown is too much of a scientist to care whether he is missed around the Museum, he fervently wishes that more of his colleagues would keep him in mind when they themselves set forth into the field. Though such a trait is rare in a man of his calling, he has a strong personal compunction against killing mammals even for scientific purposes; still, hardly any other department in the Museum has been forgotten during his own collecting expeditions, and there can be little doubt that he has unselfishly sent back more material both in bulk and variety than any other curator in the history of the institution. In his own words, he is a born "pack rat," compelled by the nature of his being to make off with everything he sees pertaining to his extraordinarily large sphere of interest. And this includes the entire visible organic world together with a fair share of the inorganic.

Probably the most important discovery outside his own specialty was made at Folsom, New Mexico, in 1928. Brown had come to this region to probe for the remains of a brand new—or rather very old—type of extinct bison which the Denver Museum had discovered. A vast clutter of bones was found after 20 feet of excavation. Then close study brought something else to light—several leaf-shaped stone arrowheads of a very high order of workmanship, which were mingled with the bones. Brown saw at once that his best course of action was to run, not walk, to the nearest telegraph station and summon an archaeologist. In fact, he sent a score of messages and within the week had about a dozen of the country's top-flight authorities on ancient man buzzing about the digging grounds. An excited conference resulted in a unanimous vote radically to revise the orthodox estimate of Man's first appearance on this continent. Whereas formerly archaeologists were loath to give him more than 2000 years of existence in these parts, the more sanguine authorities now granted him as much as 20,000. Thus did Barnum Brown figure prominently in America's most dramatic archaeological discovery of the century.

Thirty years earlier, he had extracted the first dinosaur skeleton collected by the Museum from a hillside at Como Bluff, Wyoming. In 1937, he returned there on another expedition to find the hole just as he had left it. During the 40 years between, Doctor Brown has led or served on more than a dozen major expeditions to the western badlands of the United States and Canada, returning several times to favored spots in the Rocky Mountain states and in Alberta, which he has found to contain the richest dinosaur beds in the world.

His discovery of the rich Alberta field was a lucky strike, occasioned by the chance remarks of a Canadian rancher who visited Brown's dinosaur laboratory* in the American Museum, in 1909. It seemed bones like that were six for a nickel "out my way."

The Museum's Paleontology Department always lends an eager ear to "tips," although seldom does it find them living up to their advance publicity.

But this one was an exception. Brown has unearthed tons of bones in Alberta's Red Deer River valley and knows exactly where he can pick up as many more. Indeed, wartime confinement to this continent is no hardship. In 1938 he made a 45,000 square mile airplane survey of southern Alberta and northern Minnesota, in the course of which he spotted enough promising dinosaur burial grounds to last a lifetime of expeditions. And the year before, he took a whole carload of specimens out of the Cretaceous formation in southern Wyoming.

Despite the magnitude of his own results in sheer tonnage alone, and the tremendous progress of paleontology in the last half century, Doctor Brown feels that neither he nor his colleagues have done more than scratch the surface and that their material is "all too inadequate." But this is an insider's view. To the public, their reconstruction of this planet's early life is a work to wonder at, and though some dinosaurs were as small as a barnyard hen, the layman doubtless continues to think of them all as giants like the record-breaking 67-foot long Brontosaurus in the Museum's Jurassic Hall. The acquisition of this "champion," by the way, reveals a side of zoological collecting which smacks of operations in big-league baseball rather than in a Museum. Three expeditions had worked on this specimen with the result that the University of Utah, the National, and the Carnegie Museums

*See also D. R. Barton, "The Indoor Explorer," NATURAL HISTORY, May, 1938, p. 385.

secured the neck, body, and tail among them. Each jealously guarded its portion until Barnum Brown turned trader and swapped a carnivorous dinosaur for the neck, a fossil horse skeleton plus $2,000 cash for the body, and an assortment of other bones for the tail, thus gathering the fruits of all the expeditions in one big "four club deal."

The popular preference for the more spectacular members of the dinosaur parade is not to be lamented because, fundamentally, it is popular enthusiasm that has made possible much of the scientific work of reconstruction accomplished by men like Barnum Brown. Public support—indeed any kind of support—is heartily welcome, since it costs many thousands of dollars to excavate and ship such skeletons as Brontosaurus.

Professionally speaking, Brown lives much of the time in a world where cockroaches were as large as sparrows and dragonflies had a two-foot wingspread. Nearly everything seems to have been built to scale in those "good old days." Thighbones of the still earlier reptilian vintage might weigh as much as 400 pounds, and Brown once had to build sixteen miles of road to haul the skeleton of Tyrannosaurus rex out of the badlands, and then transport it 125 miles to the railroad. If some of the beasts came back to life today, they could peer into fourth story windows without any danger of coming down with a stiff neck. Such were the Gargantuan reptiles who ruled the earth for millions of years.

Yet when all is said and done, the sauropods were not, with one or two exceptions, nearly so romantic as they now seem at a distance of 140 million years. For one thing, they were very dumb—in fact some of the biggest were the dumbest. One kind, 50 feet long, had a brain that weighed an ounce. As most people know, some of them had an extra "brain" (or muscle-controlling nerve center) located in the hips. However, the rhymster's pun to the effect that this attribute enabled them to reason "both a priori and a posteriori" is doubtless poetic license. "They had low metabolism and ate comparatively little in spite of the plentiful vegetation on all sides, their behavior being comparable to that of the salamanders of our own day."

Barnum Brown's mind is a teeming storehouse of data on the habits and capacities of these creatures as well as the whereabouts of their remains. His colleagues are, in fact, forever plaguing him to knock off exploring long enough to get it all down on paper. For instance, Brown's discovery that one species could actually regenerate the vertebrae in its tail—a feat which, roughly speaking, would correspond to a war veteran growing a new leg—is as yet unpublished in spite of its being a unique phenomenon in prehistoric vertebrate biology. But as the years advance, we may expect him to commend this and similar nuggets to the permanent archives of both scientific and popular literature.

With so much left to be done, Barnum Brown would laugh to scorn any suggestion that his brilliant career of exploration was something to look back upon. Yet by virtue of fellowships, councillorships, and other ceremonial tokens of honor which have been bestowed to signalize his outstanding position in paleontology, he is already something of an immortal. And under his guidance the American Museum's dinosaur treasures have waxed so great that if the two or three collections which rank next to his were to be lumped together, they would still come off a poor second.

LETTERS

Continued from page 305

eggs being laid any place but on land. This seems to be an interesting exception to the rule which is seldom considered.

I have often wondered at the reason for this omission, for it seems to me that the genus Plethodon is an important enough group of amphibians to be worth while mentioning. Is there an explanation?

Eugenie Clark.

Woodside, N. Y.

Miss Clark is absolutely correct. Probably the majority of plethodons do lay their eggs on land, and so do certain individuals of other amphibian groups, including some caecilians. Exceptions complicate the simplification of almost every biological question. "Dependence on moisture" would be a better distinction for the amphibians than "dependence on water." Even the land-laying amphibians generally lay their eggs in moist locations, such as are afforded by caves or damp sections of a forest floor. These exceptions to the rule of amphibian dependence on water represent animals that have adapted themselves toward drier environments. But none of them has a protective amnion in the egg as all reptiles do, nor an allantois, which facilitates absorption of oxygen when the egg is dry.—Ed.

Sirs:

. . . We had not seen this wonderful publication until it was sent us as a Christmas gift last Christmas. It is a joy to us all—and we take great pleasure in passing it on to friends.

Mrs. J. W. McMannis.

Kansas City, Kan.

* * *

Sirs:

Enclosed is my remittance for renewal to the best magazine in the field of natural science—namely yours—, a magazine that awakens a keen yearning for each number, which is sufficient indication of its worth and popularity.

More power, prestige, and publicity to you.

Rev. Nicholas Perschl,
San Xavier Mission.

NOTICE

Readers are encouraged to submit their own photographs of natural history subjects. Those published in the Letters Department will be paid for at $1.00 each, with full credit to the photographer. Return postage must be included.

YOUR NEW BOOKS

AUDUBONIANA • PLANETS • VAILLANT'S AZTECS OF MEXICO
A LOT OF INSECTS • CRATER LAKE • AMERICAN WATER BIRDS
THE BIG ZOO • LANDS OF NEW WORLD NEIGHBORS

THE BIRDS OF AMERICA

- - - by J. J. Audubon, Introduction and Text by William Vogt

Macmillan, $4.95

IN 1937 there appeared a one-fourth size edition of the plates of Audubon's elephant folios of North American birds, priced at $12.50. Bird lovers who marveled at this seemingly moderate price now have further cause for wonder in the publication of a later reprint of the same book for less than $5.00. Thanks to the enterprise of the Macmillan Company, a reprint of Audubon's great work, originally published in an edition of about 200 copies, at a cost to the individual subscriber of one thousand dollars, will doubtless become among the best sellers of American bird books. When we consider other forms of Auduboniana which continue to command a public, it is clear that Audubon's fame grows with the years.

The first edition of this reprint was reviewed in NATURAL HISTORY Magazine for January, 1938. It is therefcre only necessary to add here that in the present printing there is still further departure from the colors of the original. This is shown particularly in the increased intensity of reds and yellow which in a regrettable number of cases produces birds unknown to science. As one examines these illustrations, he realizes how much more fortunate is the quoted author than the quoted artist. The reprinted word is set anew and the integrity of black ink is uncompromising. But the color reproduction, none too good at the beginning, shows with each successive generation the inherited results of increased wear and decreased care.

F. M. CHAPMAN.

AZTECS OF MEXICO

- - - - - by George C. Vaillant

Doubleday, Doran, $4.00

AS the subtitle, "Origin, Rise and Fall of the Aztec Nation," indicates, the present book covers the entire life cycle of one of the most colorful and important peoples in the New World. Set in a broad frame of reference outlining the unique origins of native American civilization, one here reviews, as in a living pageant, the succession of peoples who contributed to the dynamic Mexico of today. From the first agricultural and religious strivings of the Middle Cultures, through the glory of the Toltec Civilization, the decline of Mazapan, and the modest beginnings and penultimate triumphs of the Aztecs, the reader participates in a new and vivid life. Through all runs the "sensation of omen" so dominant among the Aztecs. The grim closing chapter of the old life, the Spanish conquest, is depicted from the Indian sources and this throws much new light upon the causes underlying the sudden collapse of Aztec civilization before the strange war policies and weapons of a handful of daring European adventurers. Unlike his great predecessor, Prescott, Vaillant does not believe that the conquest extinguished the fire and genius of the native population, and the great renaissance of folk culture and art in Mexico today strongly supports his opinion.

Aztecs of Mexico is that *rara avis,* a book planned for the general reader which is, at the same time, a genuine scientific contribution. No one who has tried to unite the mighty but often dry bones of archeology with the living but complex data of ethnology will doubt the author when he says it was a hard book to write. It is not, however, a hard book to read. For the layman, the unusually piquant text and vivid illustrations should open a new world—while for the serious student the skillfully ambushed notes, charts, and bibliography blaze a trail into the very heart of New World anthropology. Such books are rare.

DUNCAN STRONG.

FISHING IN THE CAROLINAS

- - - - - - by Philip A. Murray, Jr.

University of North Carolina Press, $2.00

MR. MURRAY wrote me some years ago that he had in mind a handbook of fresh-water fishing in the Carolinas, hoping it would prove a real contribution to his State. This book, published since his sudden death in July, amply fulfills his hopes and in an admirably condensed form.

Clearing the land in the Piedmont region started erosion, and began the depletion of fish. This was further advanced by lumbering operations, pollution, power dams, and illegal and overfishing. Mr. Murray discusses means of restocking and conservation. He includes brief technical descriptions sufficient for identification of the more important fish both for commerce and angling, and describes methods of angling, giving a short account of the history of the sport. The book is intended for the average reader, not for scientists, and is written in accordance with the author's belief that a fundamental knowledge of the anatomy and habits of fish enables the angler to get a larger amount of satisfaction from his art.

F. LAMONTE.

EARTH, MOON AND PLANETS

- - - - - - by Fred L. Whipple

Blakiston, $2.50

BETWEEN THE PLANETS

- - - - - - by Fletcher G. Watson

Blakiston, $2.50

THESE are the first two of the nine projected "Harvard Books on Astronomy" to reach my desk. It is a pleasure to predict that their excellence will assure a warm welcome by amateur astronomers and teachers of astronomy everywhere. Although written for the nonprofessional, they are, as they should be, scientifically accurate, up-to-date, and surprisingly complete. There is much fascinating astronomy here that this reviewer has not seen in popular books, or in any books for that matter.

Doctor Whipple tells the story of the planets, their atmospheres and physical conditions. He discusses the possibility of life outside the earth, and the theories of origin and development of the solar system. In the light of the latest research, the moon is considered with regard to the probable story of its craters, mountains, and other features, as well as to its origin.

All astronomers will be grateful for the superb photographs of the planets made by E. C. Slipher of Lowell Observatory, including those of Mars made in South Africa in 1939. Another unique feature of the book is The Planet Finder, which enables one to locate the naked-eye planets in the sky from 1940 to 1970.

Doctor Watson, in his book *Between the Planets,* discusses the asteroids, comets, and meteors. He tells the story of the asteroids, or little planets, from the discovery of Ceres in 1801 down to the present time when some 1500 are known. He treats the history, anatomy, and motion of comets; how Jupiter captured his family of comets; and how comets disintegrate or waste away.

Without much doubt the author's favorite topic in the book is meteors and meteor craters, and here we have the latest information regarding meteor showers and disintegrated comets; velocities, and what these indicate in regard to the origin of meteors and their relation to the solar system; the principal meteor craters, and the largest and most striking meteorites in the world; and how to identify meteorites, either stone or iron.

Here are two new books on astronomy that can be recommended without reserve.

CLYDE FISHER.

Pageant in the Sky

- - - - - - by Raymond S. Deck

Dodd, Mead, $3.00

MR. DECK has assembled an interesting collection of facts and observations about birds, dealing largely with their relationships with man. He discusses their migrations and other habits and peculiarities, but the greater space is devoted to such matters as winter and summer guests in the garden, conservation and hunting and their effects on the balance of nature, how birds are classified and named, birdbanding, and the value of birds to man not measurable in dollars and cents. The passenger pigeon's lamentable history is accorded a separate chapter, and the woodcock is treated with similar honor though with a happier ending to the story.

All this is written in a pleasing, conversational style that is easy to read and should be digestible even by those whose chief interest is not in the study of birds.

Most of the text is accurate although there are a few statements that occupy debatable ground or need clarification. The supposed alternate wing beat of the chimney swift is an optical delusion, as the slow motion camera has shown. It is very doubtful whether any land bridge existed between South America and Africa recently enough to have permitted an interchange of bird life. The molt of birds' wing quills commonly begins near the middle of the row, not at the innermost end. In some species of hornbill, it is the female, not the male, that does the work of plastering up the entrance to the nest (with herself inside), although the males of certain species may bring the materials. And again, some young birds are known to reseal the entrance after the mother bird has left the nest.

Contrary ideas on some of these and other points were long of current belief, and it is not surprising that Mr. Deck has overlooked the more recent corrections. The faults would be more serious if this were a textbook of ornithology instead of a work designed for popular consumption. Perhaps only a carping critic would discover them in the assemblage of information here pleasantly presented.

John T. Zimmer.

Art in Ancient Mexico

- - - - - - - by Gilbert Médioni and Marie-Thérèse Pinto

Oxford, $10

ART IN ANCIENT MEXICO is a significant contribution to the corpus of carefully photographed examples of pre-conquest Mexican art. It includes the best of the sculptures assembled by the great Mexican painter, Diego Rivera. His point of view in assembling this collection was not that of an academician or a scientist. It was that of a keenly modern artist seeking discriminatingly those elements of the past which are of most interest to the aesthetics of the present day. Therefore there is little emphasis on the somewhat turgid ceremonialism of the highly developed religious arts like Aztec, Zapotec, and Maya. He concentrates rather on the art of western Mexico where ritualistic conventions did not hamper the lively naturalism of the ancient craftsmen.

In their subtle and revealing photography, Gilbert Médioni and Maria-Thérèsa Pinto have recaptured Rivera's interest. So much of the appreciation of Mexican sculpture depends on tactile values that two-dimensional reproduction often thwarts appreciation. This difficulty the authors have overcome by their recognition of the sense of touch and their arrangement of lighting so as to suggest this aspect.

We have given credit to Mr. Rivera for assembling his collection, to the authors for recapturing in this book the spirit of the ancient art and the aesthetics of a modern artist. We should not neglect to compliment, likewise, the Oxford University Press for their foresight in bringing out this book and on their care in providing the beautifully printed text and excellently reproduced illustrations.

There are a number of books on Mexico which are gauged to reproduce our knowledge of the ancient arts. This book, so far as I know, is the first to tie together the interests of modern artists with the product of their Indian predecessors several centuries ago. It will give the peruser a real aesthetic experience in bringing the interest of the ancient artist vividly to the fore.

George C. Vaillant.

Lives and Dollars

- - - - - - - - - by J. D. Ratcliff

Dodd, Mead, $3.00

THIS current volume by Mr. Ratcliff, author of *Modern Miracle Men,* is of interest principally because in some of the chapters the reader is brought right up to date on certain contemporary contributions in the field of medicine and public health, which show promise or are of distinct proven value. Mr. Ratcliff also mentions the names of the various investigators under consideration, in a manner that leads us to believe that he must have visited a number of laboratories and institutions where important work is in progress, in order actually to interview the investigators and to witness their work.

Mr. Ratcliff also writes about the nonmedical phases of scientific advances. His chapters on the atom age, and agricultural research, including the many enemies which attack our crops, make very interesting reading. So, also, does the one about glassware, upon which the scientist is so dependent for his work. Other chapters retell stories which are already familiar to those interested in the field of medical science.

Mr. Ratcliff's *Modern Miracle Men* was a thoroughly enjoyable book and well-written too, but the volume under consideration seems to have been much more hurriedly put together. Also the super-journalistic and sensational style, absent to a large extent in his other volume, does not add to the attractiveness of *Lives and Dollars.*

Morton C. Kahn.

A Lot of Insects

- - - - - - - - - by Frank E. Lutz

Putnam, $3.00

MOST of us believe what we hear most often. In other words we are orthodox in our ideas, scientific as well as otherwise. For a number of reasons—mainly traditional, psychological, and economic—most people think most insects noxious creatures. Orthodoxy sometimes goes further and penetrates and enmeshes the entomologists themselves in an unquestioning acceptance of traditional theories of insect biology. Doctor Lutz prides himself in being heterodox in these various respects. His heterodoxy is not protestation against conventional views as such, but rather a scepticism about accepting any theory or belief without himself carefully evaluating and analyzing the underlying facts.

A Lot of Insects is based on the 1402 species of insects, representing eleven major orders, that the author observed and collected in his suburban yard (75 feet by 100 feet). Although these represent a tiny portion of the great, complex Class Insecta, nonetheless they are sufficiently representative to provide a host of biological and ecological issues for consideration, especially of the type where man and insect are vis-a-vis. These problems are handled carefully and with scrupulous fairness to all concerned. The sum total is a picture of the insects' true *lebensraum* in the web of life. Brief and illuminating views of some of the craftsmen of entomology are incidentally woven into this picture.

Any layman, particularly one who breeds things, who occasionally exterminates insects, or whose taxes are partially used for insect control, will find the book thoroughly readable and valuable. The style is clear, succinct, and puckish. The language is surprisingly nontechnical yet quite adequate. One may occasionally disagree with some of the conclusions reached or the ideas advanced, but, as another entomologist once remarked, "Lutz's views are always stimulating; never dismiss them lightly."

Herman T. Spieth.

Cine—Biology

- - - - - J. V. Durden, Mary Field, and F. Percy Smith

Pelican Books, 25¢

CINE-BIOLOGY is another contestant in the field of popular biology which hopes, through the collaboration of a biologist, an author, and a photographer, to succeed where others have failed. Though in a pocket form and necessarily limited to some of our most familiar invertebrates, it deals adequately with the most important biological problems, in a manner well calculated to stimulate lay interest through abundant use of analogy. For this reason it is all the more unfortunate that its real merits should be belied by a cheap and inartistic appearance and an arrangement of photographs which, though individually good, are confusingly overcrowded.

G. H. C.

LANDS OF NEW WORLD NEIGHBORS

- - - - by Hans Christian Adamson

Whittlesey House, $3.50

LANDS OF NEW WORLD NEIGHBORS is a timely and useful book. It is organized and arranged to combine the drama and excitement of the pageant of New World history with a body of solid, factual information. The arrangement which Mr. Adamson adopts is very useful and original. In appropriate sections he puts down in tabular form the basic information of an encyclopedic character. From this point he is ready to throw his spotlight on each section, to bring out its dramatic qualities. The amount of information which Mr. Adamson has compressed into his pages is formidable. The conclusion which one draws from a brisk perusal is that it is the fault of our educational system that we know so little of our continent.

This book provides a background against which one may read, and to some extent evaluate, the trend of books on continental American themes which have poured from the presses in the last three years. A carefully selected list of popular books enables the interested reader to pursue further any specific interest whetted by Mr. Adamson's text. This Bibliography is largely nontechnical, but it is chosen to bring life and drama to the sometimes stale accumulations of fact.

For a general reader, a reading group, or a library, *Lands of New World Neighbors,* through its text, its Reading List and its Index should be most useful. It is a monument to Mr. Adamscn's versatility that he can produce a book that combines all the usefulness of a manual with the dramatic selection of an adventure story.

GEORGE C. VAILLANT.

THE BIG ZOO

- - - - - - by William Bridges, Photographs by Desider Holisher

Viking, $2.00

ONE'S first impression on scanning this book is of an ultra-comprehensive zoological picture gallery embracing all the nooks and corners, the larger enclosures, and the panoramic arenas of the Bronx Zoo. Yet the parade of animal subjects is not merely in the form of portraits. Most of the subjects are active, and a large part of the pictorial story relates to their characteristic antics and their care. By virtue of its detailed captions, its links of continuity, the book seems complete enough as a lively story of camera-recorded human observations among varied animal life, large and small. But after more careful reading, one finds that it also contains a printed story told in the conversational terms that have made Bridges' chats so popular over the radio. Moreover, the thoughtful person who studies this book will be strongly impressed, both from its text and pictures, with the evolution that is taking place in methods of exhibiting animals.

There is little in the possible pictorial history of a big zoo, behind the scenes and outside, that artist Holisher has missed. I say "artist" for he has patiently awaited opportunities, precise moments of action; and to gather such a collection of photographs is a great task. The pictures will be of keen interest to youth and adults, as well as an incentive to amateur photographers interested in animals,—a contingent that is steadily growing in numbers and enthusiasm. As to author Bridges, he has steadily hit upon the high spots and human interest points.

The captions run from 50 to 75 words per illustration, while a few, beneath full-page pictures, are longer. The text consists of an Introduction and four chapters.

RAYMOND L. DITMARS.

AMERICAN WATER BIRDS

- - - - - - by Maitland A. Edey

Random House, $1.00

THE water bird plates by Louis Agassiz Fuertes, made originally for Elon Howard Eaton's *Birds of New York* and subsequently reprinted by the University Society in 1917 and by Doubleday, Doran in 1936, are used to illustrate this volume. It thus supplements the author's *American Songbirds,* which was briefly reviewed in NATURAL HISTORY Magazine for February, 1941, and, like it, is sold for the low price of one dollar. As was said of the earlier volume, the illustrations are acceptable and the text accompanying them "gives a brief description of the markings, manner of occurrence and habits of each species."

The statement on the title page would lead one to believe that the illustrations used in this volume were made from Fuertes' original paintings, now in the possession of the State Museum at Albany, whereas, if we are not mistaken, they were made from electros of the original engravings.

F. M. CHAPMAN.

ARCHAEOLOGY OF NEW JERSEY, Volume I

- - - - - - - - by Dorothy Cross

Archaeological Society of New Jersey, Trenton, $3.00 (Paper-bound $2.50)

THIS work is a boon to archaeologists in New Jersey, to students of the American Indian, and to amateur collectors. Numerous maps, two large charts, and 73 excellent plates make up an impressive (and cheap) volume.

Of numerous collaborators the most important are H. B. Kümmel, with a brief geographical sketch; H. G. Richards, with an excellent chapter on the relationship of geology and archaeology (in which he proves, incidentally, that the puzzling "red veins" are no indication of great age); and Nathaniel Knowles, with statistical studies of the stone artifacts and of the depth at which these were found. While these elaborate analyses do not result in startling conclusions, they give evidence of the immense care with which the excavations in New Jersey were conducted. The book is chiefly the work of Dr. Dorothy Cross, Archaeological Adviser of the New Jersey State Museum, organizer and director of the Indian Site Survey and its supervisor from 1936 to 1938. Doctor Cross has a sound knowledge of archaeological technique, and her hand is everywhere apparent.

The book describes in detail 39 sites excavated by the Survey and, very briefly, over 600 sites where artifacts have been discovered. But there is more here than mere description. Interpretation of the finds is sane, and discussion of archaeological technique illuminating. There is an excellent treatment of pottery manufacture, together with other discussions of great interest such as artificial concentration of objects, resulting from erosion of surface sand; the disappointment of excavations where objects lay in such shallow soil that most were brought to the surface by plowing; the inferences, derived from pits of fire-cracked stones not mixed with ash, of the practice of sweat-bathing.

The authors conclude that the aboriginal culture in New Jersey was homogeneous, presenting no evidence either from stratification or distribution to indicate cultural breaks; that the earliest inhabitants either brought pottery with them or learned the art shortly after their arrival; and that the New Jersey culture is closely akin to "Coastal Algonkin" or to what Ritchie has recently called "the coastal aspect of the north-eastern phase of the woodland pattern."

CASPER J. KRAEMER, JR.

CRATER LAKE: The Story of Its Origin

- - - - - - - - by Howel Williams

University of California Press, $1.75

A FEW months ago this reviewer was privileged to appraise a small volume, entitled *The Tetons: Interpretations of a Mountain Landscape,* by Fritiof Fryxell, which had been published by the University of California Press. Now they have issued a similar small volume (97 pages), concerned with Crater Lake, another of our National Parks. While Professor Williams may not produce the superb descriptions which earn for *The Tetons* a place in the field of pure literature, as well as in that of science, he displays more than average ability to tell the dramatic story that is exposed to the scientifically trained observer by the record in the rocks of Crater Lake. And in Professor Williams, who has spent several years studying volcanic phenomena and the history of this region, we have the best observer available to interpret that story and to tell it in dramatic and convincing, but nonscientific, language.

The work is divided into two parts. The first, entitled "The Story," describes the development of Mount Mazama, the great volcano which reared its crater far above the present Crater Lake; its violent eruptions and subsequent collapse; and the formation of Wizard Island and Crater Lake. The second part, as its title, "The Evidence," indicates, is concerned with the geological evidence upon which "The

Story" is founded. It is an effective method of telling the story, and is exceedingly well done. The numerous illustrations, including reproductions of three paintings by Paul Rockwood, two in color, add to the value of the book.

H. E. Vokes.

ON YOUR RADIO

Programs of the American Museum and Hayden Planetarium, Fall and Winter, 1941-'42.

SUNDAYS over the Mutual Broadcasting System from 9:30 to 10:00 A. M.

This Wonderful World. Offering questions and answers on nature subjects, and featuring the Natural History Grab Bag, in which the contestants talk about some common object they themselves select.

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SUNDAYS over the Columbia Broadcasting System Network from 1:30 to 2:00 P. M.

This Is the Life. Discussion of the life history of Man in various lands, based on exhibits in the anthropology halls of the American Museum.

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WEDNESDAYS over the Columbia Broadcasting System Network from 9:15 to 9:45 A. M. (Central Time: 2:30 to 2:55 P. M.; Mountain Time: 9:30 to 10:00 A. M.; Pacific Time: 1:30 to 2:00 P. M.)

Lands of New World Neighbors. The dramatic story of men and events that are the fabric and fiber of New World exploration and expansion.

FRIDAYS over the Columbia Broadcasting System Network from 3.45 to 3:55 P. M.

Americans Map the Skies. The story of the growth and development of astronomy in America.