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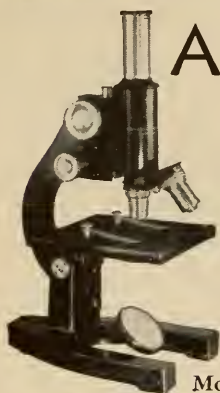


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"SHIPROCK"

So named because of its fancied resemblance to a ship under full sail, when seen at a distance. It is a volcanic plug, 1300 feet from base to summit. A lava dike shows in the foreground.

Smoke from Rattlesnake oil field, and the

Carriso Mountains are visible in the distance.

This photograph was taken at an elevation of 2000 feet, during Sinclair aerial survey in the valley of the San Juan, thirty-five miles west of Farmington, New Mexico

Sinclair Dinosaur Expedition, 1934

Excavating the great Jurassic dinosaur quarry of northern Wyoming, 140,000,000 years old

By BARNUM BROWN

Curator of Fossil Reptiles, American Museum

Photographs by the author and party

DINOSAURS pique the imagination of the beholder as do no other creatures past or present. They are usually so large and differ so markedly from modern animals as to cause one to pause and wonder.

Especially is this true of the huge Sauropods whose skeletons are of gigantic proportions. To the collector they usually mean lots of hard excavation work and long tedious hours of laboratory preparation before they can be seen by visitors; rarely is it possible for the general public to see these remains in the field or to participate in the thrills of discovery and field preparation, which is frequently as significant as the anatomical study of the specimens.

The Dinosaur Expedition of 1931 had worked intensively in the Lower Cretaceous beds of Montana, chiefly on the Crow Indian Reservation, on the outer flanks of the Big Horn and Pryor Mountains, where fourteen skeletons of Cretaceous dinosaurs had been excavated. The following year exploration was continued on the inside of the Big Horn Basin. We had followed these Lower Cretaceous beds southward as far as the vicinity of Greybull, Wyoming, where Mrs. M. L. Austin, an enthusiastic local collector, told us of large bones she had seen on the Barker Howe Ranch.

Exploration in 1934

Traveling eastward from the Big Horn River, we followed up Shell Creek sixteen miles, then northeastward along country roads over dark-colored ocean sediments that from horizontal strata increasingly tilted upward, with beds of oyster shells on either side as we approached the mountains, the last four miles being a meandering trail along a knife-blade "hogback" that no auto

driver would possibly call a boulevard.

The scenery is magnificent, — white limestone mountains several thousand feet high, rolling abruptly upward to the eastward, with a narrow red band at their base and gashed by sharp, narrow, red-tinted cañons with jagged granite peaks of the central mountain core occasionally breaking through. Brilliant blue, red, and purple clays cap many of the fantastically sculptured hilltops.

Finally we reached our destination at the base of the mountains a thousand feet above the Big Horn Valley.

Bones on the Howe Ranch

The Howe Ranch is located at the very foot of the Big Horn Mountains near the original Cloverly Post Office, twenty-five miles northeast of Greybull, and twenty-five miles south of the Montana line. Barker Howe had long known of the large bones weathered out on one of his hillsides, and he had taken several of the larger pieces to the ranch buildings — the large bones exciting his wonder as to what kind of queer creature they represented.

On arriving at the Ranch, we found Barker (a young man of eighty-two years) stacking alfalfa hay. He was interested at once when large bones were mentioned, and stopped work long enough to show us the hillside where bones were exposed. During the week of our prospecting, he neglected hay work entirely in order to watch us and speculate on the prehistoric past; he wanted to rip out the bones with a big pick and we found it difficult to keep him from digging, for in his opinion we were very slow workers.

Bones were exposed in three places under a thick stratum of sandstone; in the course of a week we had uncovered what appeared to be parts of two connected Sauropod skeletons — fourteen connected tail vertebrae of one specimen, joined to the sacrum; and a hind

leg with several connected tail bones of the other. As near as we could determine, the bones were but little crushed and several features indicated that they were different from described species. The bone layer was a clay stratum two feet thick, overlying a continuous hard sandstone, and covered by six feet of sandstone.

My companions, Mr. P. C. Kaisen and Darwin Harbicht, who are seasoned bone-diggers, agreed with me that under such conditions, with only three men, we could not hope to excavate two large skeletons of this kind in the remaining part of the season. Reluctantly we covered the prospect against rain and curious people, until we could have a force and the time necessary to excavate the specimens. Howe promised to guard them until we returned.

In 1933 our appropriation for field work was limited to a small sum — only sufficient for me to go out alone and hire teams and local help to remove the six feet of sandstone overlying the skeletons, an area 65 x 45 feet — leaving a little sandstone and the clay layer to protect the specimens.

The Sinclair Expedition

In 1934 there was no Museum appropriation for field work, but fortunately, the Sinclair Refining Company, which has for some time used dinosaurs as a symbol for their products, generously coöperated by supplying funds for our expedition.

Owing to the unusual amount of publicity given to this expedition, there were many applications to join our party. Eventually the personnel was selected, with Carl C. Sorensen in charge of the work, and during the season the party averaged from nine to twelve people. A tent camp was established near the quarry on the Howe Ranch and excavating started on June 1st.

The entire area was carefully uncovered; first with team and scraper, big picks and shovels, then with prospecting picks, awls, whisk brooms, and fine brushes, as the bones were gradually laid bare; a continuous process of cleaning.

It soon became apparent that, instead of two skeletons, there was a veritable herd of dinosaurs, their skeletal remains crossed, crisscrossed, locked, and interlocked, in a confused and almost inextricable manner.

To one not acquainted with such deposits it seemed a bewildering and hopeless confusion. Indeed, it would have been impossible to associate the parts of individual specimens with any degree of certainty had the matrix been sandstone instead of clay. Had this deposit been in sandstone, it would have taken years to remove the same amount of material.

Through the warping of the strata incident to the near-by mountain uplift, the bones had been checked and fractured to a high degree, so all had to be thoroughly shellacked as soon as uncovered. Never have I seen such a thirsty lot of dinosaurs. As soon as a bone was shellacked, it was left to harden, and a man would move to a new section to repeat the process. Thus, often at the end of a day, the work of the entire party could scarcely be detected.

Gradually the bones assumed definite form, and the entire area was laid off in three-foot squares, each of which was numbered, and the bones accurately drawn within the squares on quarry charts. Eventually the bones were plastered, and each bone, or block, given its square number, thus making definite association possible when the specimens are prepared in the laboratory.

Our camp trail over the rough country was improved, and over this road came a constant stream of cars: thousands of visitors from all parts of the United States and a few from Europe. From early morning until late at night they came, sometimes during the night, many repeating their visits as the work progressed. So many visitors lost their way on side roads that signs were placed along the trail, but they were soon taken by souvenir hunters — one day a rib came in the mail, sent anonymously by some conscience-stricken visitor.

Although it was inconvenient at times, we were glad to show the quarry to visitors and schools, for never have I uncovered a more interesting deposit of prehistoric remains or seen one where the story of their death and entombment could be read with such clarity.

As soon as we had established the character of this assemblage of many individuals, it became clear that the relationship of body sections must be determined *in situ* before any bones could be removed. Up to August 1st, therefore, not a single bone had been excavated.

The immense size of the quarry and the confused position of the bones surrounded by clay matrix made it very difficult to preserve them against deterioration by rain, which constantly, day and night, was a cause for worry by the entire party. Unusual clouds or distant thunder were immediate signals for a consultation, and a few rain drops on the tents in the night would send every one scurrying to the quarry—gas lanterns blazing here and there as the large canvas sheets were stretched. We dreaded putting over those covers almost as much as we did the rain, because the whipping canvas was almost sure to dislodge some pieces of bone.

As work progressed, photographs were taken of all phases of the excavation, and when studies had been completed, we began removing the less tangled bones on the border of the deposit. Our difficulties increased as we worked into the masses, for frequently a part of one individual would be removed, while the rest of it was so involved that it would be a month or more later before the

rest of the specimen could be plastered. Thanks to our accurate quarry chart, this method could be followed and the entire collection saved.

Four inches of snow fell September 19th, followed by a week of lighter snows, but our work was not long impeded at any time, and on November 17th the last box of fossils was loaded into a car bound for New York and the American Museum.

Evidence of dinosaur habits

In many respects the Howe Dinosaur Quarry is unique. The fossils are of Jurassic age, and here for the first time is evidence connected with the circumstance of their death and burial to indicate with moderate certainty some of the habits of the great Sauropods. This was a mixed assemblage, chiefly amphibious kinds, with the huge long-necked, long-tailed, small-headed Saur-opods predominating. In two sections of the quarry the long hind-legged *Camptosaurus* were common. There was no evidence of



WHERE THE SINCLAIR EXPEDITION OPERATED IN 1934

A sectional map of Wyoming and adjacent states. The black star shows the location of the Howe Dinosaur Quarry

Stegosaurus, the armored, long-spined, land-living forms, nor any bones of carnivorous dinosaurs that could be recognized, although a dozen teeth of the carnivorous dinosaurs were found — mostly at the bottom of the bone layer.

Skin millions of years old

Patches of skin impression, in many cases overlaid by the actual substance of the epidermal covering, were found all over the quarry in such profusion that much of it had to be destroyed in preparing the bones for shipment. This is the first recorded instance of such occurrence; it is remarkable that a delicate organic substance of this character could be preserved 140,000,000 years. The skin is being sectioned for comparison with living reptiles.

All skin impression is of the same general character, with low, close-set tubercles, not unlike the skin of the living geckos, with no pattern development as seen in the duck-billed and horned dinosaurs of the late Cretaceous period. In one instance the skin was preserved under a connected Sauropod tail, so that we are reasonably certain that most, if not all, of the skin impressions are from Sauropods.

Most of the described species of Sauropod dinosaurs were found 300 miles and more southward; it is possible, therefore, that this entire assemblage may prove to be a new fauna.

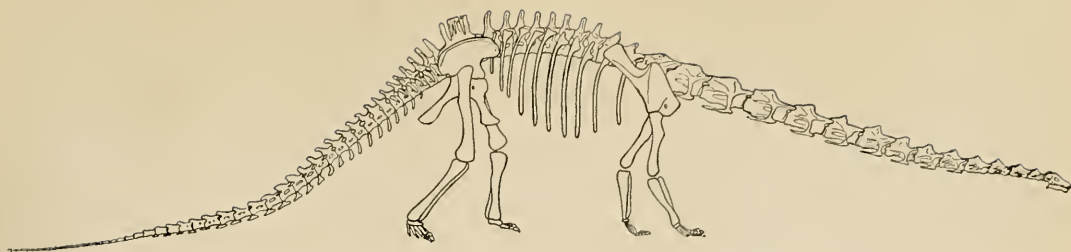
Approximately 4000 bones were excavated in this quarry. They were packed in 144 large cases weighing 69,000 pounds, and filled a large box car almost to the roof.



CHART OF THE HOWE DINOSAUR QUARRY

Owing to the confusion of separate bones and sections of bodies, it would be impossible to associate parts of one individual with any degree of certainty without an accurate

chart of the bones. This chart was compiled as work progressed, by R. T. Bird, and in importance is second only to the collection of fossil remains. (Scale: 1 in. = 12 ft.)



Barosaurus SKELETON FROM THE DINOSAUR NATIONAL MONUMENT, JENSEN, UTAH

This unique specimen has an interesting history — first a part of the tail was excavated by the Carnegie Museum; several years later the neck was excavated by the U. S. National Museum, and, finally, the body was excavated by the University of Utah. By exchange of specimens the entire

skeleton was eventually brought together by the American Museum and is to be mounted in the new Jurassic Dinosaur Hall. This skeleton is 80 feet long. A smaller species half this size was the most common type of dinosaur found in the Howe Quarry

Parts of at least twenty dinosaurs, probably more, are represented by individual bones, and body sections of varying lengths. As clearly shown in the quarry chart, many of these sections belong to the same animal, and we will without doubt be able to mount three slightly composite skeletons representing two distinct Sauropod genera — tentatively identified as *Barosaurus* and *Morosaurus* — the latter a skeleton fifty feet long and the largest in the quarry. The third is a kangaroo-shaped form of medium size identified as *Camptosaurus*. *Barosaurs* and *Morosaurus* predominated. There are several partial skeletons that may prove to be new types when the specimens are prepared and studied.

The bones had not been drifted or water-worn as are those found in a stream accumulation, and only scattered smaller bones were found on the east and west sides of the quarry, whereas in the center of the deposit the bones were two and three deep; here were found the largest individuals and no less than a dozen limbs standing upright on articulated feet.



Brontosaurus is one of the best known of the massive Sauropod dinosaurs; in general it resembles Morosaurus the largest animal in the Howe Quarry

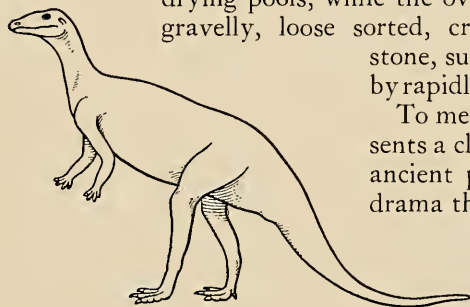
The very fine silt surrounding the bones was such as is found in the bottom of fast-drying pools, while the overlying cover was gravelly, loose sorted, cross-bedded sandstone, such as is deposited by rapidly changing waters.

To me the evidence presents a clear picture of the ancient past, a large-scale drama that happened eons ago and one of a half-dozen similar scenes enacted within a short distance of one another in the vicinity.

When these creatures were alive, conditions were very different. Here is a cross section of what had been a narrow body of water, pool or lake.

The climate was tropical, and we see a flat land rich in vegetation, dotted by countless shallow lakes and marshes. Cycads, palms, and palmettos cover the lowlands, with pines on the uplands. Countless ferns, thick grass, and rushes form a rank vegetation over the marshy, hummocked shores.

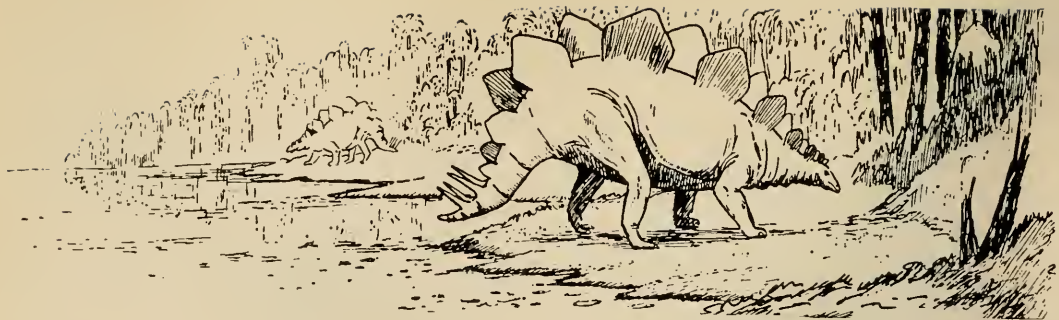
Now the actors come upon the stage: huge slab-sided creatures weighing several tons each, the largest fifty feet or more in



Camptosaurus is an iguanodont dinosaur having long hind legs and shorter front legs. A large species represented by sufficient material to mount a composite skeleton was found in the Howe Quarry



Diplodocus is typical of the long-necked, slender-tailed Sauropod dinosaurs closely related to Barosaurus. Several of the whip-lash tails in the Howe Quarry resemble this form



A PLATED DINOSAUR

Stegosaurus, the bizarre plated dinosaurs which are so common in the southern part of Wyoming in rocks of the

same age were conspicuous by their absence in the Howe Quarry. None of the armored kinds were found

length. They have long whiplike tails and long necks at the end of which is a ridiculously small head. They float, swim, and feed in the water unhurriedly. They congregate by thousands, huddling close together as reptiles do, and filling every lagoon as far as the eye can see.

Now Mother Earth changes the stage setting. The impulse that finally was expressed by the near-by mountains elevated these lowlands. The large lakes were drained and the swamps vanished. The dinosaurs became more and more concentrated in the remaining pools as they were pushed together in huge herds.

The Sauropod dinosaurs were water-living

reptiles; consequently, the disappearance of water was their death sentence. Cold-blooded, sluggish creatures of low metabolism, their habits were analogous to the living salamanders. They ate little, hence they were poorly provided with teeth — and a fifty-foot reptile with a nine-inch skull and a one-ounce brain was not adapted for migration. Water was their prime necessity.

As the water receded, the smaller, weaker dinosaurs were trampled and their bones scattered on the borders of the pool; the large ones huddled closer and closer together as they made their last futile stand against fate. They had come together in a "Last Dinosaur Round-up."

During the summer an extensive aerial survey was made over the Rocky Mountain States, an account of which will be given in a later issue of this magazine.



A FLESH-EATING DINOSAUR

Allosaurus is the largest carnivorous dinosaur recorded in Jurassic rocks of southern Wyoming. A dozen teeth repre-

senting a similar, but smaller, flesh-eating dinosaur were found in the Howe Quarry



The great dinosaur quarry on the Howe Ranch. Masses of bones, similar to those seen in the foreground, are exposed in the same stratum at the left of the open shed and among the trees on the hillside.

Above in the sky, the expedition's airplane "Diplodocus" is seen beginning the aerial survey.

In the picture at the right Carl C. Sorensen is preparing two large skeletons — the first to be found and the last excavated



EARLY STAGES OF QUARRY PREPARATION

Two months were spent cleaning and hardening the bones before any of them could be removed. At the upper left of the picture the Howe buildings may be seen, and farther in the background are the Big Horn Mountains rolling upward



EXTENDING THE QUARRY ON THE NORTH

Cross-bedded sandstone six feet thick covered the two-foot clay bone layer, which in turn overlay a continuous hard sandstone. At the lower right are bones in various stages of preparation. Granite peaks of the central mountain core rise in the distance

The eight-degree tilt of the bone stratum is plainly visible in this photograph. From the iron barrel suspended from the bay-stacker the photogra-

pher is taking pictures of the bones below. Underlying marine beds are in the middle foreground, and overlying marine beds in the distance



CENTRAL SECTION OF QUARRY WITH BONES PARTLY UNCOVERED

This photograph was taken at right angles to the bone layer, from the suspended barrel, the shadow of which is seen across the quarry.

White lines of three-foot squares used in charting the quarry are faintly visible. About one fourth of the quarry is seen in this picture



The central part of the quarry. Doctor and Mrs. Brown are examining the largest skeleton (Morosaurus) in the quarry; it is approximately 50 feet in length, with a femur 46 inches long and a 26-inch tibia standing on its articulated foot. No less than a dozen such cases were found, conclusive evidence that the bodies were lying where they died

(Below) Sauropod skin impression, shown about natural size. These three specimens give the range of variation in the form of skin tubercles. The specimen on the left is covered with the preserved outer epidermal tissue. This is the first recorded occurrence of the actual preservation of skin tissue among dinosaurs





(Above) The dinosaur quarry during the fifth month of excavation. The central sections had been removed, the more complicated masses at the right and left still remaining

The dinosaurs' last migration. The skeletons had been close together in the quarry, but they were closer in the box car; indeed, it taxed the ingenuity of the party to pack the 144 boxes in one car

Keeping in touch with the world. The party, as composed on August 17th, gathered around the radio at the end of the day. Front row: Roland T. Bird, Dr. Laurence F. Rainsford, Laurence F. Rainsford, Jr., Carl C. Sorensen, Ted Snyder, and Daniel L. Thrapp. Back row, left to right: Mrs. Barnum Brown, Dr. Barnum Brown, William Frutchey, and Milo R. Howe





Fifty million years of the earth's history are shown in the above panorama of upturned sediments of Cretaceous, Jurassic, and Triassic age at the Dinosaur National Monument near Jensen, Utah.

The site of the Monument is marked by a white X.

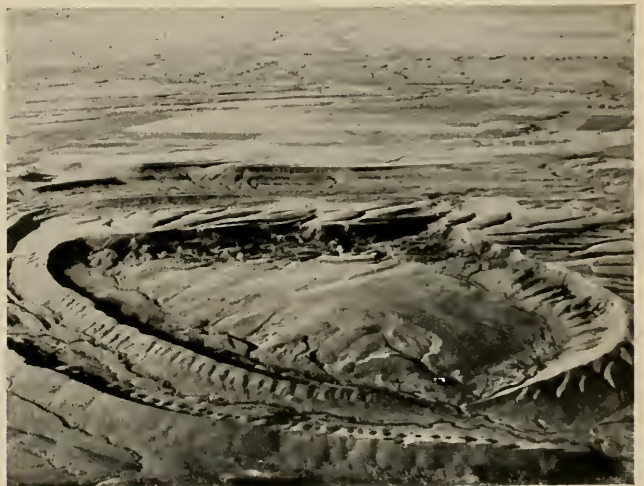
Here is the largest accumulation of dinosaur remains known — now being developed by the National Park Service and the American Museum as a great educational park.

All air views copyright by Barnum Brown



On the left is Meteor Crater, near Winslow, Arizona. The crater is one mile across and 500 feet deep. The meteoric mass that made this crater presumably lies buried under the earth at the right of the picture. Photograph taken from an elevation of 5000 feet

At the right is Middle Dome, 12 miles southeast of Harlowton, Montana. This is a perfect example of structural development demonstrating the theory of oil accumulation





(Left) The King in ceremonial dress with coral decorations. This plaque, of traditional design, was cast in Mrs. Boulton's presence. In the early days metal plates like this one decorated the beams of the Obba's palace in Benin City

(Below) One of the bronze heads representing an early Yoruba ruler who is now an important deity



Bronze Artists of West Africa

The natives of Benin and Ife—their beliefs, customs, and art forms

By LAURA C. BOULTON

*Photographs by John F. Jennings
By courtesy of Field Museum*

SINCE the early Portuguese navigators discovered Benin in the Fifteenth Century, the great west African kingdoms of southern Nigeria have furnished the western world with romantic, vivid, sometimes horrifying tales of strange peoples and their weird ceremonies. In the Fifteenth Century Benin was a great metropolis, the capital of the kingdom of the same name and the political and religious center of a wide area.

The Bini people, pushed down from the north by more warlike peoples, found themselves in a region of dense forest where they could not only maintain themselves but were able to extend their influence and power for hundreds of miles east and west.

During the Fifteenth, Sixteenth and Seventeenth centuries, under powerful rulers, the kingdom of Benin was greatly expanded and reached from Lagos to Bonny as well as northward into the savanna country. Regiments of these tribesmen went forth from Benin to conquer new territories. An important general was never expected to return. If he was vanquished, he dared not return. If he was victorious, he preferred to establish himself as the chief of his newly acquired territory and pay tribute to the Obba of Benin rather than return to his service.

The people of Benin

It is thought that the Bini are an offshoot of the Yoruba nation. Though their language differs somewhat from the Yoruba, their customs, traditions, religious practices, and beliefs definitely link them together ethnologically.

According to the accounts of early European navigators, the King of Benin, although

a mighty ruler of a great kingdom, received his investiture from another powerful monarch who lived "toward the east" and who sent each new king of Benin a staff, a cross, and a cap of shining brass. Heads of bronze were also sent as gifts to these new kings. It is believed that this mysterious potentate was the Awni of Ife, the spiritual ruler of the great Yoruba nation.

Ife, the sacred city, boasts a long and glorious past. The Yorubas have a tradition that their ancestors came from Egypt and settled there, and their nation increased and spread until it now numbers more than three million people and covers a huge area in southern Nigeria.

The father of all the Yorubas

Native tradition tells that through the centuries there always have been a war-king and a priest-king ruling equally. The first king was Oduduwa, a mythical personage, a great leader who brought his people safely through the northern desert to Nigeria. He died at Ife and later was deified and identified with the Earth Goddess. His grandson, Awranyan, who succeeded him on the throne, is regarded as the father of all the Yorubas existing today.

Awranyan moved the capital to Oyo, a city near Ife, and left a henchman in charge of the treasure of Ife. This man, as the High Priest, became very powerful and received the title "Awni of Ife." His descendants still hold sway over the religious life of the Yorubas and are the rulers of the spiritual affairs of the natives, while the temporal head rules from Oyo.

Awranyan, who was a powerful and warlike ruler, extended his kingdom in every direction. After a long period he found it necessary to return to Ife from Oyo to examine his father's treasures. His stay in Ife was so prolonged that in Oyo his people thought he must have died and they proclaimed his son king. Later, Awranyan started back to Oyo,

and while he was still some distance from the city, he heard the kakiki trumpet which is never blown except for the king. When he learned that his son was king, instead of entering Oyo, he quietly returned to Ife, where he lived peacefully.

Awranyan's staff

Near one of the sacred groves where religious rites are performed is a granite obelisk about twelve feet high and four feet square at the base, which is known as the *Opa Awranyan*, or Awranyan's staff. To prove what a mighty man he was, the Yoruba say that he carried it about with him as a walking stick.

This obelisk is erected on the spot where he is supposedly buried. At present there is evidence that a storm blew it over and damaged it considerably. A section four feet in length was broken off the top but has been replaced. Several fragments lying about the base indicate that perhaps it was once much taller, or that there was another obelisk of less imposing proportions.

On one of its faces there are three rows of nails with coiled heads. In the center from the bottom reaching nearly to the top is a row of 61 nails. About four inches on each side of this are two parallel rows of 31 nails each. A few hieroglyphs can be seen where the lines converge.

One explanation is that the 61 nails represent the years Awranyan lived, 31 nails on one side indicate that he was 31 when he came to the throne, and the second row of 31 indicates that he ruled 31 years, counting the first year of his reign twice according to Yoruba custom. The ancient hieroglyphs may stand for Awranyan.

The art of carving or drilling in stone such as is used on the obelisk has long since been lost. The Yorubas believe that the staff was once wood and the nails were driven into it then. It was turned to stone when the ruler Awranyan was deified. In the grove near by are the sacred trees, *Dracæna*, called *peregun* in Yoruba. It has been suggested that these trees have a symbolic meaning and are planted in the sacred groves because of the similarity of their exudation to the blood of human beings.

In the sacred groves near Ife have been found remarkable sculptured heads and

figures in terra cotta and bronze. The Yoruba explanation of these antiquities is that the ancient rulers were deified and at the same time petrified. They believe the bodies have in most cases disappeared, but the heads remain to receive adoration and offerings. When Frobenius, the German scientist, discovered some of these in 1910, he believed he had found the descendants of the lost Atlantans. Since then many theories have been advanced regarding these works of art. The natives regard them with the highest respect as sacred objects. Many of these sacred heads have now been brought from the groves into the Awni's palace, where they are kept in chests carefully protected from the elements and marauders.

An audience with the high priest

I was eager to study the art which had made this sacred city famous throughout the world and to record the music of the court musicians of the Awni. Every effort was made to observe the necessary native etiquette in order that nothing might mar the success of the plans. The Awni received me in the throne room where great chairs were provided beside his throne. He had sent for his priests who came from the outlying regions to salute their High Priest. The salutation ceremony was indeed impressive as they prostrated themselves before the throne, first the greater priests, then the lesser priests, chanting a prayer for the long life and prosperity of the Awni. He responded briefly to each phrase of the chant.

Although the Awni understands English perfectly, all "official" conversation was carried on through an interpreter. Through this interpreter our English escort spoke at great length, telling the Awni what fine people we were, how many thousands of miles we had come to visit him, and ended by informing him that we buy large quantities of his cocoa in America where we live. As that is their chief produce for export, this remark drew smiles of appreciation from the assembled chiefs.

The Awni, in a very quiet and dignified manner, made a long impressive speech in Yoruba, which the interpreter translated as a glowing speech of welcome. It was then my turn. With sincere truthfulness I told him how happy we were to be there, how very

much interested we were in the customs of his people, especially in their music and art, and how eager our own people in America would be to hear about it.

Every courtesy was shown us as long as we stayed in Ife. To show his hospitality, the Awni offered us large gourds of kola nuts—bonbons to the natives but bitter as gall to us. He had the chests of ancient treasures brought out, and we were permitted to photograph the sacred heads, the sacred carved doors, to make measurements of these objects, and to go wherever we wished in the palace and the sacred groves. He called his court musicians to perform for me their ceremonial music. And as a final tribute, when we said farewell and were leaving his palace, the royal trumpet which is ordinarily blown only for the king was sounded. When I saw this great trumpet (so long that an assistant had to support the outer end while the musician blew it) and heard the terrific blast which seemed to make the whole world quake, I had a vague conception of the emotions which must have swept over Awranyan, the ancient ruler, when he turned back to Ife as his final home and resting place.

Modern travel between ancient cities

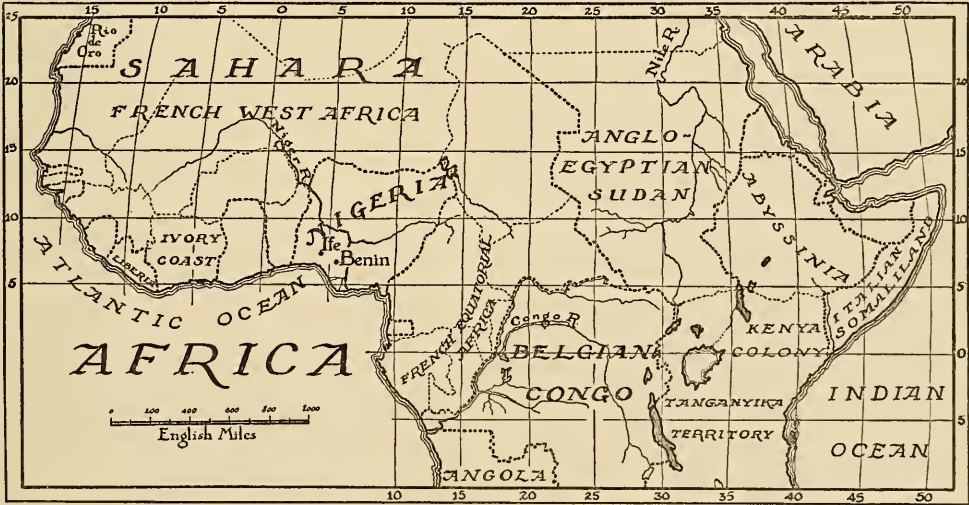
Formerly it must have taken many days

for the Awni's messengers to travel on foot through the treacherous forest to reach Benin with gifts of brass and bronze for the newly inaugurated Obba. The present hard-surfaced road follows the path of the early travelers, but with modern motor cars and excellent highways the distance between these historic cities can now be covered in one good day's drive.

The "City of Blood"

Benin, situated more than fifty miles from the coast, has long been famous as the "city of blood." It is said that a Catholic mission was established here in 1485, but the prosperity of the mission was short-lived. In return for "the small consideration of a Portuguese wife" the Obba promised to drive all his subjects into the bosom of the church, and the missionary settlement soon had 1000 members. However, the climate was extremely unhealthy for Europeans and the natives were not sufficiently enthusiastic about Christianity, so missionary efforts were abandoned.

The Obba of Benin continued to be friendly with the Europeans and trade prospered through the Sixteenth and Seventeenth centuries. European traders were not often encouraged to visit Benin itself, and human sacrificial rites were rarely wit-



THE WEST AFRICAN KINGDOM OF SOUTHERN NIGERIA

During the Fifteenth, Sixteenth, and Seventeenth centuries, the kingdom of Benin was greatly expanded along the coast and northwest into the savanna country. Benin City

is the political and religious center of the Bini, while the sacred city of Ife is the dwelling place of the spiritual ruler of the Yoruba nation

nessed by outsiders. But the early Portuguese, Dutch, and Swedish navigators brought back to Europe rumors of a mighty kingdom with a capital city five miles in girth surrounded by a moat and a great wall ten feet high.

It was said that the King's palace was very spacious and filled with magnificent carvings in ivory and wood and castings in brass and bronze. A report brought to the western world in 1825 stated that much of the ancient splendor had disappeared. By 1892, when Captain Gallwey visited Benin, the town was greatly reduced in wealth and in size. Occasional civil wars had ravaged the city, and with remunerative slave raids ended and all trade relations with Europeans forbidden by the King, much of the former greatness disappeared.

A fateful expedition

In 1896 an English expedition left the coast, carrying gifts and merchandise to Benin. Neighboring chiefs urged them not to approach the city at that time. Overami, the Obba, warned them not to come, as the Bini tribe was celebrating the great feast for the anniversary of the death of Adolo, Overami's father. Courageously but very unwisely the small group of Englishmen proceeded unarmed toward Benin and walked directly into an ambushade prepared for them. All were massacred except two. These escaped and after terrific hardship reached the English settlement at the coast to tell the tale.

Within five weeks (January, 1897), a powerful expedition retaliated, advanced on Benin, and after fierce fighting, took the city. The Obba fled to the dense forest but finally tired of bush life, surrendered, and was brought back with certain of his chiefs to be tried for the massacre of the white men. Seven chiefs were sentenced to death (for the seven white chiefs who were killed so mercilessly). The Obba, whose innocence in planning the massacre was established by all the witnesses, was exiled to Calabar. As he was a great juju man, it was necessary to send him far from his province in order to break down his influence with the Bini people.

Of all the riches that had formerly been his to command nothing was left. His lands were taken over by new rulers. His eighty wives and his concubines were sent back to

their families with the exception of two — his favorite wives — whom he begged to take with him into exile.

The taking of Benin City

Due to the sacrificial rites which were being observed, the English expedition found Benin in a terrible state of bloodshed and disorder that made its name "the city of blood" seem very appropriate. Yet the Obba was not regarded by his subjects as a cruel or bloodthirsty man. He was simply carrying out the tribal traditions which had been handed down through a score of dynasties from the reign of the first Obba, a son of the great Yoruba ruler, Awranyan of Ife.

The taking of Benin City revealed not only the horrors attendant on the practice of human sacrifice, but it led to the discovery of art treasures exceeding all expectations. Travelers in west Africa had reported seeing in the King's compound and in the juju houses remarkable works of art in bronze, brass, and ivory. But no traveler or ethnologist dreamed of the vast quantity and the amazing variety of objects hidden there.

Every house had its altar, and sometimes these bronze objects were buried in the altar itself or in the surrounding walls. In these unexpected spots bronze jugs, vases, staff heads, and figures were found. Plaques with intricate designs decorated the beams of the Obba's palace. The most spectacular works were on the juju altar in the King's compound. Early descriptions of these altars indicate that the same sort of objects decorated the altar then as at present.

Bronze casting

Most of the ancient works were removed to European museums soon after the capture of Benin, but the artisans continued to fashion these castings in bronze after the same style and method. Now the altars are again filled with the traditional ceremonial objects. Some have been made since the capture of the city; some had doubtless been hidden in the forest and have been brought forth from their hiding places. Large carved ivory tusks are supported by life-sized bronze heads. There are smaller bronze heads and figures of equal excellence and brass bells remarkably well executed. Metal

swords and staves of wood carved to resemble bamboo which served both as rattles and as clubs are also used on the altars.

These bronze castings are made by the "cire perdue" process. A core of special clay is formed on which the figure is modeled in beeswax. The very fine details in wax, such as the beads of the headdress and necklace, are attached to the model by means of a heated wire which serves as a soldering iron.

Preparing the mold

The wax model is carefully coated with fine clay and eventually completely covered with a heavy mass of clay in which an outlet is made for the wax to escape when melted. The mold is then baked in charcoal embers. A mold of exactly the design of the original wax model remains after the wax has melted.

The molten bronze fills every hollow left by the wax. After the metal has cooled, the clay mold is broken away. Obviously only one casting can be made from the wax, and this accounts for the fact that no two works are identical. Incidentally this complicated method used with success and familiarity by the Benin "savages" is the same process as that used in Italy during the Renaissance. By no other conceivable method could such elaborate detail and such extravagant relief be obtained as is found in the plaques or tablets representing the victories of the Bini over their enemies.

A series of about three hundred of these panels is now in the British Museum. The masterful way in which the detail is treated and the composition indicate that these highly developed castings were produced by a people long familiar with the art of working metals. The plaques show only one phase of the bronze casting of Benin. These artists are equally successful with objects in full relief, such as heads, bells, vases, and other things of minor importance.

The question is invariably raised as to where the people of southern Nigeria learned the art of metal working. Both in Ife and Benin are found remarkable bronze castings which are absolutely unique; there is nothing like them in any other part of the world. The *method* of casting may or may not be indigenous; in a short article that discussion cannot be adequately dealt with. The *style*

is definitely African; the Benin productions represent a form of real native art with stylistic features which are fundamentally negroid.

As we entered Great Benin last August, it was impossible not to recall the tales of her past glory and horror. All is changed now. Instead of traveling on foot through almost impenetrable forests and swamp-lands, one motors on a good highway. The town is peaceful, quiet, and orderly, under the present Obba who rules in friendly coöperation with the British government. Even though we had been informed that the Obba was a well-educated, intelligent young man, we were a little surprised to find him seated in a beautifully carved chair with a volume of Chesterfield's *Letters to His Son* in his hand.

In order to have a ready-made topic of conversation for the occasion, I had recorded a few Bini songs to take with me. These I played for the Obba and he found them most interesting. But he said, "My court musicians could perform these songs very much better. Would you not like to have them sing for you?" Of course, that was exactly what I wanted more than anything else in the world. So the matter was quickly arranged.

Court splendor

At the appointed time I arrived with my recording apparatus at the royal palace and was ushered into a huge hall to await His Majesty. Soon I heard great excitement outside. The Obba in his ceremonial robes was emerging from his private quarters in the palace, attended by his entire retinue. His headdress was a magnificent creation of coral woven in such a fashion that the hair and head were entirely covered, allowing only the face to be seen. His necklaces, bracelets, and sandals were of coral. No one knows exactly at what remote date coral came to represent royalty among the Bini people nor where that coral came from. The flowing garments of the Obba were of brilliant brocades.

The Obba's entourage

Among the followers of the Obba were, first in importance, the chiefs who make up his advisory board and who have consid-

erable authority. There were about fifty of these, bare to the waist, with necklaces of coral and long loin cloths drawn about the hips and knotted at the waist. Two groups of musicians accompanied the Obba; one playing flutes preceded him, the other playing horns and gigantic gourd rattles brought up the rear. The sign of office was a huge executioner's knife with wrought iron blade and wondrously carved handle. This knife shadowed the Obba constantly; if he advanced a step, the knife advanced; if he retreated, the knife did likewise. Two young boys were continually at the Obba's side, literally as his arm-bearers. They supported his arms at the wrist and elbow while he walked. When he paused, he rested what seemed to be his whole weight on one of the boys by leaning his arms on the boy's head.

After a ceremonious greeting, we progressed slowly amidst a cheering throng of several hundred of the Obba's devoted subjects to the court, where we entered through the east gate according to custom. It was here that the ancient sacrificial rites in honor of the spirits of the dead kings were performed. The memorial mounds erected for the previous Obbas were piled high with carved ivory tusks, heads and figures in bronze and brass representing the former kings always shown in ceremonial robes. Brass bells with unbelievably sweet tones were used to call the spirits to come and accept the sacrifice.

The musicians, as well as the Obba and chiefs, wore ceremonial dress, because the songs of the ceremony to the dead kings cannot be sung without it. This rite is performed only once a year. In the old days it lasted three months and was a great orgy of human sacrifice. Now it lasts only twenty-four hours, for the sacrifice now consists of domestic animals which are expensive. I recorded the entire cycle of songs for this ceremony, the songs for the greater chiefs, for the lesser chiefs, for the Obba's wives, while they all in turn performed their part of the ceremony, and so on until the Obba's song which ended the dancing and was the signal for the priests to proceed with the sacrifice.

New means of art expression

In the art treasures of Benin and Ife one is impressed by the grave simplicity, the beautiful proportions, the strength, vigor, and boldness of the modeling, and the feeling for design which is always evident. A study of the music of this region also furnishes additional evidence of the genuine, innate artistic sense of the African negro. In his art forms he has preserved for posterity the traditions and inspiration of his ancestors, and through the influence of these artistic forms modern artists and composers of the western world are finding new means of expression.



*Sketch of a
Benin bronze*



(Above) The Awni of Ife, spiritual ruler of the Yoruba people, surrounded by his high priests



(Left) The present Obba of Benin, in ceremonial robe. His beaddress, necklace, bracelets, and foot-coverings are of coral, and the executioner's knife, symbol of power, is constantly near him



(Above) These aged musicians played the ceremonial music for the great ceremony to the spirits of former Kings. This rite is now performed only once a year for twenty-four hours. It used to last three months, and was an orgy that earned for Benin the name "City of Blood"

(Below) Human sacrificial offerings were formerly made on this juju altar in the King's compound. Now the sacrifices consist of domestic animals. Bronze beads carrying huge carved ivory tusks, brass bells, and staves carved to resemble bamboo and used as rattles, are piled on the altar





(Above) To show his hospitality, the Awni of Ife called his court musicians to perform their ceremonial music for Mrs. Boulton. This group is equipped with huge gourd rattles



"Opa Awranyan," the staff of a mythical ruler of the Yoruba nation. This granite obelisk marks Awranyan's supposed burial site

The art of carving or drilling in stone such as is shown on this obelisk has long since been lost

Many carved figures and groups decorate the Awni's palace. In the art treasures of Ife and Benin the African negro has preserved for posterity the traditions and inspirations of his ancestors



(Left) This terra cotta head and the one at the upper right on the opposite page are among the works of art recently unearthed in the sacred groves near Ife. The natives regard them as sacred objects, and many have been brought to the Awni's palace, where they are carefully protected

The Yoruba explanation of the remarkable sculptured beads found at Ife is that they are all that is left of the bodies of ancient rulers who were deified and at the same time petrified, and that these beads alone remain to receive adoration and offerings



One of the doors in the Awni's palace, bearing scenes from his life represented in carvings. Mrs. Boulton was permitted to photograph the sacred doors and art objects that are so carefully guarded at the Awni's palace



(Above) Bini boys escorting Mrs. Boulton from her morning hunt in the forest.

Mrs. Boulton was treated with every courtesy during her visit to Benin and Ife, and was successful in obtaining much interesting information about the customs of the natives, particularly their music and their art



(Above) The highway recently opened through the forest to Benin. The present hard-surfaced road follows the path of the early foot travelers, who must have taken many days to cover the distance between Benin and Ife, through the treacherous forest and swamplands



The picture at the left gives an excellent idea of the height and character of the oil palms growing in the lowland coast country

A Contribution to Maya Architecture

Rio Bec "B" — a temple in the heart of Yucatan is restored in miniature at the American Museum

By CLARENCE L. HAY

Research Associate in Mexican and Central American Archaeology, American Museum

[Almost all the material for this article was gathered from the photographs of the Peabody Museum of Harvard University Expedition of 1911-12, and the very accurate field notes of the late Raymond E. Merwin, without which the model could not have been constructed.

Doctor Merwin was an archaeologist of the first order, an ideal leader and companion in the trying conditions of the Central American bush, and the news of his death on November 25, 1928, was received with the greatest sorrow by his many friends and colleagues in the Maya field.]

IN THE YEAR 1908 the French explorer and archaeologist, Comte Maurice de Périgny, discovered in the central portion of the peninsula of Yucatan the remains of an ancient city, to which he gave the name "Rio Beque." From later expeditions it has been shown that this site covers a very large area with several localized groups of buildings. The Périgny discovery included a main building to each end of which is attached a two-roomed building and a tower-like structure.

About a quarter of a mile south of these buildings lies the best preserved edifice ever found in this region. Owing to the great density of the jungle, this was not at that time discovered, and was first found in 1912 by R. E. Merwin, field director, and myself as assistant field director, of the Peabody Museum of Harvard University Expedition. The Périgny group we designated by the letter A and called this structure "Rio Bec B." The spelling "Rio Bec" is now in general use.

The members of the Peabody Museum Expedition landed in Belize, British Honduras, in January, and, traveling in a small sailboat about ninety miles, reached Payo

Obispo, a small town at the mouth of the Hondo River. We visited some small ruins in that neighborhood. In a motor boat we made further progress up the Rio Hondo, and at Xcopen, a little settlement some forty-four miles from Payo Obispo, we secured mules and set out for the interior.

The trails were in a wretched condition owing to recent heavy rains, and the bush was incredibly dense. We traveled in a northwesterly direction, following up every lead that we could get from the chicle rangers, and discovered a number of small ruins in an indifferent state of preservation, though the walls of some of them were elaborately sculptured and embodied important architectural details peculiar to that region.

Finding the temple

At last on Easter Sunday, on the border line between the State of Campeche and the territory of Quintana Roo, we found our temple. It was so camouflaged with trees and vines that it was practically invisible.

We slung our hammocks between convenient trees, and, armed with axes and machetes, began the job of clearing. Gradually the accumulated verdure of a thousand years fell from the walls and towers, and a structure fifty-four feet in height emerged from the encircling jungle.

The multiple hardships and annoyances of the Yucatan bush were forgotten, for here, at the end of the season, in one unit, were most of the architectural elements we had been finding in fragmentary form all the winter.

No hieroglyphic stelæ were found in the region to identify the age of these structures, but from the study of architectural detail it seems evident that this building belonged to the period between the Great Empire of the Mayas and the Renaissance, and probably was built between 600 and 700 A.D. The two towers with the conventionalized masks suggest the temples at Tikal, Guatemala,

but in the Tikal type of temple the walls occupy most of the space, leaving room only for minute shrines in the dark interior. In Rio Bec "B" the rooms are broader and more habitable, and this might be said to represent a transition between the earlier purely religious monuments and the later structures in the cities of Northern Yucatan, of which Uxmal is a famous example. As at Rio Bec, the buildings at Uxmal have usable rooms.

Our ruin, facing east, contains six rooms, two long rooms in the center and two shorter ones at each end. They are all about 16 feet high, with the characteristic Maya vault, and from 7 to 9 feet wide. The center rooms are about 33 feet long, and the end rooms about 17 feet in length. The medial walls are about 4 feet thick, as are the outer walls, with the exception of the great mass of masonry which supports the towers.

Unlike the earlier temples of the Tikal type which were built on high pyramids, it has no monumental base, and on three sides rises directly from the ground. On the east side there is a terrace about 5 feet high extending 35 feet in front of the building. The rooms are all on the level of this terrace, and on the other three sides there is, in effect, a substructure about 5 feet 6 inches high below the level of the rooms.

Construction of the temple

The construction throughout is of rubble, faced with a veneer of finely cut limestone. The walls were originally covered with plaster, but this has largely disappeared, and the beauty of the stone facing is exposed. Built into the southeast and northeast corner is a solid masonry tower nearly fifty-five feet above the ground level. Typical Maya masks representing highly conventionalized serpent heads with upturned snouts, curved eyeballs, and fangs are on the east and west sides.

From the ground to the level of the roof of the building are two rounded corners supporting a steep flight of stone stairs, which are purely ornamental, as the slope is only about eight degrees from the perpendicular. The perforated stone trellis known as a roof comb is in two sections. On each section were originally four human figures of stucco, two in front and two in the rear, but these were in a poor state of preservation and very fragmentary. Below each of the human fig-

ures is a conventionalized mask panel.

A large panel, set into the east and west fronts of both towers below the great masks, is topped by a wooden lintel. The panel suggests an entrance to the god's house, for the solid towers contain no earthly rooms and none but a god could climb the steep stairs which lead to the portal.

As in all Maya work, the building is not entirely symmetrical. The central doorway is set slightly to the left as is the double roof comb. An amazing accuracy, however, was reached in the length of the building, for, although the north wall had fallen, the measurements taken on the site indicated a length of 84 feet 1 inch on the east side, and 84 feet 2 inches on the west.

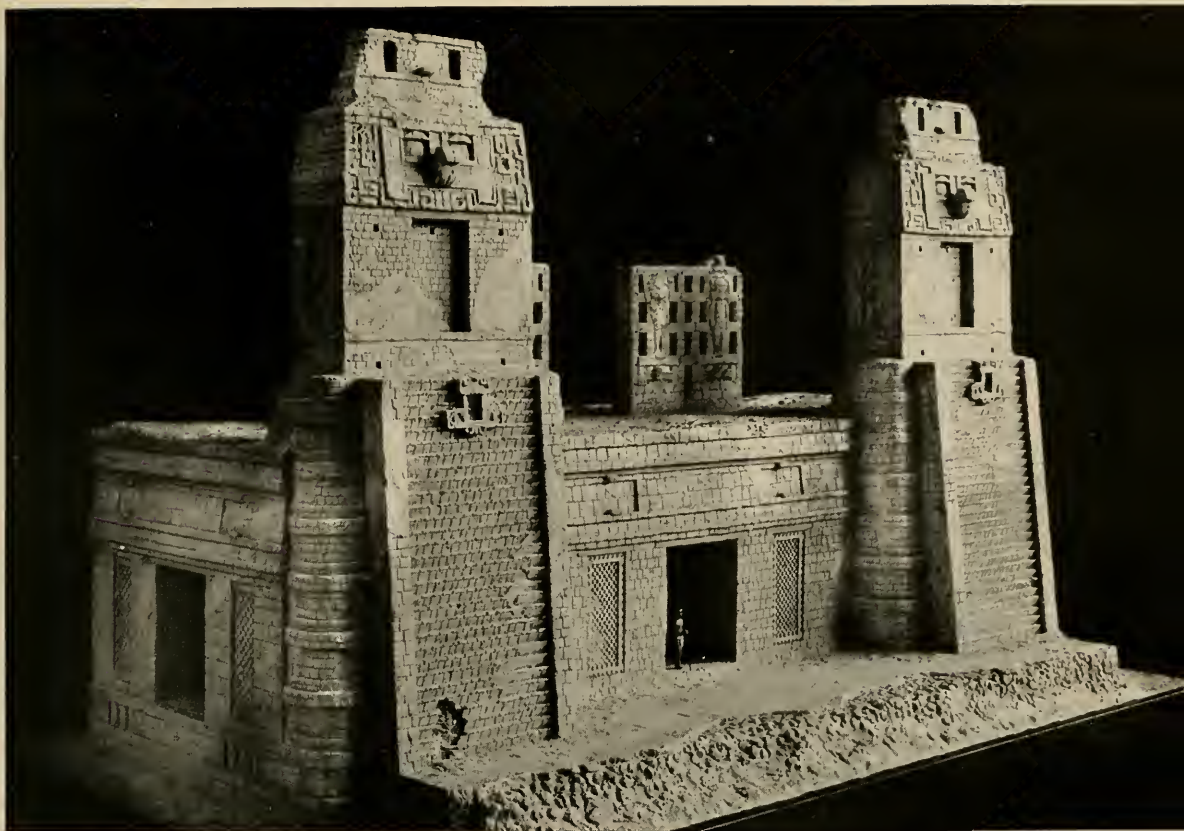
An unexcelled model of a temple

A model, scale 1 centimeter to the foot, has recently been installed in the Mexican Hall of the American Museum of Natural History. It was constructed after plans and photographs of the Peabody Museum of Harvard University Expedition of 1911-12, by Mr. Shoichi Ichikawa of the Division of Anthropology of the American Museum. This model is generally conceded by archaeologists to be the finest reproduction of a Maya temple ever constructed. All measurements were followed most faithfully and every stone in the building that could be detected in the original photographs was lined out with meticulous care. A certain amount of restoration was necessary, as portions of the walls had fallen before the site was visited, but the modeler indulged in no flights of fancy and the destroyed parts, except where the design clearly indicated the missing sections, are shown in the model in a state of ruin.

There is an ethereal and elusive quality in Rio Bec "B." As soon as our expedition left the scene, the jungle applied itself to the task of repairing the green mantle that we had torn aside. Since that day in 1912 all attempts to penetrate the veil have been futile. Recently, two successive expeditions attempted to find this temple, and although the other buildings in the group were rediscovered and several new ones added to the site, "B," only a quarter of a mile away, has remained invisible.

The jungle is a jealous custodian of its mysteries.

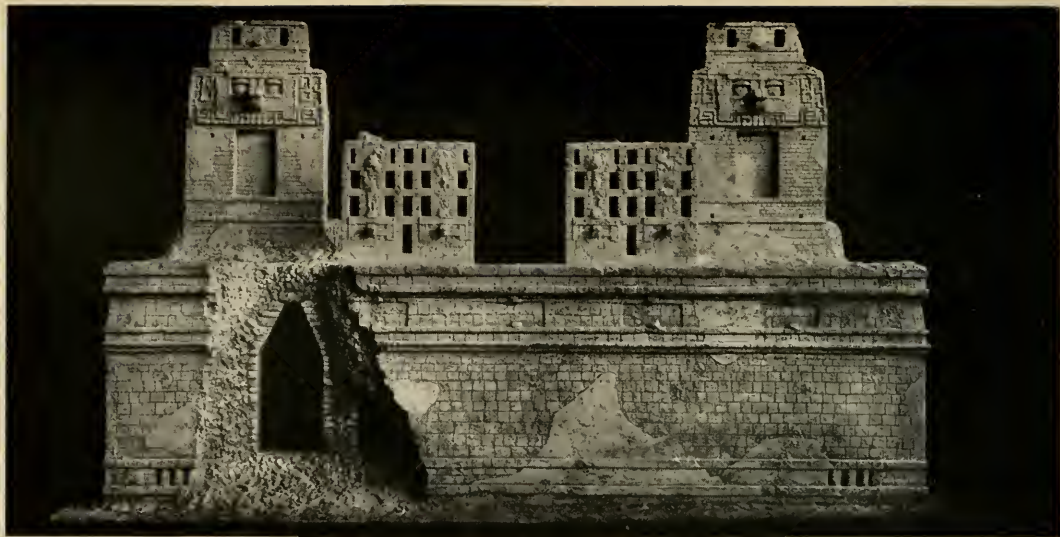
A Temple in the Jungle



The model — southeastern view. The purely ornamental nature of the stairs is evident at this angle. It is impossible for a human being to ascend them. Panels with checker-board design decorate the walls

The original temple from almost the same viewpoint as the model above. The rounded corners which support the stairs are characteristic of the buildings in this area. One of the weaknesses in Maya architecture is the use of wooden lintels over the doorways. In this door the lintel is still in place.





(Above) Western elevation of the model. An opening appears in the model to show the construction of the interior rooms. The fine stone facing is carefully worked out and the original plaster surface is indicated



(Left) At the end of the day hammocks were slung between trees
(Below) The eastern façade after clearing. When discovered, the building was almost completely hidden by vegetation



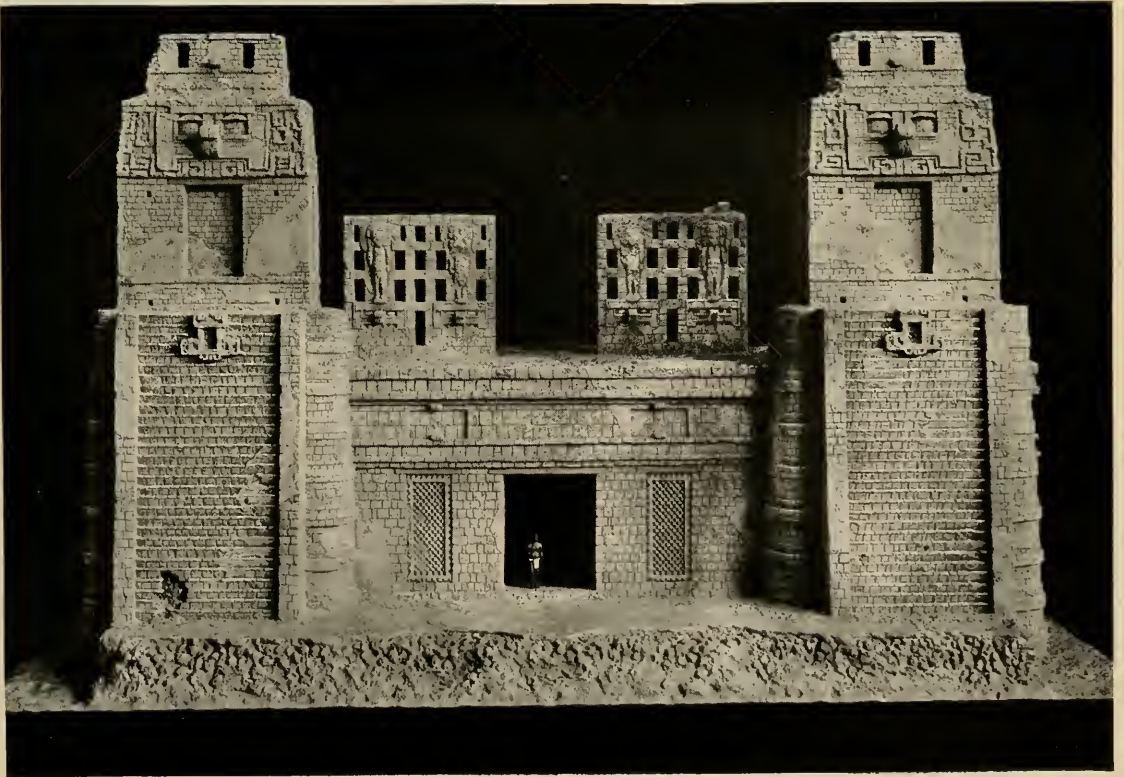
The Maya Temple

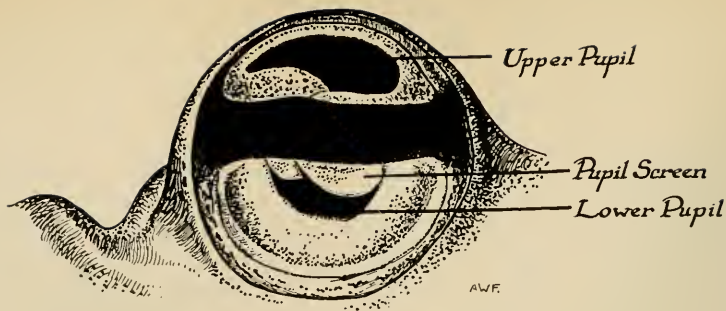
Cross section of a typical Maya room. Note the capstone at the apex. An unusual feature is the lack of an offset at the spring of the arch. A stucco molding is substituted



East elevation. Only a portion of the broad terrace is reproduced in the model. The rooms are on a level with the terrace. The towers are of solid masonry, rising nearly fifty-five feet from the ground level.

Human figures of stucco appear on the double roof-comb





THE EYE THAT SEES IN AIR AND WATER

The four-eyed fish has only two eyes, but each has become divided into an upper and lower section by ingrowth of the iris. The lower pupil is shaded from the glare of the surface film by a

double screen which, like horse "blindings," prevents the water-eyes from looking anywhere but in one direction, namely downward, where the fish's enemies prowl about



THE FOUR-EYED FISH

In the opaque waters of the American tropics the four-eyed fish has developed the habit of floating with the upper half of each eye thrust above the surface. In this manner the fish can spot from afar prey borne to it on the surface of

the current. In correlation with this habit the upper half of each eye has become modified into an organ of efficient vision in air, while the lower half retains the near-sightedness of the normal fish eye

The Four-eyed Fish

A fish that sees both above and below the water surface—The first stage in the evolution of vision in the air

By G. KINGSLEY NOBLE

*Curator, Experimental Biology,
American Museum*

RECENTLY two pairs of the famous four-eyed fish of the American tropics were brought to the American Museum alive. These were procured in southern Mexico by Mr. T. McDougall, a distinguished naturalist who has traveled extensively in that region. The specimens represent the species *Anableps dowii*, the most attractive of the genus.

The optical equipment which enables this fish to see in the air as well as in the water makes it unique in the whole series of back-boned animals. Inhabiting waters which are often so muddy that objects cannot be seen for any distance, it swims almost continuously at the surface with its "air-eyes" thrust above and its "water-eyes" directed downward. It has specialized in feeding on the floating material which it encounters in its wanderings in the dual realm of air and water.

A rare aquarium species

Although *Anableps*, as the fish is technically called, has been mentioned frequently in the writings of naturalists for a century and a half, it is still one of the rarest species in aquaria. There are very few records of the fish having reached northern aquaria alive, and fewer still of its having lived there for more than a short time. The four *Anableps* which Mr. McDougall collected and with great trouble brought to the Museum have been installed in one of the large tanks in the greenhouse on the roof of the African Building. These "queer fish" have proved a very important addition to the collection of live animals under observation in the biological laboratory.

The double pair of eyes which *Anableps* has developed have an important bearing on the evolution of vertebrate animals from water to land-creatures. Perhaps the most

stupendous step in the entire evolutionary change from fish to man occurred when a certain group of fish living in the drying pools of Devonian times had to adapt themselves to life on land. This change, which took place probably 400,000,000 years ago, involved a tremendous reorganization affecting many parts of the bodies of the animals undergoing it. For the moment we may consider only the eyes.

New requirements for land existence

The fish which left their pools for an unknown world of dry land and sunshine had to make over their short-sighted eyes into structures which could see objects accurately at a distance. Water is relatively opaque, and distant vision is consequently not possible in this medium. On land ability to see objects at a distance was not only possible but a necessity. The changes in the eye which were occasioned by the new existence on dry land were more complex than might be supposed. The lens of a fish's eye is large and spherical, and for distant vision in the air the lens had to be flattened, reduced in size, and moved back from the cornea. How this was actually accomplished we shall never know, since the soft parts of animals are not preserved as fossils.

What we do know, however, is that the first land vertebrates, having evolved directly from fish, were devoid of necks. In order to secure an unobstructed view, they had to develop muscles to periscope their eyes above the surface of their heads. The eye in dry atmosphere, further, had somehow to be kept moist. The first land vertebrates therefore gradually gained protective eyelids and glandular mechanisms which would keep the cornea moist and yet free from dirt.

The reptiles early made an advance over the first land vertebrates in developing special muscles to change the form of the lens by pressure from the outside. The birds in turn improved on this compressing mecha-

nism considerably. As a result, a recently hatched chick may have its eye focussed on a worm in front of it and in a moment throw the head back to focus on a passing hawk.

The mammals, which sprang from a different group of reptiles, evolved an entirely different mechanism for rapidly changing the focus of the eye. When at rest, the mammalian eye is far-sighted like that of the first land vertebrates, but the lens is flatter than that of the Amphibia and it is held in place by a series of delicate fibers which keep it flattened. As we grow older the lenses of our eyes lose their elasticity and the delicate fibers holding them can no longer change the curvature of the lenses. Hence, our eyes do not focus as efficiently as in youth.

Anableps has none of these special devices of reptiles, birds, and mammals to change the form of the lens. Its aerial eye merely represents the first stage in the evolution of vision in the air. *Anableps* was confronted with the problem of developing eyes for vision above the surface while at the same time it could not afford to give up its water-eyes entirely. Nature in this dilemma modified half of each eye for vision above the surface while retaining the other half for duty below the surface.

Two pairs of optical equipment

During the early years of the last century the four-eyed fish attracted the attention of the great anatomists who studied the wealth of animal life sent to Europe from the British, French, and Dutch colonies in northern South America. As long ago as 1803, a German anatomist, Schneider, very accurately described the structure of the fish's two pairs of optical equipment. Even

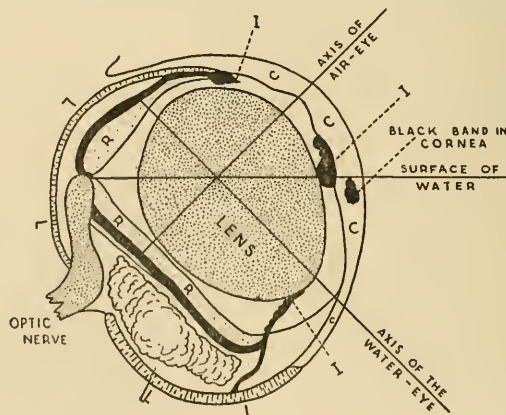
at that time it had been established that the four-eyed fish has only one pair of eyes, but that each eye is divided by an opaque band into upper and lower sections, the former adapted for vision in the air and the latter for gazing under water. Each pupil is divided in two by ingrowth of the iris. For distant vision a lens must be well back of the cornea, while for close viewing the lens must be in the reverse position. *Anableps* has only one pair of lenses but they accomplish this double function by being egg-shaped, with the long axis directed into the water and the short one into the air.

The "air-eye"

The "air-eye" is not equipped with glands to keep it moist in the dry atmosphere. Consequently, the fish must frequently dip its eyes below the surface. McDougall observed the creatures in their native haunts ducking their heads below the surface, and he guessed correctly the reason for this habit. Apparently no other naturalists, who have studied *Anableps* in the field, have called attention to this habit.

Nor has anyone previously noted that the lower pupil is shielded by a double shade formed by the projecting parts of the iris. This double screen no doubt prevents surface-reflection from striking into the lower pupil. The accompanying sketch of the eye of a living fish shows the lower pupil-screen in normal position.

All species of *Anableps* have the strange bifocal eyes which, far from being merely a curiosity of nature, actually show us an important stage in the evolution of the eyes of higher forms, including our own.



CROSS SECTION OF THE
DOUBLE DUTY EYE

As shown in section, each eye is equipped with only one lens. In order to accomplish near vision through the upper, the lens is egg-shaped and receives light rays through both axes at the same time

C-cornea
I-iris
R-retina
L-sclerotic capsule

Exploring the "Mighty Chindwin"

A great river, magnificent jungle, head-hunters, unknown territory, yield adventure to an American Museum collecting expedition in inner Burma

By ARTHUR S. VERNAY

*Field Associate, Department of Mammals,
American Museum*

THE plan to penetrate the Chindwin region of inner Burma grew out of a conversation that I had several years ago with Mr. S. F. Hopwood, Chief Conservator of Forests of Burma.

At the time, we were collecting specimens in lower Burma for the South Asiatic Hall of the American Museum of Natural History. Mr. Hopwood pointed out to me the exceptional rewards which this remote section would yield to a scientific expedition. The Chindwin River, or the "Mighty Chindwin" as he called it, wound through a country which in many parts was unknown, a region buried in dense jungle, unvisited by white men. Interest was added by the fact that a journey to this region would take one within the territory of the head-hunting Nagas.

Thus the seed was sown. From time to time we further discussed the possibilities of an expedition, and later I took up the matter with members of the scientific staff of the Museum. When I was informed that no animals from the Upper Chindwin country were in the collections of the Museum and that such specimens were greatly to be desired, the importance of the undertaking became apparent.

Personnel of the expedition

It was in December, 1933, that Mr. Hopwood offered his help and also expressed his willingness to do all he could to further the objective, with the result that definite plans were made for the expedition to form in Rangoon early in January, 1935.

The personnel had been carefully chosen. We were fortunate in being able to have an old friend of mine, Mr. Randolph Morris, the foremost "shikari" (hunter) of southern

India; also Major Rowley, an experienced shikari, and Mr. Charles McCann, assistant curator of the Bombay Natural History Society. And finally, a few months before the expedition set out, Mr. H. C. Raven, associate curator of comparative and human anatomy at the American Museum, fortunately was able to join us. Mr. Hopwood accompanied the expedition for a few weeks. The task of organizing fell chiefly to his lot, and the success of the expedition is evidence of his thoroughness in these preparations.

The departure

Major Rowley and I flew from Paris to Rangoon, arriving there on the morning of January 6. Two days later we all departed by rail for Mogaung in northern Burma. From there a motor journey of a few hours took us to Nanyaseik, where our mule train was waiting. Including interpreters, skimmers, Burmese bearers and cooks, and Yunnanese muleteers, our party numbered fifty-eight persons.

There were 110 mules, and the manner in which each of the Yunnanese drivers handled the five animals under his control was astonishing to witness. A driver would give a curious call and immediately his five mules would come to hand and be saddled. This process was repeated until all the animals were laden. The two leading animals were gaily decked out with brilliantly colored plumes of dyed goats' hair, and a mirror was put into the harness to keep away the spirits. And away we went.

A march of nineteen miles took us into heavy jungle. Railways, motor- and cart-roads were left behind. We were on jungle paths.

At Lonkhin, about fifty miles from the railroad, we halted for a few days to visit the jade mines. A description of these mines would make a story in itself, for it has been from these and other sources in this region

that the famous jade of China has been drawn for a century and a half and carved into the objects of art that now are prized by us as priceless museum pieces. The prevalent idea that all jade comes from China is an error, for there are no sources of imperial jade in China. The great jade mines of the world are in northeast Burma and on the borders of Burma and Yunnan.

But we must return to Lonkhin and con-

tinue our journey. I will not attempt to describe the various marches, which covered from ten to twenty miles per day, according to the topographical conditions and camping facilities. The length of time we stayed in any place depended entirely upon what we expected that place would yield; if specimens were obtainable we tarried, if the prospects were unpromising we forged ahead.

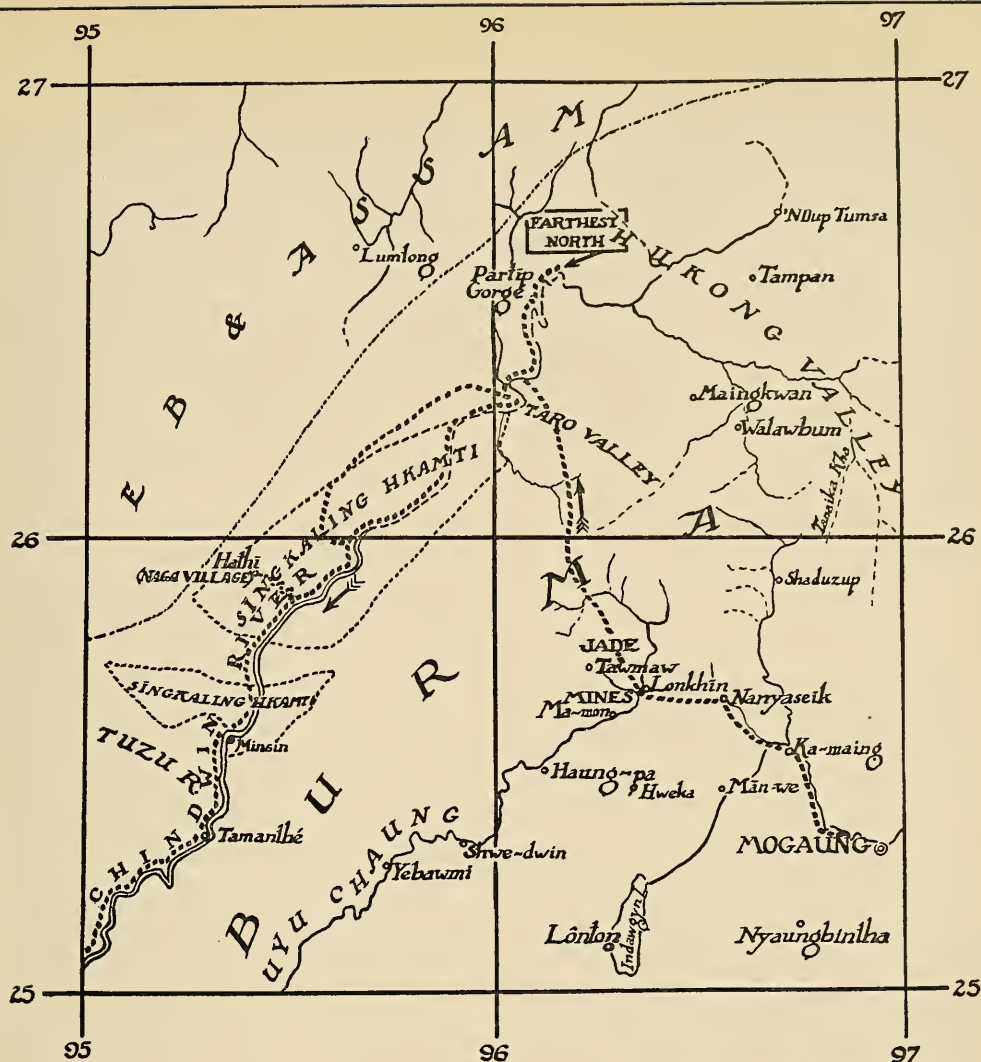
The first nine marches brought us to the



RECENT EXPLORATION IN SOUTHEASTERN ASIA

The Vernay-Hopwood Expedition set out from Rangoon and, after traversing lower Burma, entered the little known

area in the north indicated by cross batches, which was the field of its major exploratory activities



THE ROUTE OF THE EXPEDITION

The heavy dotted line traces the course of the Vernay-Hopwood party to the upper reaches of the Chindwin River

upper waters of the "Mighty Chindwin." Those nine marches took us farther and farther into the unknown parts of Burma. Fairly early in this stage of our travel we left the Burmese members of the party behind, for beyond a certain village the Burmese were not allowed to go.

We were now in the country of the Kachins, a fine, hardy, warlike race of hill men. We had learned a few Kachin words to assist us when we should meet these people. Information of this sort had been given us by Mr. G. K. Stanford, District Commissioner of Myitkyina, who had favored the expedition with every possible assistance.

On meeting the head man of the village we greeted him with, "*Duwa é Grai Kaji*" ("O Chief, are you well?"). He answered "*Kaji*," meaning "Very well," and we were friends. Those who had told us that a greeting and a smile would meet with ready response from the Kachins, had been correct. "*Grai Kaji*" soon became a camp expression.

The Kachins

The Kachins are a most interesting people. They are good hunters, and are fierce and determined in the protection of their own people. They are neighbors of the Shans,

Chins, and Nagas; but there is almost no intermarriage between these peoples. The Nagas, Kachins, and Chins are much finer specimens than the Shans.

The expedition created great interest among all these people, and the farther we got into the country, the more interesting we became to them and they to us. In one instance quite away from civilization a man and his wife and daughter had heard of our being in camp and made a three-days' journey over the hills in order to see "the white men." They brought with them as presents four eggs and an interesting piece of hand-woven Chin linen which was most effectively embroidered. The eggs left much to be desired, but were accepted in the spirit in which they were given. In return we presented a bag of salt.

Items of barter

In each instance where we were in touch with villages, the head man would bring us presents of eggs, chickens, bananas, etc. We responded with presents of salt, tobacco, blankets, jerseys, and various other articles such as needles, cotton, and thread.

Unfortunately our supply was limited in one of the most popular and desirable items of barter. I refer to the ordinary safety pin. Safety pins are prized as earrings, one pin being linked to another; and the short jackets the natives wear would often be decorated with a dangling chain of safety pins. They serve as an invaluable medium of trade, and in the future they will be included in large quantities as part of our equipment.

In the Upper Chindwin extremely dense jungle is found. In the perpetual green the minimum temperature during our stay ranged from 40° to 56°, while the maximum ranged between 70° and 84°. The rainfall is about 100 inches a year, and the dews are very heavy.

Collecting begins

For food, pheasants, partridges, geese, and various other game birds were brought in, but the country could not be relied upon to supply a great deal of sustenance. We were not hunting for food, however, but for specimens: mammals, birds, reptiles, and

fishes, as well as for anthropological material from the various tribes.

Our entry into a village always met with considerable surprise and interest. Our first endeavor was to ask the inhabitants to help us in collecting specimens. For anything brought in we gave a present of a small amount of money according to our estimate of the value. Anything we desired particularly was paid for accordingly. For instance, the big bamboo rat which was most desirable (this species being different from others we had formerly collected in lower Burma) was valued at one rupee (35 cents), with the result that we got a dozen specimens. Without the help of the people we could not have obtained them. Rare birds trapped were listed somewhat higher.

The natives were skillful hunters and trappers, and knew every inch of the terrain. Thus, although we ourselves were collecting as diligently as we could, the local inhabitants were the crux of the situation.

In certain parts of the country there were a number of tigers. Some of the members of the party who particularly wanted to obtain this animal built machans (sheltered platforms up in the trees) near a "kill" and sat in them waiting for the tiger to come back to his quarry, there being no other way of hunting tigers in this almost impenetrable jungle. But the tiger would not return, and they met with no success.

Nocturnal hunting

Elephants were quite numerous. These animals do an immense amount of damage to the crops of the inhabitants. We were not interested in hunting them, however.

Night hunting was done with electric headlights. Our defense of the use of this method was that we were collecting for science, and a number of highly desirable specimens not otherwise obtainable could be brought in by this means. Owls, night-jars, lizards, fishing cats, and a slow loris, a truly nocturnal animal, were procured. Regarding the latter creature, the natives told us that only a few persons had ever seen it, as it only came out at night, and that it never ate anything, but lived "on the rays of the moon." They did not go into the question of what happened when there was no moon.

All our endeavors interested our friends, the savages, enormously, and they entered into the spirit of the game and gave all they could of their jungle lore in order to help us. One can realize the importance of having these people interested and friendly by the fact that on one occasion we were surprised and delighted to hear that one of the chiefs of a large territory had given instructions that thirty-five miles of road were to be cut through the jungle so that the expedition could pass. In another instance forty miles of road were cut. All this resulted through the kindness of Mr. Stanford, who had made it known that a large expedition from America was coming through their country.

Masks of natives

Mr. Harry Raven offered useful suggestions in connection with the particular "desiderata" of the Museum. He accomplished one particular objective which on our return astonished the various officials to whom we described it. This was taking plaster cast masks of people of the various tribes. These tribes are very superstitious, for their religion is "Nat worship," the worship of the spirits of the jungle. Anything that seems to them in the slightest degree uncanny disturbs and terrifies them, and taking a plaster cast of one's face has a certain uncanny aspect. However, we wanted the casts, so it had to be done. How could we persuade them to submit?

We asked several men and women, offering a reward of one rupee; but they would not hear of it, although the rupee was extremely tempting. Then Mr. Raven had a bright idea, namely, that I should be "operated" upon in order to give them confidence. This was done, and I think the rupee given to the others who underwent the ordeal was very well earned. I did not find it an agreeable experience. Let me describe the procedure:

Vaseline is first applied to the eyebrows, eyelids, and around the edges of the hair, and two glass tubes are inserted into the nostrils. One has to keep one's eyes and mouth tightly closed when the wet plaster is lightly sprinkled on the face. The entire face is covered with it in a thin layer and then a large quantity of plaster is spread over and it is left to harden, which takes

from fifteen to twenty minutes. Breathing through the two glass tubes is not easy. And when the operation is finished the victim blinks his eyes and thinks the rupee was well earned. Our muleteers and bearers who saw this performance would assure the various people as we went along that it was "perfectly all right." In this way a number of masks were obtained without great difficulty, although it required a considerable amount of persuasion. The result is that we have extremely good casts of Burmese, Shans, Kachins, Chins, and Nagas.

Each expedition has some episode which stands out in one's memory apart from everything else. Our visit to the head-hunting Nagas was this episode.

It was a rare experience. We enlisted the services of a "Sawbwa" (a territorial Sawbwa chieftain) with the promise of a shotgun and 200 cartridges, to take us to the village, which lay about twenty miles from our camp. This particular village with other villages had within the last few months made a raid on another settlement forty miles away and brought back fifteen heads. It was with keen anticipation that we set out early one morning for this destination.

The head-hunting Nagas

It was not an easy journey. From an altitude of 680 feet we had to go to 2100 feet. Ordinarily, this would be simple, but there were saw-tooth hills intervening which made the march, up 1000 feet, down 500 feet, and so on, quite tiring. It was not until late in the evening that, to our delight, we saw the small village, Hathi, tucked away in the hills, the home of the Nagas.

On our approach, one magnificent specimen of humanity came out, sat on the top of the hill, and awaited our arrival. Our desire to see the village was explained to him. The Chief did not appear to be unduly impressed, but nevertheless met us with courtesy, and we soon became good friends.

The entrance to the village was between two large tree trunks. Nailed on these were human hands and parts of arms and, farther into the village, the skulls which had recently been obtained, gruesome relics of religious fanaticism.

During the day which we passed with these people they danced the Head-hunting

Dance, and a more impressive savage dance I have never witnessed. We were deeply stirred on hearing the chanting which heralded the approach of the procession entering the village. Louder and louder it grew, and then the participants came upon the scene. The dancers were dressed in their war regalia, the most conspicuous feature of which was the headdresses, decorated with boars' tusks, hornbill feathers, and goats' hair dyed a brilliant red. Spears and heavy knives were their weapons. The long knives of the Nagas, when they are not being brandished, are carried in holders hanging at the back, parallel to the spine. There were magnificent voices in the weird ceremonial chorus. The dance continued far into the night, long after we had gone to bed.

The next morning we departed, leaving these strange people to their secluded existence, which seems happy in spite of the possibility that at some time they may lose their heads.

Results of the expedition

The unpleasant part of an expedition is that it comes to an end. I will leave it to Mr. Raven to tell the story of the scientific side of the journey and of the large collection brought back, which includes 900 mammals, 800 birds, reptiles, and fishes, as well as important anthropological material.

This is only a brief outline of our journey through dense, magnificent jungle, a great river, and interesting people.

Burma, of which the section discussed in the foregoing article is one of the least accessible, is the largest province of India. Its population, though twice as great as that of Texas, whose area is approximately the same, is sparse in comparison with peninsular India and with China, which it touches on the northeast.

Agriculture is the chief occupation of the people. Rice is by far the most important crop, the production of which averages more than half a ton per head of population. The alluvial lands of the delta and the valleys of the Irrawaddy, Chindwin, and Sittang are the most productive areas, and support the major portion of the population. The hill sections of northern Burma are inhabited sparsely by primitive tribes.

The people of Burma are predominately Mongoloid, but many racial subdivisions are recognized among them. It is believed that the prehistoric inhabitants were a Negrito race, of which the modern natives of the Andaman Islands, not far distant, may be considered survivals. Burma's present Mongoloid derivation is explained by successive waves of migration from the north, which have continued in the border regions down to quite recent times.

About nine-tenths of the population embrace Buddhism. Spirit worship prevails, however, among the hill tribes, such as those visited by the Vernay-Hopwood Expedition in its traverse of the Chindwin country north to within a hundred miles of the Tibetan border.

Little more than a century ago inner Burma was unknown to Europeans except for the Irrawaddy River as far as the center of the province, and even today sections in the north remain obscure. Difficulties of transportation and hostility of the natives are the chief hindrances.

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Along the Chindwin in Northern Burma



The Chindwin is the largest tributary of the Irrawaddy. The Vernay-Hopwood Expedition followed it through little-known regions of northern Burma, where its upper reaches are broken by falls and rapids. The members of this expedition were the first white men to fish in Kyaukse Rapids, shown above



Extremely dense jungles flank the upper Chindwin



Interior of a Kachin hut, photographed with flashlight. The Kachins are hardy, warlike hillmen, who exhibit staunch determination in

the protection of their own people. Complex laws govern marriage within their clans

Kachins—Natives of Inner Burma



The smile of friendship was bestowed upon the white men. Although the Kachins are fierce toward their enemies, they received the Expedition with cheerful hospitality



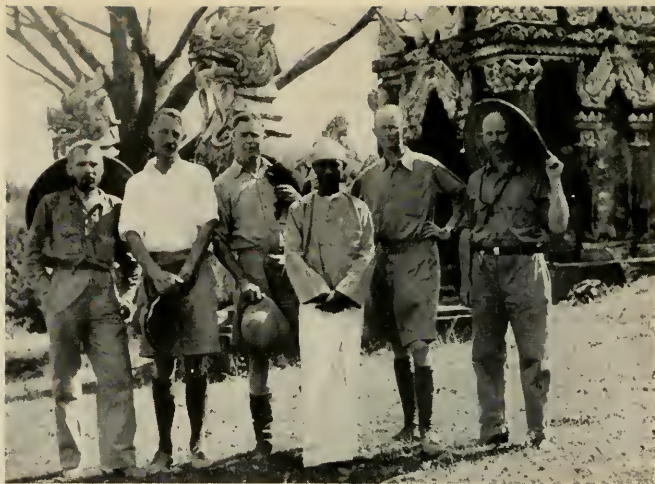
(Above) A Kachin boy. The Kachins live by agriculture and hunting. Cultivation of rice without irrigation is one of their chief pursuits



The ear-plugs worn by the girl at the right are bars of amber, which is mined locally. Plaster casts were taken by the Expedition of these and other native types



The Vernay-Hopwood Expedition, with the chief who escorted them to a village of the head-hunting Nagas. Left to right: Charles McCann, G. S. Rowley, Arthur Vernay, Sawbwa of Singkaling Hkamti, R. C. Morris, H. C. Raven



River Travel

Native dugouts facilitate transportation in the dense jungles of northern Burma

The Expedition is ferried across the Chindwin. The many mules had to swim here, while their pack saddles were transported on native barges



Mule Pack

The transportation unit comprised 110 mules and 22 Yunnanese muleteers. Interpreters, skimmers, and cooks rounded out a personnel of 52 assisting the 6 white men

In breaking camp, each of the muleteers would give out a curious call and his five mules would come to band and be saddled





A village of the head-hunting Nagas



(Left) Heads which had been taken within a few months of the Expedition's visit

(Below) The dance of the head-hunters





The dancers wore beaddresses decorated with boars' tusks, feathers, and goats' hair dyed red

(Right) Drumming an accompaniment on a hollowed tree trunk



(Below) Ornaments are more important than clothing. The bone through the back of the men's hair is from the rib of the water buffalo

Nagas—Head-Hunters





The scientists "took heads" in a different manner. Permission to make plaster casts of the various tribal types was difficult owing to superstitious fears. Patient persuasion and the gift of a rupee were necessary



Breathing through the glass tubes inserted into the nostrils as shown in the center picture is not easy. The plaster hardens in about twenty minutes, and when the operation is finished, the victim blinks and declares the bribe well earned



Winged Monarchs of the Air

Birds used in falconry, an ancient pastime worthy of a place in the field sports of today

By GEORGE G. GOODWIN

*Assistant Curator, Department of Mammalogy,
American Museum*

WHEN the old eastern travelers, Marco Polo and Father Rubruquis, explored the little-known regions of Asia during the Thirteenth Century, they found falconry practised by the wandering tribes of Tartars. Marco mentions a palace at Chang-nor where the "Grand Khan" says the old Venetian "derives the highest degree of amusement from sporting with his falcons and hawks." The Grand Khan, Kublai at that time, who was Emperor of Tartary and China, had two court officers of the highest rank called "Masters of the Chase." Marco Polo was a keen sportsman and falconer himself and apparently often accompanied the Grand Khan, or Emperor, with whom he stood in high favor, on his hawking expeditions, attended by the incredible number of ten thousand falconers. The old Venetian lets us into the interesting secret that even in those days strict game and forest laws were rigorously enforced in China and Tartary.

Falconry in history

Falconry played an important part in the early history of Persia and India, and in later years all Europe was enthusiastic about the sport. It was preëminently the national sport in England at the time of the Crusades and has done more to make the English-speaking people a race of true sportsmen than all the rest of our pastimes put together. While a revival of falconry to the old standard would mean the restoration of a state of things that is past and cannot return, there is no reason why it should not take a place in the field sports of today where the country is suitable and game is found.

In recent years various attempts have been made to establish falconry in America, but

the sport is a costly one; game in suitable localities in the East is scarce, and results more often than not have been both unsatisfactory and disappointing as compared with its success in England. Falconry has much to recommend it, especially in this age. It is surrounded by many distinguished associations, and is in itself so fine and picturesque a sport that attempts to introduce it here will in time, I hope, prove successful. Contrary to the general belief, the practice of this sport is not apt to drive game away from the region where falcons are used, and it is humane to the last degree. The quarry is either killed outright or goes scot-free; and there are no crippled birds to crawl away and die by degrees.

Types of hawks

The training of hawks and falcons, though easy enough to practice when once learned, is one of those arts which cannot be readily gained from a description in a book. During the last few years I have had a rapidly increasing number of requests for information on falconry, which has induced me to give a few hints and a very brief outline on the management of hawks.

There are two very different types of hawk to be had in America which are suitable for this sport, and the training and nature of each is widely different.

First are the long-winged, high-flying falcons, which include the duck hawk or noble peregrine falcon, prairie falcon, pigeon hawk or merlin, generally known as the ladies' hawk, and the northern species of stately gyrfalcons. These, with the exception, to a degree, of the pigeon hawk, can be flown satisfactorily only in open country.

Secondly come the short-winged, fast, low-flying hawks, which include the gay goshawk, Cooper's hawk, and sharp-shinned hawk, and can be used in enclosed and forested

country. In a class by itself should be included the golden eagle, though as a falconer I would not recommend an eagle except as a possible experiment or in open desert country where jack rabbits are abundant or a possible fox can be found in the open. All other American hawks are really, for all practical purposes, unsuitable for this sport, although a beginner at first can do no better than practice on a red-tailed hawk or a red-shouldered hawk. They can, when in good condition, and with a fair chance, catch a rabbit.

Early training

The process of training falcons has been discussed by numerous authors in many books and in various languages, all of which are today out of print and difficult to obtain. The Hollander catches his hawks when in passage or migration and these are termed passage falcons; while the Scotchman takes his from the nest, and his are called eyess falcons. The objective, however, in either case is the same, and that is to teach the hawk to be obedient.

The eyess, or young hawk, taken from the nest, though much easier to train than the haggard or wild-caught falcon, lacks the dash and style of the latter. To overcome this drawback, the falconer puts his young hawks out to hack — that is, they are put in an open basket on a roof or the stump of an old tree, fed with fresh meat tied securely on an elevated board, and left entirely alone. The wilder they get, the better hawks they make when trained. Young hawks, when properly handled, will learn to fly and stoop in a remarkably short time, making long flights into the neighboring country, but returning at regular intervals to feed. For fully three weeks the young hawks must have freedom, but as soon as they kill for themselves, which usually occurs the third week after they can fly, in the case of the tiercels or males, they must be taken in. The falcons, the name usually applied to the females, being larger birds, take longer to mature, and can be left out for a greater period of time. Taking the young hawks in from hack will need a certain amount of skill and a bow net.

Care should be exercised when the young birds are taken from the eyrie that they are at the proper age, having attained all their feathers, and with only a little or no down

left. The longer they can stay in the nest, the better. At least half of the brood should be left to ensure a similar breeding place near by the following year. Occasions arise, however, when the young hawks to be taken care of are far below the desired age. These should be put in a clean box with a wire screen on one side facing an airy but sunny window. The box should be about three feet long, two wide, and two deep. The young hawks must be fed every two hours from daybreak until dark through a curtain at the back of the box. A long pair of forceps may be used, if necessary, to hand-feed them, but under no circumstances must the young hawks be permitted to see the hand that feeds them or suspect the origin of their meals. Freshly killed poultry, pigeons, birds, and rabbits may be used, and small feathers or fur and crushed bone included in their diet. It is interesting to note that lack of food during any period of the growing stage in young hawks will result in hunger traces or white lines across the wing and tail feathers. This not only weakens the feathers so that they snap under pressure, but results in a useless hawk.

“Manning”

The real training of the hawk, or manning, as it is technically termed, starts when the eyess is taken in from hack or at the time of the migrant's capture. First a soft leather hood is put over the hawk's head, covering the eyes, and a pair of jesses — short strips of leather — are fastened around the legs just above the foot. The jesses are joined together on a swivel which in turn is attached to a leash and tied to a block. To keep the falconer in constant touch with his bird, a bell is fastened on each foot just above the jesses. In this way one can know exactly what the hawk is doing from the sound of the bells, and in the case of a lost hawk, they are of infinite value, for as the hawk moves, the tinkle of the bell can be distinctly heard for more than a quarter of a mile. The best bells are now made in India, but European bells, though of a different shape, answer the purpose very well.

The hawk, equipped with all the necessary trappings, is now ready for the delicate business of training. It will be well here for the beginner to resolve to keep before him the two major maxims of the falconer, “Gentle-

ness" and "Patience," because he must have the former and he will need plenty of the latter. The hawk is carried on a gloved hand for as many hours as is reasonably possible each day. Carrying is the most important factor in training, but it must be done in such a way as to gain the complete confidence of the bird. Hawks are among the wildest and shyest of birds in existence, and at first require unlimited patience. Haggards, or wild caught adult hawks, especially of the short-winged group, should be carried for twenty-four hours for the first few days and gently stroked and spoken to. Young hawks will do with much less carrying, about six or seven hours a day. The feeding is first done through the hood. Later the hood is removed by candlelight while the hawk is feeding and replaced before the end of the meal. In this way the hawk does not associate the hood with the end of the meal and resent it. When the hawk gradually has become used to people by artificial light, it is fed unhooded in daylight, and the hood is replaced before the end of the meal.

The hood

The use of the hood is a little misunderstood. The hawk is not kept blindfolded nearly all the time but, on the contrary, when trained, is hooded only when there is a possibility of its being unnecessarily disturbed, or to keep it quiet until the right moment when approaching game.

After a week of constant carrying, a young hawk will look forward with apparent pleasure to the daily walks, and will unhesitatingly jump on the trainer's fist and look for the scrap of lean meat that should always be found there.

If it is a falcon that is being trained, the lure is next brought into use. This is the most important factor in the falconer's equipment. It consists of a padded weight covered with leather and with the wings of a pigeon attached to either side. It is provided with strings for the attachment of meat and a long string by which to swing it. The weight in the lure must be discarded when the hawk has been trained, for by then it has been taught not to follow its natural inclination to carry its victim away. Should the hawk strike a weighted lure while in free flight, it would kill itself.

The feeding is now transferred from the fist to the lure and after a few lessons the falcon goes immediately to the lure for food. The distance it has to fly is increased day by day, first with a line attached to the jesses, until it will come a distance of fifty yards or more. The hawk should start the instant the lure is shown and be on the way by the time it hits the ground. Frequently, if in condition, it will follow up before the required distance can be reached.

A critical stage

It is now ready to fly loose, but the distance at first should be shortened to half and then gradually extended each time the hawk is flown. When the hawk will come unhesitatingly two hundred yards, step in between the hawk and the lure and remain perfectly still, as this is a critical time. If all goes well, the young hawk, being somewhat clumsy on the wing, will not be able to make a quick turn, but will swing to one side and mount in the air and wing around for a second attempt at the lure. This time it is rewarded. After several repetitions of this, the falcon is kept on the wing, or "waiting on" as it is called, for several minutes, by concealing the lure. This exercise is increased daily for a time, and then the falcon can be entered.

An easy bird of the particular quarry that the hawk is to pursue is put out in a small cover in an open field and sprung when the hawk is overhead. If a crow is used, the falconer places a freshly killed pigeon under the black wing of the crow before the hawk has a chance to taste the unpalatable flesh of the crow. The error is often made of entering the hawk to a pigeon thrown out of the hand. An eyess will faithfully follow the game at which it is entered, and there is no surer way of losing a valuable game hawk than having it check off after some stray pigeon half a mile or more away. Throwing the pigeon out of the hand also gives the "show away" and the hawk will always expect a repetition and will pass up the wild game.

No attempt should be made to fly a hawk in the rain or high wind. When hawking, always approach the quarry up wind and fly the hawk into the wind to help her mount. A falcon, on attaining her pitch, almost invariably works down wind. Take care that in that direction there is no such obstacle as a

large wood where the quarry can hide, or a sheet of water or river which you cannot cross.

On preparing to "hood off" at the quarry, the falconer, having approached up wind, must be ready to slip the hawk at a moment's notice. The leash and swivel are detached from the jesses, which must be held securely between thumb and forefinger, and the braces of the hood are half drawn to admit its removal by the plume the instant the quarry rises, care being exercised not to release the hawk before the hood is removed. At the whirr of wings the hawk is off, trusting to you to remove the hood.

As to the distance at which a young hawk may be slipped, that will depend entirely upon circumstances. A young and inexperienced hawk should have short slips to start with, say sixty or seventy yards at most. It is astonishing what a distance a good hawk will go up to her quarry when she has had a few good flights. In England it is not unusual to slip a falcon after rooks more than a quarter of a mile away.

Game hawking is usually practised with dogs which point the bird; the falcon "waits on" overhead. The higher the pitch the better. If it is a pheasant that is sprung, the falcon, stooping downward, knocks it headlong to the ground. In this case, however, an effort is made to send the quarry down wind instead of against it, enabling the falcon to make her stoop. Pheasants, Scotch grouse, and other fast-flying game birds with short wings and heavy bodies have a knack of cutting through the wind like cannon balls, whereas the falcon is slightly harassed therein by reason of her longer body, wings, and tail — termed by the falconer her train.

Short-winged hawk

The goshawk and other short-winged hawks are trained in the beginning in much the same way as are the falcons, except that they are flown to the fist and not the lure. They need more carrying than the falcons but will suffice with less exercise. They are flown directly from the fist at the quarry and the flights are relatively short and quick. While less spectacular in flight than the falcons, they can be flown in forested country, are extremely plucky birds, and are rarely disheartened by unsuccessful flights.



A Dutch Hood

The hood protects the hawk from being startled by seeing unfamiliar faces and objects while it is undergoing training. After the training is completed, the hood is used to prevent the bird from starting off after undesirable game

All hawks must be weathered a few hours each day before flown, that is, they must be put out on blocks or perches on the lawn or in the orchard, where there are no horses or cattle. A bath should be given about three times a week and every day during hot weather from 9 to 11 A.M., and should be put down and filled before the hawk is carried out, so as not to alarm the bird unnecessarily. A zinc tray about three feet square and four inches deep makes a capital bath, and a hawk will go freely into it, stooping down, extending its wings and tail, and throwing the water up over its back in evident enjoyment.

When feeding a peregrine, goshawk, or Cooper's hawk, the meat should be fresh, lean beef; for a pigeon hawk or a sharp-shinned hawk, sheep's heart. The latter is more easily digested than beef and is the nearest approach in butcher's meat to natural food, namely the flesh of birds. It will not do, however, to feed them on this daily without a change. About every third day a peregrine should have a pigeon, the leg of a fowl, or a rabbit with the fur. A pigeon hawk should have small birds or mice. The latter, to be kept in good condition, should be fed twice a day. The early meal, if light, will not interfere with their flying in the later afternoon. A peregrine needs to be fed only once a day and that about five, unless it is an eyess, in which case it should be fed twice a day or even oftener for young and growing hawks. A peregrine will take about seven or eight ounces at a meal, smaller hawks much less. Hawks must not be fed or flown until they have cast. Fur and feathers are not digested

but thrown up in the form of a pellet, usually sometime before noon the following day. These should be fairly dry, compact, and evenly rounded. Loose, wet castings indicate a poor condition of the hawk, and freshly killed poultry or pigeons should be fed while still warm with plenty of small feathers until the castings appear normal.

Obtaining hawks

Frequently I am asked where a pair of falcons can be obtained. It is generally known by those interested in birds that hawks do not breed in captivity. In this country there are no professional hawk trappers and one must depend on his own ingenuity to secure birds. Falcons breed on almost inaccessible high cliffs and are fairly plentiful on both coasts. A falconer usually prefers to obtain his own hawk, or they must come into his possession soon after taken in captivity. Cooper's hawks and sharp-shinned hawks are not uncommon in wooded localities within fifty miles of New York. Goshawks are northern birds and rarely breed south of Canada, but periodically visit the States during winter migrations.

The reader will doubtless find an account of the actual practice of falconry more amusing if not more interesting than the dryer details of training.

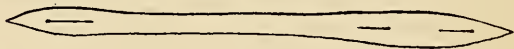
In Great Britain hawking, like shooting and fishing, has its proper seasons. In the early spring, the long-winged hawks are flown at rooks, crows, and magpies. When the twelfth of August comes around, these same hawks are through the molt and ready for the Scotch moors, where the falconer sees the remarkable sight of his hawk stooping downward from a great height at a fast-flying grouse and knocking it headlong into the heather. This has to be seen to be believed. In September, these same hawks will be ready to make short work of the partridge.

An idea of an actual flight can be gotten from the following excerpt from the classic work of Major C. H. Fisher, *Reminiscences of a Falconer*, which describes how his falcon "Taillie" killed a full-feathered woodcock after a splendid flight:

"I may here mention a singular flight I once witnessed at a woodcock. This bird, when put to it, possesses remarkable powers of flight, as its extended migrations, and

splendid shape and length of wing, abundantly warrant. It occurred in this wise. In October, 1866, I found myself with hawks (eyesses), dogs, gillies, a keeper, and my gun, on the moor near the western end of Loch Eil, in Argyllshire, at a place called Fassiefern, not far from the place where Prince Charlie met his devoted Highland clansmen in arms for his crown, only to lose the day and their lives at fatal and bloody Culloden. I made a line to beat out a wide bank of bracken, then brown with early autumn, and saw a bird which I believed then to be a cock, and the keeper, a winged grouse, jump up in front.

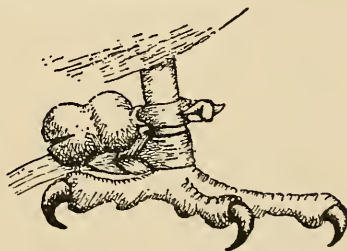
"Had I but had the courage of my convictions, and put my favourite falcon, called 'Taillie,' from her broken tail — a Welsh hawk she, from the Glamorgan precipices of the Worms' Head — aloft, then she would probably have been saved much trouble, and we should have lost a glorious sight, and flight, for the day was stilly, bright, and lovely, and the sea-loch and its waves sparkled in the sun. No, I took her on my fist, and struck her hood in readiness, half disposed to believe in McPhee the gamekeeper. Just where I saw the bird spring, suddenly up went a fine woodcock. No winged bird she, but in full possession of the excellent pair that had not long before brought her (I



The jesse or strip of soft leather is fastened round the hawk's leg to tether it



Bells betray the whereabouts of the trained hawk. The European bell is illustrated above



FOOT EQUIPMENT

Sketch showing how the jesse and the bell are attached to the hawk's foot. The Indian bell shown here is preferred by most falconers

suppose, for we do not know) from Finland, or elsewhere in the north of Argyll, I unhooded and cast 'Taillie' after her, and the flight began. This woodcock would have much astonished sportsmen only used to their actions in a thick covert. Up and up she went in long zigzags, with precisely the style and action of her small relative, the common snipe, but mute.

"The falcon mounted rapidly in her train, though at a considerable disadvantage at first. I saw it was going to be a long affair, got out my glasses, and lay down on the heather, and on one side was my then falconer, Jamie Barr, one of the well-known family of Scotch falconers. There were once a father and three sons of that name (all falconers by profession), with most acute and trained vision, and on the other side the proud possessor of the best pair of eyes in all Argyll, if not in the West of Scotland — the so-called 'fox-hunter's' son, my gillie, Sandy Kennedy. This man got much employment in seeking sheep lost on the hills and mountains, and long practice had rendered his ancestral eyesight (his father's had been as good) equal to most glasses on the moor.

Warfare in the air

"The woodcock, with the falcon below and behind her, did not dare to come down or return — *vestigia nulla retrorsum* was her motto — and soon the pair of dots were high over the sea-loch, there a mile wide, the cock's point being evidently Morven, on the other side of the strait. Soon I called out, 'I can see but one.' Presently from Barr came, 'I canna see them;' from Kennedy, 'I ken 'em fine!' I hardly believed he could, for my own eyes were then far above the average, and, aided by the best of Voigtlander's field-glasses, it was as much as I could do. Presently methought that the single dot in the sky which I still discerned became, instead of fainter, faintly more visible.

"'They are coming back,' quoth Kennedy, and before long the spot had visibly increased, and the falconer Barr declared that he saw them once more. So did I, and so did

all before long; for the woodcock, finding herself over the water, and unable to shake off her pursuer or gain the distant haven of Morven, had no alternative but to seek the shelter of the bracken on our side, from whence she sprang; so the poor fowl turned tail and 'went for it' in a long slanting descent from an incredible altitude.

"As they both neared us they presented the appearance of two little balls falling out of the sky right toward us, and quite straight, with the difference (fatal to the poor woodcock) that 'Taillie,' who began below her, was now well above. The hawk was evidently unwilling or afraid to stoop over the water, but the moment the cock was over the land, she shot herself forward, and straight in the air, instead of slanting, half perpendicularly down, like her quarry (both moving with incredible speed), turned over, and stooped.

The speed of the falcon

"No one knows the speed of a falcon's stoop, but it must be very great, as I have seen it bring a hawk up to old grouse flying hard down wind, just as though they had been sitting still, with absurd ease, if only she be but high enough. Anyhow, it was fatal this time to the woodcock, for, leaving a cloud of feathers behind, she tumbled head over heels before us into the very patch of bracken she came from, and meeting there with an old anthill, bounded off it many a yard and lay still. The hawk soon recovered herself, and dashed on to her well-earned quarry. Needless to say I did not disturb her thereon, but served out the whiskey, and we drank her health all round. Then we too set to work at our lunch, and when this very tame pet hawk had nearly done hers, I went up to her and took her up, and having replaced the swivel in her jesses and the leash in her swivel, and cleaned her feet and wiped her beak and kissed her, I fastened her to a stone in a lonely burn close by, and witnessed her bathe and dry herself in the sun, preening her feathers to her and our entire satisfaction, and I trust to the satisfaction of the readers of my tale."

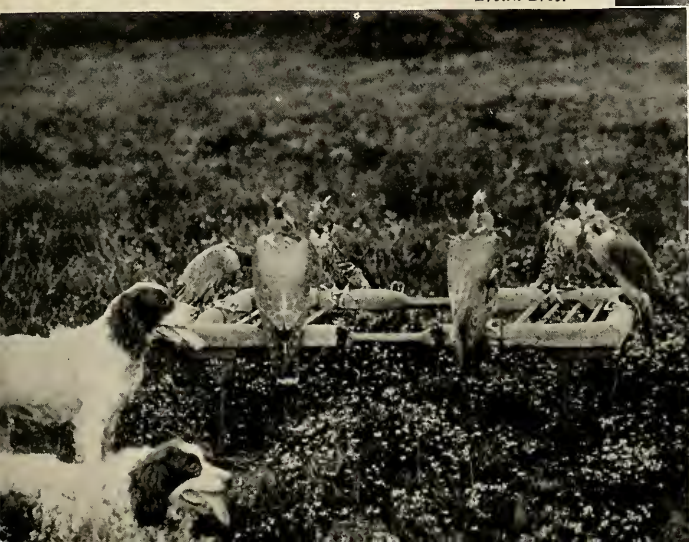


Capt. C. W. R. Knight and his famous golden eagle pose for the camera man. The Kirgbez and many wandering tribesmen of Middle Asia have used eagles as a means of livelihood through the centuries.

(Right) A peregrine falcon on its block. The falcons are cliff dwellers and rest most comfortably when perched on a flat surface. The falconer provides a block of wood 6 inches in diameter and 10 inches high; a 12-inch spike in one end holds it in position, and there is a steel ring round the spike to which to fasten the leash; the top of the block is covered with a thick piece of cork

(Below) The falconer's cadge (one style of which is shown here) is a device on which a number of hooded hawks can be carried in the field. Individual hawks are flown in turn as required.

Brown Bros.

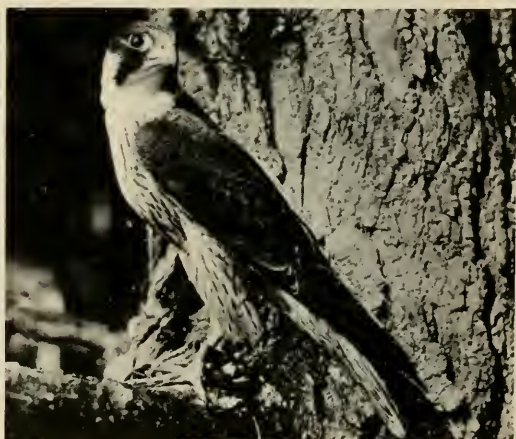




(Above) An Iceland gyrfalcon. From a painting by G. E. Lodge. Modern falconers seem unable to adapt this splendid northern gyr to present conditions. It was so highly esteemed in the Fourteenth Century that it was considered a kingly gift, and often employed when the good will of a potentate was especially desired

The nest and young of the red-shoulder hawk are shown below at the left. A peculiar habit practiced by many hawks is the decorating of the nest with evergreen branches.

At the lower right is an eyess falcon. Normally these falcons prefer to rest on cliffs and similar open spaces, but in enclosed country the broad limbs of a big tree may be used



Brown Bros.



(Above) The Greenland gyrfalcon, painted by G. E. Lodge. It was probably more highly valued in the Middle Ages than any other living creature. The late Lord Lilford, who in modern times had a good deal of experience with this gyr, opined that it was an excellent flier and stooper but is not hardy and is difficult to keep in condition

(Below) A stud of American game hawks at Cedarhurst, L. I. The process of "manning" hawks or getting them accustomed to the society of men requires great patience and care; when used to people, they must be placed out in the open several hours daily to be "weathered." The falcons are put on blocks, and the short-winged hawks on bow perches





The death of the rook. From a painting by G. E. Lodge. Only in recent years has the rook been pressed into service as a quarry for the falcon.

This is one of the most thrilling uses of the peregrine. The chase often continues for many miles. A good rook will mount and ring up in spiral curves into the very clouds almost as fast as a falcon, and then make off down wind

(Below, left) Mr. W. J. Goodwin and his tiercel. The falcon is carried hooded until the game is located, then the hood is doffed, the leash and swivel removed, and the falcon cast off

(Below, right) Unlike the true falcons, this European goshawk hunts ground quarry and kills by the vice-like grip of its piercing talons. The hood is not used on this hawk when looking for game in the field



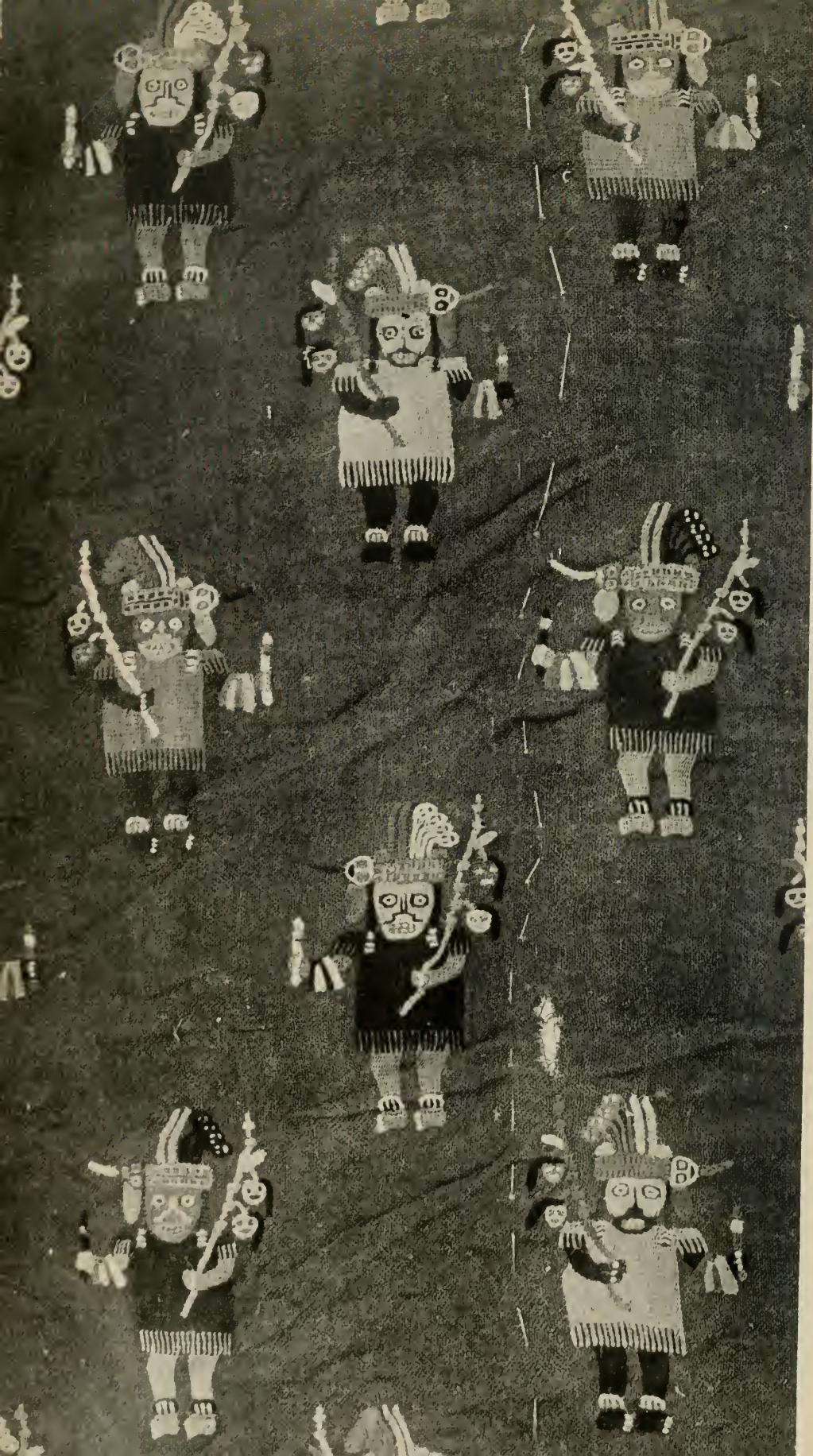


Brown Bros.

(Above) Falcons hooded and ready to be transferred to the cage. The hawks are hooded a little while before starting for the day's sport, to keep them quiet and conserve their strength. Falcons and hawks should be weathered daily, unhooded, on the block

(Below) Two peregrines and four merlins hooded and ready for a day's sport on the South Downs, England. The cage was especially designed by Captain Knight to fit in the back seat of his car when he wished to transport his stud to a distant field





Weaving in the Land of the Incas

The extraordinary artistic and technical products created in Pre-Spanish Peru

By WENDELL C. BENNETT

*Assistant Curator of Anthropology,
American Museum*

THE Spanish conquerors and colonists who entered Peru during the Sixteenth Century were not met by the traditional naked savage. On the contrary, the accounts of these early settlers and travelers are filled with descriptions of the elaborate costumes of the Inca upper classes.

The men wore beautifully designed cotton and wool ponchos (sleeveless shirts) augmented by a capelike mantle over the shoulders. Four-pointed woven hats, knitted caps, headbands or lacelike nets were used by the men, different styles of headgear designating rank in the society. A narrow loin cloth, sandals, and the inevitable woven carrying-bag completed the costume.

The women were described as wearing a cloth mantle from beneath the shoulders to the knees, secured at the waist with a belt. Additional shawls and a headband completed their costume.

The early writers did not elaborate too much on the variety of the Peruvian weaving, nor could they furnish much information about the pre-Inca periods. However, our knowledge of both these subjects does not depend upon the eyewitnesses. Fortunately, the dry desert coast of Peru has furnished evidence by preserving the most delicate samples of this weaving, even through the hundreds of years that have passed since the early periods of the Peruvian civilizations. Consequently, the specimens themselves reveal the achievements in technique and art of the ancient weavers.

The pre-Inca people of the coast of Peru buried their dead with considerable care.

A PERUVIAN TEXTILE

On the opposite page is a polychrome embroidery showing warrior figures in typical costumes, holding staffs to which trophy heads are attached

The bodies were tied in a flexed position, knees to the chin, and then wrapped with cloth. The finest shawls and mantles were included as parts of these multiple wrappings.

The bundle was finally covered with a coarser cloth, adorned with a stuffed false head, and perhaps with ceremonial sticks and dolls, and placed in a carefully prepared hollow tomb in the hot sands of the desert country. Logs covered the opening of the tomb and the sand was replaced above it. There in this oven-like situation the bodies dried out into natural mummies, and the cloth wrappings were maintained in an amazingly perfect state.

Highland climatic conditions

The highland section of Peru, in the lofty Andes, is subject to rather extensive rainfall, unfavorable to preservation of cloth. Even the most elaborately prepared tomb could not resist the dampness for many years. About the only large pieces of cloth excavated in the highlands were two Inca ponchos found by Adolph Bandelier more than thirty-five years ago on an island in Lake Titicaca, which lies between Peru and Bolivia on the high plateau. Doctor Bandelier found these two tapestries in a stone box, fitted with a stone cover, which made the preservation possible. Consequently, because of the contrasting geographic conditions, most of the textiles in museums today have been found in association with the coast burials.

The collections of Peruvian cloth have been examined by modern textile authorities (notably by Mr. M. D. C. Crawford for the American Museum's collections) which has resulted in detailed analysis and in unbounded enthusiasm for the skill of the pre-Spanish weavers. Cotton and wool were the basic weaving materials, plus a secondary use of maguey bast-fiber and human hair. The cotton was indigenous on the coast of Peru. The seeds were separated and the fibers

carded by hand and then arranged in cones, ready for spinning. The wool was obtained from the mountain camel-like animals, the llama, alpaca, and vicuña. The long, silky hair of the wild vicuña was especially prized for spinning the finest thread.

The contrasts in topography between coast and highland were sharp enough to permit sufficient isolation in the various regions for the development of distinct design styles, pottery types, and building techniques. Still, both wool and cotton were used in weaving in all periods of Peruvian prehistory, implying trade, because the cotton was a coast material and the wool came from animals whose habitat was the highlands. Even the earliest coastal textiles have a high percentage of wool thread. However, the trade was probably in raw materials, since the early coast designs show little influence of highland style.

The cotton and wool fibers, having been straightened, were spun into thread by a hand-twisting process aided by slender pointed spindle shafts on which were narrow bands of clay, bone, or metal. The work baskets of the weavers have been found in graves which contain all of the spinning and weaving tools. Besides the spindles, the baskets contain long bobbin shafts with raised carved figures on both ends to keep the thread from sliding off, balls of spun thread, small clay bowls in which one end of the spindle was placed as an aid in twisting, copper needles, and other instruments.

In spite of this elementary spinning process the resulting threads average about two or three times finer than modern machine spun thread from the same materials. Two or more single threads were twisted together to form a stronger yarn before being woven. Two- to seven-ply yarns have been found, but a single-ply was seldom used. Some of the yarns were dyed various colors but many were used in their original hues. Both brown and white cotton were cultivated, and the wool ranged through many shades of brown.

A primitive loom

The loom on which all these textiles were woven was a simple apparatus consisting of two horizontal bars to which the warp threads were attached, either directly or by means of an additional heavy cord. The upper bar

was attached to a tree or to stakes, and the lower bar to a girdle which encircled the back of the weaver. Thus the weaver could increase or slacken the tension on the warp threads by leaning forward or backward. This type of "girdle-back" loom is definitely established by the archaeological record, as well as by actual specimens. An early Chimú picture vase from Chicama, on the northern coast of Peru, bears a scene of weavers, all of whom are using "girdle-back" looms.

Even in modern times the use of the old type looms has persisted with but minor changes, and one can still see Peruvian Indians weaving, although without the versatility and skill of their ancestors. Finally, a study of textiles made by Miss O'Neale and Doctor Kroeber at the University of California has shown that most Peruvian textiles are less than thirty inches in width, and that wider pieces have either been sewn together, or skillfully loom-joined so that they could be woven on the narrow looms.

The weaving process

Weaving consists of passing weft threads back and forth through sheds formed by separating alternating warps. In the Peruvian loom one shed was formed by a flat stick, or weave sword, which, when turned on edge, separated alternating warps, and the reverse shed was formed by lifting a round stick (heald rod) to which the opposite set of alternating warps was attached by means of a looped cord. This was for weaving plain cloth or solid color band decoration. More complex design, which involved special groupings of warps, was inserted in small sections, the sheds being separated with a short pointed stick or weave dagger. This was the basic technique of all the weaving, although various specialties will be described later.

With this simple spinning and weaving apparatus the Peruvians produced not only quality but quantity of fabrics. Thousands of complete and fragmentary textiles have found their way to museums. How many thousands were destroyed by plunderers hunting for gold, even up to recent years, is unknown. The textiles made in the highlands and buried there have been destroyed by time and weather. Furthermore, it is said

that many fine textiles were sacrificed as part of religious ceremonies.

Many of the Peruvian fabrics are classed as plain cloth, that is, loosely beaten up weaves of individual or group combinations of warps and wefts. These fabrics are commonly without decoration or color, except for the natural shade of the yarn. However, some pieces were dyed in solid color. In our admiration for the elaborate designing of some fabrics, the large quantities of plain cloth are apt to be forgotten. Simple stripe ornament is a variant of plain weaving. Stripes of one or more colors were inserted as warp threads before the weaving was started, or wefts of colored yarns were woven in bands on plain warps. The combination of both warp and weft stripes produced a checkered pattern known as gingham.

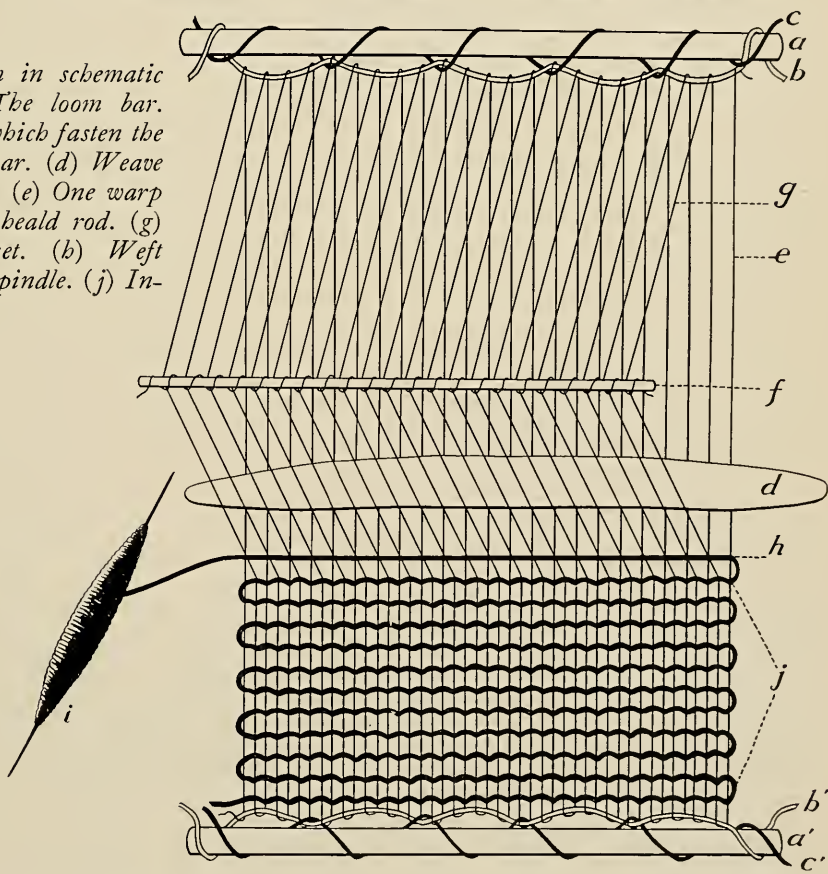
Plain cloth formed the basis for several types of designing. For example, designs were painted on a plain cloth surface, either free hand, or with stencils and stamps. Or a

plain cloth was bunched and tied with a waxed or clay-covered cord and then dyed. The coated cord resisted the dye and left a plain design on a colored background. This process is commonly called tie or resist dyeing. Plain cloth shawls were decorated with elaborate borders, or bands of other techniques. Finally plain cloth was used as the basic fabric for most of the elaborate embroidery.

Tapestry technique

A tapestry, in the Peruvian textile group, includes any fabric in which the weft threads cross over and under equal units of tightly stretched warps, and in which the wefts are beaten up so that they cover the warps completely. The old Peruvians made very ambitious tapestries with elaborate designs. To insert a design each color must be woven back and forth only on the warps which it is to cover. Consequently, when two color areas join, they must be interlocked in some way

The Peruvian loom in schematic arrangement. (a) The loom bar. (b) and (c) Cords which fasten the warp to the loom bar. (d) Weave sword or shed stick. (e) One warp set. (f) Heddle or beald rod. (g) Separated warp set. (h) Weft thread. (i) Bobbin-spindle. (j) Inserted wefts



or a slit will be left. The Peruvians often left the slits open as part of the design effect, outlining a figure or unit with open slits. They knew several methods of closing the slits, however, the most common being the looping of alternating weft threads from contacting color areas about a common warp. Even curvilinear figures were effected in which wefts were made to cross warps at other than right angles by being beaten up more closely in one part than in another.

Respect for these tapestries is enhanced when comparisons are made with the work of other famous weavers, old and modern. According to Mr. Crawford the Gobelin tapestries seldom contain more than twenty warps per inch, while one Peruvian tapestry contained forty-two warps per inch and from 260 to 280 weft picks per inch. This is due partly to the spinning of the thread and partly to the weaving.

Pattern weaving

Design patterns in these textiles were also inserted by special manipulation of colored weft threads over and under arbitrary groups of warp. This is known as a weft pattern weave, or "bobbin" weave, since wefts are inserted with the bobbin itself. In many pieces the colored weft threads are brought to the front surface of the cloth only where needed to fit the design, and carried in loose floats on the reverse side. However, the Peruvian weavers were skillful enough to finish a pattern weave on both sides by planning a design which eliminated the necessity of floats. A similar effect was gained with colored warps instead of wefts. The warp threads were arranged in color bands on the loom, and a design was produced by special shedding which brought the desired colors to the fore. This latter technique, known as warp pattern weaving, was particularly common for designing belts, and the combina-

tions of sheds to produce a geometric design was reduced to a mathematical formula. Interestingly enough, this same technique of belt designing is still used by the Indians today.

In embroidery the Peruvian Indians achieved colossal effects. Embroidery is the addition of a needle-work design to a plain woven fabric. Copper and silver needles with the ends bent over for eyes, and pierced fine thorn needles have been found with which this work was done. Even decorated cane and reed needle cases are found. The technique of embroidery is not basically difficult, although it requires delicate skill and tremendous patience. There is no necessity for following the weave pattern in applying needle work to a fabric, and consequently the complexity and variety of design are almost unlimited. The amazing part of the Peruvian embroidery is the large areas which are solidly covered with polychrome needle designs of ornate figures. In some of the Nazca and Paracas embroideries units of complex mythical animal figures are repeated again and again with machine-like accuracy.

Some samples of needle work show stitches that follow the weave pattern, much like the samplers designed for pillow covers today. These are apt to be confused with the true brocades. The basic difference is that a brocaded thread is added during the actual weaving of the fabric. These additional ornamental threads are more loosely beaten up than the regular wefts and consequently stand out like needle work. The brocaded thread need not follow the regular over and under weave pattern, but may be manipulated to appear on the face of the fabric only where needed in the design. True brocades are common in the Peruvian collections.

The gamut of weaving techniques known to these pre-Spanish artisans need not be described in detail, although the experts have



A design from an Early Chimú vessel which is now on exhibit in the British Museum. Here

marvelled at the versatility of the weaving tricks known. True gauze is common, in which the adjoining warps are twisted one half turn about each other between each insertion of weft. Knitting, crocheting, and special forms of needle work such as pile knotting and tubular weaves, are not uncommon. A typical refinement is found in the so-called "double" cloth, in which two sets of parallel warps and corresponding wefts of contrasting colors are used. The wefts alternate from one set of warps to the other to produce designs. The finished piece has the same design on both sides, only in reversed colors, and except where the designs interlace the two webs are separate.

The actual specimens confirm the costumes described by the early chroniclers. In the various geographical and cultural regions there was considerable variation in the costume details, but the pattern was essentially the same. Painted figures on pottery as well as embroidered figures on textiles also augment and confirm the historical and specimen record. Aside from clothing, the spinning and weaving technique was used for other purposes. Large pieces of cloth were used for hangings, even on the walls of some of the coastal tombs. Coarse, stuffed textiles were used as sleeping mats. Fringes and tassels, cords, nets, and slings are common archæological finds.

Textile designs have had considerable influence in the ornaments applied to other media. In some periods the ceramic and textile designs are quite distinct, but in others, such as the early Nazca, the same mythical animal figures appear in both groups. Quite apart from this use of the same figures are groups of ceramics in several periods that have designs which in their geometric repetition appear to have been copied from textile patterns. It is impossible to be certain about the sequence of application of a design style, but the painted pottery

designs bear such a close resemblance to the woven figures that they are commonly called "textile pattern."

Textile designs were probably applied to the carved stone figures. In the highlands of Bolivia where climatic conditions are unfavorable to the preservation of such fragile material as cloth, our whole knowledge of textile patterns is based on a study of the fine incised designs on stone statues. The incised design areas on the statues are so arranged that they appear to represent clothing. We know that the highland style spread to the coast in the middle periods of Peruvian archæological history, and there tapestries are found with designs which are virtually replicas of the incised statue decorations. A decorated stone gateway at Tiahuanaco has a series of running figures in the design pattern which suggests, from coastal textile counterparts, a representation of a tapestry hanging. Likewise on the coast of Peru where adobe is used in place of stone for a building material, wall arabesques, combining relief and painting, are patterned after textile designs.

Archæological significance

To the craftsman the Peruvian textiles are of interest for the technique and skill which they display. The art student is interested chiefly in the designs and their treatment. Both of these studies depend only on the collection of textiles, *per se*. The archæologist, however, is interested in the chronological problem involved, which demands a rather detailed account of the excavation of the graves which contained the textiles and considerable information about the pottery and other artifacts associated with these graves.

The prehistory of Peru has been divided into several periods, largely on the analysis and isolation of distinct ceramics. The



weavers with "girdle-back" looms, bobbin-spindles, water jugs, and design patterns are depicted

following summary gives a simplified picture of the present sequences, which fall, roughly speaking, between the beginning of the Christian era and the Spanish invasion of 1532.

EARLY PERIODS: Early Nazca, south coast of Peru; Early Chimú, north coast of Peru; Classic Tiahuanaco, Bolivia. A period of intense styles, with elaborate designs of a realistic nature.

MIDDLE PERIODS: Epigonal periods on coast of Peru. An influx of highland Bolivian (Tiahuanaco) influence on the coast of Peru, with following local developments, which generally trend toward stylization.

LATE PERIODS: Late Nazca (Ica); Late Chimú, Decadent Tiahuanaco. Further differentiation in geographic regions but generally toward geometric design.

INCA PERIOD: Inca geometric patterns and characteristic artifacts follow their political spread over all Peru and Bolivia.

The identification of textiles with these various periods has been done largely by analogy of fabric and ceramic designs. This is principally because there are very little data in existing textile collections. On the north coast of Peru, for example, no textiles have been positively associated with Early Chimú ceramics, in spite of the tremendous collections of the latter. About the only extensive study of this subject has been made by Lila M. O'Neale and A. L. Kroeber (*Textile Periods in Ancient Peru*, University of California publications in American Archaeology and Ethnology, Vol. XXVIII, 1930-31). From this we learn many interesting things about Peruvian weaving.

Basic characteristics of weaving

First, there are a number of rather basic characteristics of the weaving art that occur in all periods and thus unite, rather than differentiate, Peruvian prehistory. Cotton and wool were used in all periods, as before stated. Most all wool (warp and weft) fabrics come from the early periods, which shows that the trade of raw materials, coastal cotton for highland wool, had an early start. All fabrics were woven on the girdle-back loom, or on smaller looms. Furthermore, no changes can be detected in the loom-type throughout the various periods, which implies that the textile technique of the early periods was as fully developed as at any of the later times. The dyes appear in every period, although the combinations of colors which typify a region or period may vary. Finally, virtually

all techniques of weaving appear in Early, Middle, and Late periods, although the emphasis changes considerably. That is, the weavers of one period selected a technique which they chose to emphasize, but their adherence to this technique was not because of lack of knowledge of the others.

The Early period (referring to Early Nazca and a special variant of it found at Paracas) is characterized by elaborate embroideries of complex animal figures, in which the needle work covers large areas of the fabric. Three-dimensional knitting is found only in this period, while tie-dyeing and double cloth is practically absent. The design is largely of a realistic nature.

The Middle period introduces ambitious tapestries composed of design elements which have become stylized, that is, have utilized elements of realistic figures in a pattern design. Double cloth is characteristic of the Middle periods.

The Late periods place the emphasis on gauze, brocade, and pattern weaves, although tapestry and double cloth is still common. Tie-dyed and painted cloth are typical. The textile style, like the ceramic style, emphasizes geometric design.

Inca and Spanish weaving

In the Inca period weaving became formalized into quantity production, with a corresponding reduction of design to mechanical geometric patterns. Weaving of ponchos persisted well into the Spanish times, as is witnessed by the use of gold and silver threads, and the incorporation of European figures, geometric, human and animal, into the design. Actually the art of weaving has never died out and modern Indian weavers are still to be seen, although their products are now rather ordinary blankets for home use.

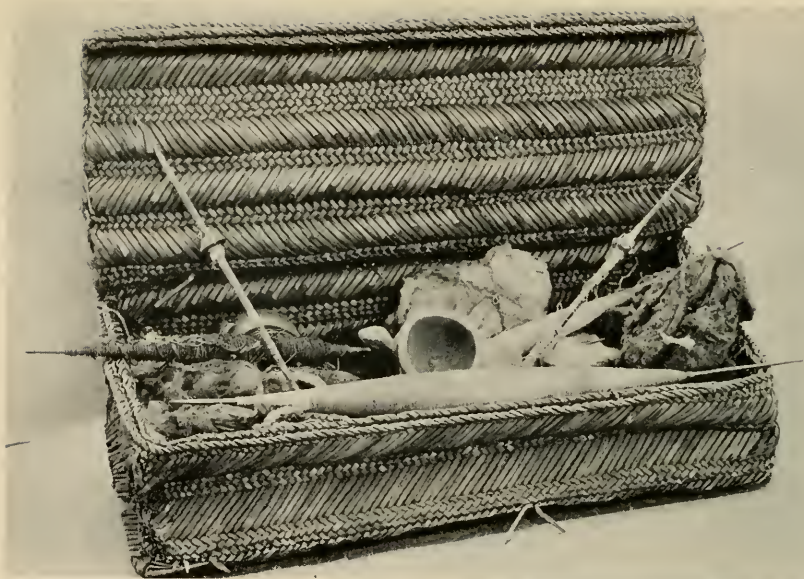
The textile art of the Peruvians is one of the finest examples of the achievements of that civilization. A thorough appreciation really demands seeing and examining the numerous examples in museum collections. While the Europeans checked the further development of indigenous culture in Peru by introducing a higher energy civilization, the products of the loom still stand as one of the great artistic and technical accomplishments of the world.



A MUMMY BUNDLE FROM THE COAST OF PERU

The dessicated body, in flexed position, is wrapped in fine cloth inside the large bundle. The false bead on top is for decorative purposes.

Dolls, woven bags, and ceremonial sticks decorate the bundle. Most of the Peruvian cloth is found as mummy wrappings

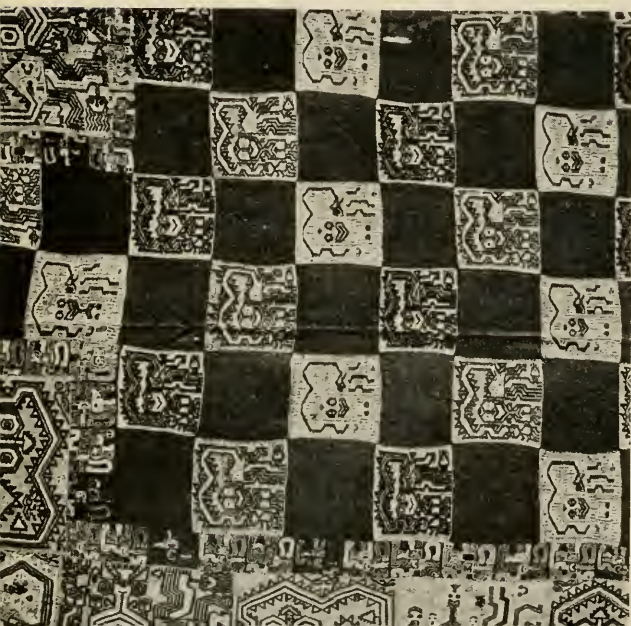


(Above) A woman's work basket containing spindles, bobbins, carded fiber, and other materials for spinning and weaving

(Right) The girdle-back loom is still used by men and women weavers in Peru

(Below, left) An elaborate example of Paracas type solid polychrome embroidery in the private collection of the Canal brothers

(Right) An excellent tapestry from Pachacamac, Peru, with slits left open between color areas as part of the design, in the so-called Kelim technique



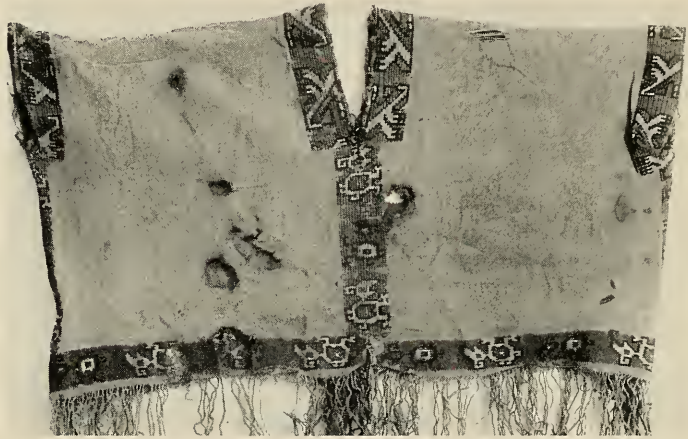


Above, left) A weft pattern weave in polychrome design for breech cloth

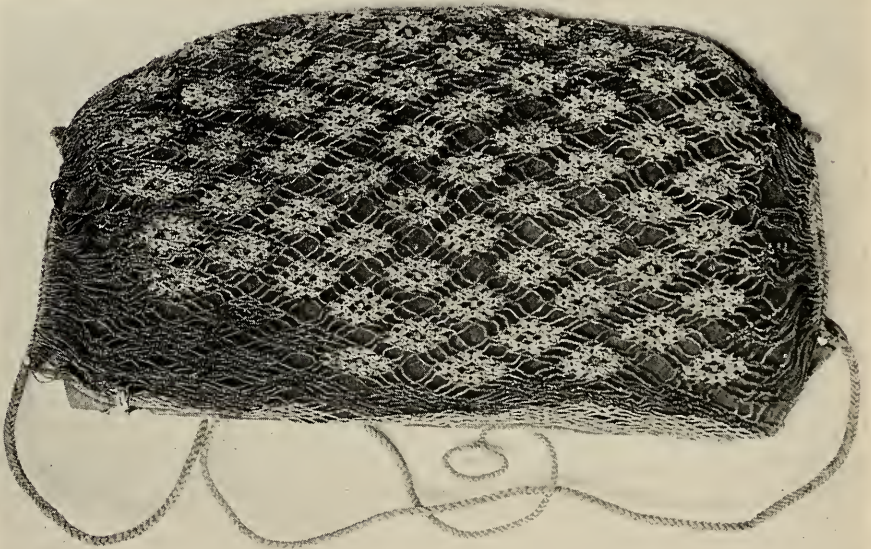


Right) A double cloth in brown and white with bird design

Right) A complete poncho-armorment with needle work decoration around the borders



Below) A netted cap of maguey bast-fiber for the head. Similar caps have actually been found on the heads of mummies





(Above) Inca pottery which illustrates the application of textile designs to ceramics

(Right) A wall of La Sentinela ruin at Chincha, Peru, with a relief design that is a direct copy of a textile design

(Below) Incised design of a running figure on the waist of a stone statue found in the bigland Bolivian site of Tiabuanaco. Similar designs have been found in coast tapestries and indicate that the incised designs on the statues probably represent clothing



Friday Harbor's Nets and Dredges

Harvesting marine life from the waters of Puget Sound for study at the Biological Laboratories of Friday Harbor

By HARRIET GEITHMANN

"I've got a little animal in my pocket," muttered a stranger at the door of Prof. Trevor Kincaid's office in Johnson Hall at the University of Washington, as we sat talking about the pioneer days of the Oceanographic Laboratories at Friday Harbor. "I found him in a can of cocoa."

The zoölogist who has made himself dear to the hearts of thousands of students as well as to the general public took a good look at the tiny frog which the stranger proffered him, then replied with that whimsical smile of his: "He is not a native of this country. Somewhere along the line of grinding up the cocoa he hopped in. As far as poison is concerned, you could swallow a dozen like him and it would do you no harm, but it might prejudice you a little against that particular can of cocoa."

A perfect location

Just an incident in the crowded day of this scientist, the real daddy of Friday Harbor's international fame today as an ideal place for the study of oceanography.

He, it was, who had the vision more than thirty years ago to choose Friday Harbor in the tawny San Juans of Puget Sound as the perfect location for a biological station, because of the wealth of marine fauna and flora readily available in the neighboring waters.

Time has but confirmed the wisdom of his choice. This pioneer in science personally directed the research work at Friday Harbor from 1910 to 1914; then along came the Japanese or-Pacific oyster to claim a goodly slice of his time.

In Professor Kincaid's footsteps followed that friendly and famous botanist, Dr. T. C. Frye, who took over the reins of government

at Friday Harbor and put fifteen of the best years of his life into its development as a marine station.

Due to the prescience and persistent efforts of these two scientists, was the sound foundation of the field laboratories at Friday Harbor laid. On this groundwork, the past five years, under the directorship of Dr. Thomas G. Thompson, professor of chemistry, have witnessed greater progress in the field of marine research than in the preceding thirty years of plucky pioneering.

About one hundred miles northwest of Seattle lies Friday Harbor on the rugged shores of San Juan, the second largest island in the San Juan Archipelago, 172 isles populated with people, pixies, and sea parrots, 57 varieties of enchanted islands bounded on the north by the Gulf of Georgia, on the west by the Canal de Haro, on the east by Rosario Strait, and on the south by the Strait of Juan de Fuca, that ocean lane over which travels the commerce of the world via the Pacific.

It was on San Juan that a tempest in a teapot was staged in 1859, one which threatened forthwith to plunge two of the greatest nations on earth into war.

On San Juan the Union Jack, emblematic of British authority, floated for the last time within Uncle Sam's domain. Here, Lyman A. Cutler, an American frontiersman, shot a British pig bent on rooting up his potato patch.

Boundary lines

On the heels of this shot which echoed through the evergreens on San Juan and reverberated in Pall Mall of London and on around the globe, a shot which but precipitated an old boundary question, military events crowded one another; finally, in 1872 England and America buried the hatchet, after Kaiser Wilhelm, grandfather of the

present royal woodchopper at Doorn, decided that the boundary line ran through the Haro Strait to the west where the water is 100 to 190 fathoms deep instead of Rosario to the east where it is less than 50 fathoms deep.

The death of the British porker simply stirred up the question of boundary lines and the ownership of 172 tawny isles instead of "1000 desolate and volcanic islands" as one of the senators called them derisively while the tempest raged and he was thinking in terms of "every inch and acre up to 49 or war."

Garden of the sea

Today the weather-beaten blockhouses and barracks remain to tell the story of the soldiery that once trod the forest trails of San Juan in the making of international history. Today, he who saunters along the beaches of Friday Harbor's "unique garden of the sea" may discover not only starfish ranging in color from lavender to purple and lemon to orange, sea urchins and sea anemones of every hue, and giant kelp, but also he may even stumble across military buttons which once adorned the uniforms of those British and American troops who occupied the island during that long and famous fracas.

On this historical island are the field laboratories of the University of Washington's Oceanographic Laboratories some two miles from Friday Harbor, the county seat of San Juan County.

And why the name of Friday Harbor? More than eighty-five years ago some 1300 sheep were being herded by a Kanaka for the Hudson's Bay Company on Bellevue Farm in the smiling valleys of San Juan. When an English boat sailed into the harbor, the Captain sent a messenger to the old Kanaka to ask him the name of the harbor. He did not know. Then they asked for his name. "Friday," he replied; whereupon the Captain said, "I'll call this Friday Harbor." Subsequent efforts to change the name to Bellevue have luckily failed. The Hawaiian sheepherder's name clings to this romantic spot.

Through the faithful efforts of Dean Herbert T. Condon, the present campus of 484 acres at Friday Harbor, formerly an old military reservation, was deeded to the

University of Washington by Act of Congress in 1921. This campus, with its two miles of indented shoreline, commands a view that is immense, — the Cascade Range and Mount Baker, that snow-crowned volcano all but asleep, which loom up beyond the glistening channels of the San Juan Archipelago. Approximately \$100,000 worth of buildings, six laboratories of concrete and hollow tile with red tile roofs shining among the evergreens, a library of 4000 volumes, a stockroom, a dining and social hall, and the director's and curator's cottages skirt the shoreline.

Open the year round for investigation, and every summer for a session of nine weeks from June to August, are Friday Harbor Laboratories. Here more than one hundred independent investigators and students hailing from all points of the compass congregate every summer and fill up the colony of tents. The gathering of the clans represents many states and foreign countries, men and women who work out their individual problems in oceanographic zoölogy, botany, chemistry, and bacteriology.

Emigrants from Puget Sound

Allied with Friday Harbor and backing up all its activities are the main Oceanographic Laboratories on the campus of the University of Washington at Seattle, an imposing three-story Gothic structure of brick dedicated in 1932 to the field of oceanographic research by the eminent physicist, Dr. Robert A. Millikan. It stands on the shores of Portage Bay, which links Lake Washington with Lake Union, from which the Lake Washington Canal with its upper and lower government locks, second in size to those of Panama, lead the way out to Puget Sound and deep water.

This building, which houses the offices of Doctor Thompson, is interested primarily in the fact that 70 per cent of the world's surface is water. Beneath its roof are numerous aquaria built of soapstone and glass, through which circulates a constant stream of sea water from the Strait of Juan de Fuca, — 60,000 gallons which were brought in on a huge scow and poured into the storage tanks of concrete from whence the centrifugal pumps force it up through the hard rubber pipes of the building and into

the various aquaria. En route the water is cooled to 9° C. the average temperature of Puget Sound.

In these tanks is many an emigrant from the waters of Puget Sound, the San Juan Archipelago and beyond: bristling sea urchins of all sizes carrying shells on their spines, sea anemones of all colors, some of which look like fuzzy cauliflowers in an alabaster vase or an Edam cheese, or a girl's beret trimmed with ostrich plumes or flowers of vivid hue, hermit crabs living in the homes of snails, soft-shelled clams in sandstone, demure as white leghorn hens, pop-eyed flounders that sweep across the bottom of the tank with the pride of a peacock, scallops gallore, teredos operating on sawed-off sticks of wood and piling up sawdust, demonstrating that they can eat right through a wooden ship, giant barnacles six inches tall and four inches thick, working overtime in their crusty homes, spider crabs, baby octopuses, shrimps and brilliant starfish and seaweeds.

Here the scientists have a rich opportunity to study oceanographic life at first hand in the various laboratories dedicated to chemistry, botany, zoölogy, bacteriology and physics. In order better to accommodate these various laboratories, the corridors circle the outer side of the building, an excellent feature.

The laboratory boat

A stone's throw away floats the "Catalyst," or laboratory boat, a seaworthy craft which also was completed in 1932 and dedicated to oceanographic research. All Doctor Thompson has to do when he wants to confer with Capt. C. T. Larsen is to cross his office and shout out the window, "Oh, Captain." Presently the skipper strides in, a sturdy Norwegian-American mariner who was chosen from 397 applications for the responsible post of commanding the "Catalyst." Since 1903, the Captain has been sailing out of Seattle on windjammers, famous ships of both sail and steam over all the seas that encircle the globe. For twelve years his good wife sailed with him.

With the skipper is associated Louis Mortensen, a Danish-American cook, who knows well the art of keeping up the morale of the scientists on a cruise, because the

Director believes that, if an army travels on its belly, so do the scientists. When asked if he could cook for professors, he tartly replied: "Oh, I've cooked for millionaires before."

Personnel of the "Catalyst"

The rest of the crew consists of Frank Melder, the engineer, a student of mechanical engineering with all the necessary papers to qualify him for the job, and the deck hands or students and professors aboard, for the "Catalyst" carries a total of sixteen.

This 120-horsepower diesel-driven research boat, already famous, is 75 feet long with an 18-foot beam. Its hull is constructed out of yellow Alaska cedar, its rib of oak, and all the trimmings fore and aft are of the precious teakwood. Amidships is the laboratory, 10 by 18 feet, fully equipped for oceanographic research work. Here is Dr. Clinton L. Utterback's own invention for the penetration of light in the sea, a regular octopus of cast-iron with two eyes, photo-electric cells, and a rubber cable 500 feet long in which there are several electric wires. Operated by the electric winch is a quarter-inch cable of stainless steel, one length 15,000 feet long, which is used for the sampling of both water and plankton.

The galley accommodates a gas range, a hot-water heater, and a refrigerator. It was around this friendly galley that a Haida buck was loitering suspiciously as the "Catalyst" lay anchored in the harbor of Skidegate in the Queen Charlotte Islands. The Haidas had entertained the scientists royally in their village, and in return Doctor Thompson invited them to visit the "Catalyst." The other bucks of the tribe were particularly interested in the engine room, and the squaws crowded into the galley, where the gas boiled water and manufactured ice at the same time.

"Keep an eye on that buck," Doctor Thompson warned Louis.

"Oh, I know what he wants; he's all right," returned Louis.

Finally, the curious fellow asked Louis, "What do you feed these wise men to make them so wise?"

When Louis told him that they ate salmon and codfish just like the Indians, he saun-

tered off profoundly disappointed. The pilot room, where the skipper has his bunk, his books, and his nautical instruments, is also the social hall.

Dedicated to oceanographic research

The "Catalyst," which operates out of Seattle from October to June and from Friday Harbor the rest of the year, has a cruising radius of 3000 miles, all of Puget Sound, both the inland and outside passages to Alaska and to the south of Cape Flattery. Already has this laboratory boat sailed more than 20,000 miles and called on some 2000 different stations in its brief career of investigation of the North Pacific waters, working in each station from three to four hours, sampling the water and plankton, dredging and harvesting specimens of marine life.

Many a person asks, "Whence comes the name of 'Catalyst'?" While the Director explains it scientifically thus, "A catalyst is a substance which will alter the speed of a reaction without itself undergoing any change," perhaps the most graphic explanation comes from Mrs. Robert A. Millikan: "When an Arab chieftain died, he left his three sons 17 horses, $\frac{1}{2}$ of the horses for the first boy, $\frac{1}{3}$ for the second boy and $\frac{1}{9}$ for the third. The question arose about the division of the horses. Another Arab solved the problem by adding a horse to the 17 so that the first son got $\frac{1}{2}$ of 18 or 9, the second $\frac{1}{3}$ or 6 and the third $\frac{1}{9}$ or two which made a total of 17. The Arab's 18th horse was the catalyst."

To the Rockefeller Foundation, the Pacific Northwest is indebted for not only the Oceanographic Laboratories on the campus of the University of Washington but also for the "Catalyst," moored at the dock in Portage Bay, the two staunch allies of the field laboratories at Friday Harbor, a generous legacy for the use of all scientists, north, south, east, and west.

"And don't forget the staff," added Doctor Thompson.

There are Dr. John E. Guberlet, who is concerned with fish diseases, embryology, and the general distribution of marine organisms in the sea; Dr. Bernard S. Henry, who is primarily interested in sea bacteria, which is practically a new phase of bacteriology; Dr. Robert C. Miller, who has traveled the world over in his study of the teredo and the distribution of zoo-plankton; Dr. Earl R. Norris, who is concentrating on the biochemistry and particularly the distribution of vitamins in marine organisms; Dr. Lyman D. Phifer, who is interested in phytoplankton; Dr. George B. Rigg, who is interested in the physiology of marine plants; Dr. Clinton L. Utterback, who is famous for his work in the penetration of light in sea water and the study of other physical phenomena in the sea; and genial Forrest Fuller, the curator at Friday Harbor who is responsible for the maintenance of the buildings and grounds.

The chemistry of the sea

Both Doctor Thompson and Dr. Rex J. Robinson are particularly interested in the chemistry of the sea and the nature of the ocean currents. These men keep the "Catalyst" cruising, and the laboratories at Friday Harbor and on the University of Washington campus busy as beehives working overtime delving into the private life of the teredo and the barnacle, a menace to maritime commerce, the starfish and the shrimp, the pop-eyed flounder and the hermit crab, dredging the bottom of the sea, adding page by page to the world's book of scientific knowledge on oceanography, and justifying year by year the pioneer dreams of the founder of the present field laboratories at Friday Harbor, Prof. Trevor Kincaid, and all the other scientists who have dedicated both time and energy to those dreams which have finally come true.

A Biological Station in Puget Sound

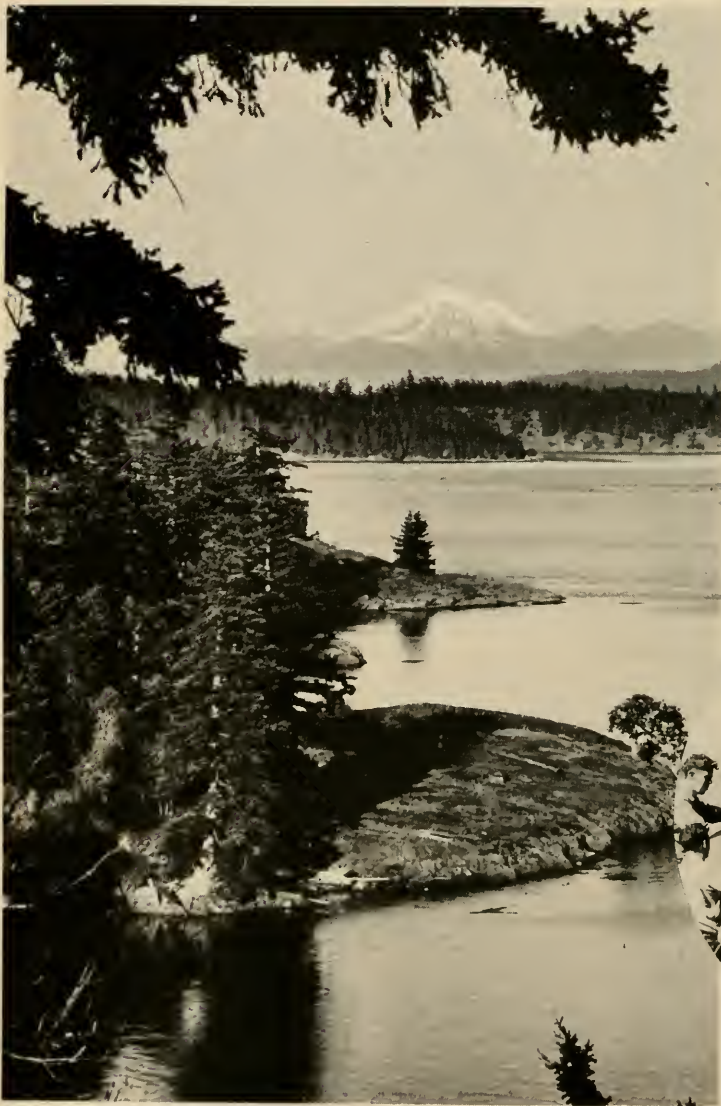
Dr. Robert C. Miller examining a specimen which has been brought up from the sea in a plankton net

Friday Harbor in the San Juan Islands of Puget Sound is an ideal location for a biological station, for the neighboring waters abound in marine fauna and flora. Photograph by J. A. McCormick



Scientific Collecting Amid Scenic Beauties

From the site of the Oceanographic Laboratories at Friday Harbor may be seen the snow-covered volcano of Mount Baker, which is pictured in the photograph below. The present campus of the Laboratories includes 464 acres, with two miles of indented shoreline. Photograph by J. A. McCormick



Dr. T. G. Thompson, the director of the Laboratories, waiting at the cable to report the filling of bottles with samples of water from the ocean depth

(Below) The dredge, heavily loaded with marine specimens, is enthusiastically greeted by the Laboratory students





Dr. Clinton L. Utterback preparing to lower his cast-iron octopus, his own invention for measuring the penetration of light in the sea.



Frank Melder, the engineer, at the controls which raise and lower the nets, — a real job, for the "Catalyst" carries almost three miles of cable



Louis, the cook, views the harvest of the dredge, spread out on deck. Along the deck house may be seen the storage tanks for live specimens from the sea

*(Right) A view of the Oceanographic Laboratories at Friday Harbor in Puget Sound
(Below) The laboratory boat "Catalyst," which was completed in 1932 and dedicated to oceanographic research*





A pipe fish caught in Puget Sound. It is a relative of the sea horse

(Right) Captain C. T. Larsen with a 500-pound porpoise which was harpooned just outside Cape Flattery and west of Vancouver Island



(Below) Playmates at Friday Harbor. The young son of two laboratory students getting acquainted with a baby seal



Science in the Field and in the Laboratory

American Museum Activities, Expeditions, Education, and Meetings of Societies

Edited by A. KATHERINE BERGER

The cover picture for June "Natural History"

The June issue of *NATURAL HISTORY* bears on its cover a sketch drawn by George F. Mason, which shows a white gyrfalcon breaking its speed after striking. The feathers flying were apparently ripped from the head or neck of its victim.

The flight of the gyr is marked by an appearance of power befitting its size and shape, and combines in an extraordinary degree swiftness, and ability to turn readily. When taught to wait on, it does so in majestic style, often at a stupendous height; so great is the vehemence with which the gyr flies and stoops, that the quarry is struck down with a blow so violent that it is either killed outright or stunned by the shock.

The Third Scarritt Expedition

Through the continued generosity of Mr. H. S. Scarritt, the work of the Scarritt Expeditions will be resumed this summer in a new field. The first Scarritt Expedition in 1930-31 and the second in 1933-34 were both directed to Patagonia, where large collections of very ancient fossil mammals were made.

The third expedition will also seek early fossil mammals, but this time in Montana. The region to be visited has yielded the oldest known remains of primates, fossil lemurs that represent the earliest mammalian ancestry of man, and the expedition hopes to add to knowledge of these extremely important and still very little known creatures, as well as to collect other primitive mammals.

Ever since the founding of its department of vertebrate palæontology, the American Museum has made special efforts to investigate and collect the earliest mammals, especially those of the Palæocene epoch, and the coming expedition will fill an important gap in its collections, which already are incomparably the best in the world.

Like the first two Scarritt Expeditions, this one will be under the leadership of Dr. George Gaylord Simpson of the Museum staff, who will be accompanied by Mr. Albert C. Silberling, a Montana collector. Mr. Fenley Hunter, a Life Member of the Museum, is also contributing to the expedition and, it is expected, will accompany it for a month.

The Hispaniola Expedition

A letter dated April 26 from W. G. Hassler of the department of herpetology, American Museum, an-

nounces the safe arrival of the Hispaniola Expedition at Port au Prince, Haiti. Preparations were immediately made to explore St. Marc's, and from there the party journeyed to the cotton plantation of Dr. H. D. Barker of the Agricultural Service. At the time of writing, they were living at the Sugar Company's quarters and working the cotton field out in the dry plain about eight miles distant.

One interesting development so far is a collection of live material, including an adult iguana with a young one, and a baby crocodile, which has formed the nucleus of an exhibit of local reptiles, installed by request at the Agricultural College, Damien. Several tables in the main hall of the building are laden with jars and aquariums of snakes and lizards, and the big iguana is tied in a corner, where it can wander about in some grass and rocks that have been provided for it. A label over the exhibit indicates that the animals were collected by the expedition, and that at the conclusion of the exhibit, they will be sent to the American Museum.

A number of tourists and townspeople have already viewed the exhibit.

Morden Expedition for Hawaiian Fishes

The William J. Morden collection of Caranx-like fishes made in Honolulu this spring, comprising several species belonging to four genera, has proved of value in connection with a study of the taxonomy and considerable age changes in this group, which is being carried forward in the American Museum.

This Hawaiian material has already been used in the preparation of a *Novitates* in which it is shown that one form, the so-called "akule," ranges from Hawaii to Japan, as distinguished from a related form in the Philippines; and in which an allied form from the South Pacific is described as new. Young of the "ulua," which, when adult, is one of the most important Island food fishes, are now being examined critically. This species is closely related to the "horse-eyed Jack" of the Bahamas, but seems to grow differently, certain characters which differentiate the two becoming noticeable in it at a length of six or eight inches.

The fishes, preserved in formalin, then wrapped in oiled paper and sent to the Museum by parcel post, arrived in excellent condition. Mr. Morden found that native names were not very serviceable in distinguishing closely related kinds, those of a certain size and character in general being known by one name irrespective of species. When he returned to New York, he made arrangements for further material desired, to be shipped to the Museum as the season advanced and it became available.

During the summer months the radio programs given over Station WOR under the auspices of the Amateur Astronomers Association will be discontinued. It is hoped that they may be resumed in the fall. During June the programs will be as follows:

June 4 — THE STORY OF TELESCOPES — Arthur Draper
June 11 — THE HAYDEN PLANETARIUM — Clyde Fisher
June 18 — SEEING THINGS WITH OUR BRAINS — John J. O'Neill

Noted astronomer dies

Dr. Edwin B. Frost, director emeritus of the Yerkes Observatory, died on May 14 at the age of 68. Although blind since 1920, he had carried on with enthusiasm his astronomical work, including occasional public lectures. His autobiography, *An Astronomer's Life*, published in 1933, was reviewed in NATURAL HISTORY for November, 1934, by Dr. Clyde Fisher. One of the asteroids or minor planets was discovered by him and afterward named "Frostia" in his honor.

Planet notes for June

On June 22 at 2:38 A.M. (Eastern Daylight Saving Time) the sun reaches the summer solstice. This marks officially the beginning of summer in the northern hemisphere and winter in the southern hemisphere. Mercury, during the first part of the month, will set about an hour and a half after the sun, but later in the month it will be in the morning sky, rising about an hour before the sun. Venus continues to be most brilliant during this month, setting about three hours after the sun. Mars sets about midnight, and will be in conjunction with the moon on June 10. Jupiter sets about three hours after Mars. It is particularly interesting that at this time the half circle of the Ecliptic can be traced across the heavens from Jupiter in the east, through Mars overhead, and Venus in the west. Saturn rises as a morning star during this period about the time that Mars sets.

Astronomical gleanings

The various stars composing the beautiful and well-known constellation, the Pleiades, do not, as has been believed, have a common motion. By a comparison of two photographs made through the same telescope, — one recently, the other nearly seventy years ago, — it is discovered that each member of the cluster has a motion independent of the rest.

* * *

Einstein's theory of relativity has received another bit of verification at the hands of an American astronomer who has been studying Class O stars, the most massive stars known. Einstein's theory predicted that the spectra of such heavy stars should be shifted appreciably over toward the red end. This has been found, observationally, to be the case.

* * *

Dr. V. M. Slipher, director of the Lowell Observatory, states as a result of recent researches that the earth would look *blue*, could we view it from outer space.

CITY COLLEGE: On May 22nd the American Museum's department of education, in coöperation with the staff of the department of education of City College, entertained about 100 students from the upper junior and lower senior classes of the College, and members of the faculty.

WASHINGTON IRVING HIGH SCHOOL: The entire student body and faculty members of Washington Irving High School enjoyed a Museum Day on the 23rd of May. Under the guidance of the American Museum's educational staff the students visited several exhibition halls and viewed special motion pictures.

RADIO TALKS: The weekly radio talks over station WNYC have been continued and will last through June. These talks, given every Thursday at 5 P.M. by Messrs. John Saunders and Robert Coles, have been followed by free public tours of the Museum exhibits mentioned.

SUMMER COURSES IN NATURAL HISTORY: Two intensive out-of-door courses in natural history will be given during July and August by the Division of General Education of New York University under the sponsorship of the American Museum of Natural History and the garden clubs of Long Island. The instructors will be Miss Farida A. Wiley, staff assistant in the department of education at the American Museum of Natural History, and Mr. George T. Hastings, chairman of the biology department of Theodore Roosevelt High School. Headquarters for the courses will be at the State Institute for Applied Agriculture at Farmingdale, Long Island, thirty miles from New York. Further information as to dates, fees, and content of courses may be obtained from Miss Wiley.

VISIT OF CRIPPLED CHILDREN: On April 25 about twenty-five crippled children and adults from Montefiore Hospital made their annual visit to the Museum. This is arranged for yearly by Mrs. Max Binswanger, a member of the American Museum, and is always pleasantly anticipated by both the patients and the nurses who accompany the group. The Museum trucks were used for transporting the chair- and bed-patients, who, upon arrival, were taken on a general tour of the Museum. After a special luncheon provided by Mrs. Binswanger the group saw several Museum films.

CRAFT WORK: The American Museum has coöperated with the American Institute of New York City in offering a course in craft work for boys and girls of high school age. Miss Agnes G. Kelly of the department of education has given the spring course which consists of instruction in the technique on gathering material and preparing exhibits. Among the crafts that have been taught are modeling, casting, and the construction of observation trays, insect mounting boards, and bird houses. Other institutions offering similar courses sponsored by the American Institute are the New York Zoölogical Park, New York University, and the Brooklyn Children's Museum.

TEACHER TRAINING: On March 4 the Museum's department of education, in coöperation with the department of education of the College of the City of New York, introduced a new phase of teacher training. Under the supervision of Mrs. Ramsey and Miss Mastin an intensive three weeks' course of classroom observation, practice teaching, and special museum techniques is given to groups of senior students. These students are

assigned to the Museum by the College faculty in charge of the practice teaching ordinarily done in the public schools of the city of New York. The first course was so favorably received that two additional courses were given, and it is planned to make this new feature an integral part of the college work.

BEAR MOUNTAIN TRAILSIDE MUSEUMS: In May Bear Mountain Trails and Trailside Museums opened for the ninth season. They are maintained and operated jointly by the American Museum of Natural History and the Commissioners of Palisades Interstate Park, and are under the immediate supervision of Mr. William H. Carr, assistant curator in the Museum's department of education. In all, there are now five Trailside Museums in the fifty-seven acre area, and separate structures for botany, zoölogy, geology, crafts, history, and archaeology. Two and one half miles of labelled outdoor nature trails acquaint visitors with the broad natural history features of the Hudson Highlands. The Trailside Zoo has been extended, and a large, circular snake pit displaying snakes, turtles, and lizards has proved a popular spot. During the past eight seasons, more than 2,000,000 people from all parts of the world have passed over the trails. A cordial invitation is extended to all members of the American Museum and their friends to visit the Nature Trails and Trailside Museums during the coming season.

International Nature Photography Exhibition

COUNTRY LIFE, Ltd., an English publication, has announced an international exhibition of nature photography, to be held in the "Whale Hall" of the British Museum (Natural History), London, S. W. 7, from October 16 to November 30, 1935.

This exhibition is being arranged by *Country Life* and is intended to show the best of Nature Photography from its inception. It will be confined to birds and mammals photographed alive and in their wild state, and it is hoped that the exhibition will be the largest and most comprehensive of its kind ever held.

There is no entrance fee, and the number of photographs that can be sent is not limited; neither must they be the sole work of the exhibitor. No distinction will be made between amateur and professional.

The latest date for receiving entries is August 31, 1935. Entry forms and full information may be obtained from *Country Life*, 20 Tavistock Street, London, W. C. 2.

Sequoias

On page 392 of the May issue of *NATURAL HISTORY* is a statement that *Sequoia sempervirens* grows in Sequoia National Park, California. On the opposite page is a beautiful photograph reported as illustrating the same species of tree. *Sequoia sempervirens*, however, is found only along the sea coast. The photograph really shows *Sequoia gigantea*, which does grow in Sequoia National Park.

Samples of dust on exhibit

Recent accessions in the department of geology at the American Museum include samples of dust from Kansas, Colorado, Texas, and Oklahoma. This year's dust storms in the central Great Plains area have been unprecedented, and many farmers have been obliged to abandon their farms. Letters received from corre-

spondents state that many daylight hours have been turned into absolute darkness. In some quarters the dust blew 50 per cent of the time during the months of January, February, March, and April; in the Panhandle of Oklahoma it is reported that there was but one pleasant day in ten.

It is impossible to keep this dust out of the houses, and numerous cases of "dust pneumonia" have developed.

Additional samples of dust are solicited for the exhibit, which is now on view in the foyer of the American Museum. — CHESTER A. REEDS

The Castillo Cave Model

A small scale model of the famous prehistoric Castillo Cave at the village of Puente Viejo in the Pas valley of the Cantabrian mountains of northern Spain has recently been installed in the Archaeological Hall, Southwest Pavilion, on the second floor of the American Museum.

The model measures 3.5 feet in width by 3.5 feet in height and is 12 feet long. Its frontal aspect shows the position of the cave on the steep slope of the Castillo peak, some 400 feet above the valley floor, and a camp scene staged at the entrance suggests the type of hunting life lived by the occupants just before the cave was abandoned in Late Palæolithic times.

Along the twelve-foot sides of the model, openings are provided to show several interior portions of the cave. Thus, nearest the front appears the partly excavated 50-foot section of stratified culture debris, made up of twelve separate layers as laid down by the prehistoric occupants in the entrance chamber to the cave during an interval of time comprising probably several tens of thousands of years. The culture history represented by these layers is the most complete single record ever discovered and, named in order from bottom to top, includes the Chello-Acheulian, Mousterian, Aurignacian, Solutrean, Magdalenian, Azilian, and Early Neolithic stages.

Directly back of the debris-filled entrance chamber, vacated when standing room failed, a full view is to be had of the "grand gallery," where Palæolithic artists are seen at work making additions to the animal paintings scattered about on the cave walls. This large chamber with a nearly smooth and level dirt floor seems especially suited for dances or other ceremonies which may be supposed to have been performed in connection with the sympathetic magic rituals of which the paintings are thought to have been a part, the purpose being to bring good luck in the hunt of the animals represented.

Still farther toward the rear are to be seen portions of the narrower cave passages leading on for several hundred yards back into the heart of the limestone peak. The proof that early man visited these inky black avenues of the cave is a scattered succession of wall paintings, suggestive of the plant and animal life of that early day. Bones of the same now partly extinct animals, it should be said, are found also in the culture debris in the front part of the cave, so that the time at which the animals lived is certain.

The Castillo Cave was discovered in 1903, and the immense task of excavation was carried out during the decade 1910 to 1920 by Professor Hugo Obermaier, under the auspices of the Institute of Human Palæontology of Paris. During the progress of excavation, the cave was visited by many distinguished scientists from all parts of the world, including Prof. Henry Fairfield

Osborn of the American Museum. Owing to his inspiration, Curator N. C. Nelson of the department of anthropology was privileged to spend part of a summer at Castillo, taking part in the work. It was on that occasion that the necessary measurements and data were obtained for the construction of the model which, with the help of Mr. Nelson, has been executed by Basil E. Martin of the staff of the department of preparation, under the general direction of Dr. James L. Clark and Mr. Albert E. Butler.

Honors

Mr. Clifford H. Pope of the American Museum staff attended the annual meeting of the American Society of Ichthyologists and Herpetologists which convened at Pittsburgh on May 2, and was elected president of the Society for the year 1935-1936, succeeding Dr. Carl L. Hubbs of the Museum of Zoology, University of Michigan.

Dr. James P. Chapin, associate curator of continental Old World birds, American Museum, was honored at the annual dinner of the National Academy of Sciences, April 23, by being awarded the Daniel Giraud Elliott Medal for 1932, and an honorarium of \$200.

This honor was conferred in recognition of Doctor Chapin's work entitled "The Birds of the Belgian Congo, Part I," which was published in the *Bulletin of the American Museum of Natural History*, as Volume 65, 1932. It comprised 756 pages and 220 illustrations and maps.

A fifteen-foot whale shark

Mr. Charles T. Wilson, of New York City, a member of the American Museum, has presented to the department of fishes the skin of a fifteen-foot whale shark which he helped capture at Acapulco, southwest coast of Mexico, in March, 1935.

Dr. E. W. Gudger, associate curator, has been studying the whale shark for many years, and when he heard of this capture he got in touch with Mr. Ralph L. Smith of Mexico City, who previously had supplied him with much data on whale sharks from Acapulco. Mr. Smith, acting as agent for the Museum, purchased the skin and supervised its shipment to New York.

When Mr. Wilson learned of the scientific value of this skin and of Doctor Gudger's interest in it, he kindly sent a check covering the cost of the skin and its transportation.

Mr. Wilson's generous action puts the department of fishes in possession of one of the greatest of ichthyological rarities. This is the seventy-seventh whale shark recorded since the first specimen was captured at the Cape of Good Hope in 1828. There is an unmounted skin in the U. S. National Museum at Washington; there are old and inaccurately mounted specimens in the British Museum and the Paris Museum, and others in the Colombo (Ceylon) and Madras Museums. In the Naturhistoriska Riksmuseum at Stockholm, there is a modern mount of a skin obtained at Acapulco in 1934.

A rare tuna

The "dog-tooth tuna," *Gymnosarda nuda*, has a very wide distribution from the Red Sea and Japan across the Indian and Pacific Oceans. It is, however, rarely

met with except in remote waters, and is little known to the angling fraternity. Hence, and in view of the present considerable interest in tuna fishing and different kinds of tunas and related large mackerel, an excellent photograph of one taken by the Templeton Crocker Expedition off Pitcairn Island December 29, 1934, on the yacht's trolling line, is worth mention. It was 44 inches long and weighed 43 pounds, which must be nearly of maximum size, and it must have been about at the southeastern edge of its range. — J. T. N.

Changeable colors of fishes

While cruising in Florida waters in April, Mr. J. T. Nichols, curator of recent fishes, American Museum, made some interesting observations regarding the changeable colors of fishes. These are presented herewith:

"Where the Gulf Stream sweeps the east coast of Florida, there is a concentration of many different fishermen, human and otherwise.

"Solemn brown pelicans flap above the waters of Biscayne Bay. Now one turns suddenly down wind and plunges headlong after a small fish. Here and there a black cormorant or white royal tern flies by, and a tall, watchful heron stands in the shallows.

"Beyond the keys the bright green water over the reefs and sand turns abruptly to deeper blue where the bottom dips under the edge of the Stream. Now and then little groups of flying fishes glisten for a moment in the sunshine above the waves, and this is where one finds kingfish, sailfish, and marlin, and the swift, predacious blue and yellow dolphin, with colors so changeable that they defy description.

"The colors of such free-swimming fishes in general are less bold and patterned than those of species which lurk among the coral, and their color changes, therefore less obvious, make detailed and accurate descriptions or reproductions of these colors all the more difficult.

"In the course of one April morning we had several sailfish hooked. As they fought and leaped, their sides shone uniformly bright silver in the sun, but those of one landed were immediately smoky brown. Another time we caught a cero mackerel with steel-blue back, and when a second one was secured a little later we were surprised that its back was bright greenish, the launch without our realizing it having meanwhile run from the edge of the deep blue into the edge of the shallow green water."

Buffalo Museum opens a new hall

A new Hall of Man was formally opened at the Buffalo Museum of Science on the evening of April 4, the American Museum being represented at the function by Curator N. C. Nelson of the department of anthropology.

The unique exhibits there assembled aim to explain the human body as a machine, and consist chiefly of models (of glass, cellon, and other substances), many of which can be manipulated by the visitor so as to show the elementary facts of anatomy and physiology, and incidentally to teach some of the basic lessons of hygiene and sanitation.

The display is the only one of its kind in this country, some of the models being derived from a similar museum in Dresden, while others were designed by the Museum's own director, Dr. Carlos E. Cummings.

Reviews of New Books

Stars, Radio, Travel, Plants, Bird Portraits, and Archaeology

PROGRESS OF ARCHÆOLOGY. By Stanley Casson. *Whittlesey House, New York, 1935, pp. 111, 43 illus. \$2.00.*

SINCE the world war, archæology has enjoyed a burst of activity and a popular appreciation beyond anything it had previously experienced. Though no one has enumerated the actual number of field parties engaged in shoveling away the accumulated débris of hundreds and thousands of years, I venture to guess that the post-war annual average would run up to several hundred. With such activity, at almost feverish pitch, it is to be expected that new discoveries of exquisite art, the unfoldings of cultural developments, and the prehistoric connections of vanished people would be announced in bewildering succession. Each new bulletin from the archæological front has obscured its predecessors. Mr. Stanley Casson, therefore, has performed a service of the greatest value by summarizing in brief form the significant advances made in post-war archæology. He has covered the world and the results of scores of diggings in a hundred pages. His account, therefore, is necessarily brief and rigidly selective.

For the specialist this book will be useful for its summary of other fields. For the lay reader, it is a fascinating description of an appealing adventure — the tracing of man's own cultural development. Mr. Casson has sketched the setting and significance of each discovery that he describes so that the reader may follow the progress without a detailed knowledge.

— H. L. SHAPIRO

WHEN THE STARS COME OUT. By Robert H. Baker, *New York: The Junior Literary Guild and The Viking Press, 1934.*

DR. ROBERT H. BAKER, professor of astronomy in the University of Illinois, has written a star book for boys and girls and for grown-ups who are beginning their study of the sky. It is a most attractive volume with its silver and blue cover and a jacket by Artzybasheff. It is copiously illustrated by line-drawings and half-tones, the latter being in blue ink, very appropriate for astronomical photographs. The end-papers show nine phases of the ever-changing moon on the dark blue of the night sky.

Professor Baker's textbook, *Astronomy*, has for years been familiar to college students and teachers of astronomy, and it is an excellent, modern treatise, dealing with the broad scope of the subject from the dawn of the science to the physical tests of relativity. With this in view, it is gratifying to find that the author belongs to that rare group who can turn from his profound studies, and write a book which "not only accuracy governs, but imagination inspires."

We had some idea of Professor Baker's ability to popularize astronomy from his many radio talks on the subject, which have been enjoyed and praised by so many of his countrymen, both young and old. In the book, *When The Stars Come Out*, he has put into per-

manent, accessible form, his own introduction to a study of the stars, — not technical, but a readable book that will stimulate one to want to know more about the heavenly bodies and their movements, and to achieve something of the satisfaction of understanding the causes of things.

I noted but one slip in the entire book, and that is on page 134 where the distance of the nearest fixed star, Proxima Centauri, is given as "25 million miles," instead of 25 million million or 25 trillion miles.

Like the good teacher that he is, he continually connects the new information or explanation with past experiences. For example: "That is why the moon appears more rugged near the sun-rise line, as we view it with the telescope, and flatter in regions where the sun shines down more nearly directly. As everyone knows who drives a car, rough places in the road ahead look rougher at night when the headlights illuminate them from the side than they do with the sun shining down upon them."

In this book his explanations are always non-technical. In the chapter, which gives the title to the volume, he says:

"It is really the air around us that hides the stars in the daytime. If anyone lived on the moon, which has no atmosphere — so, of course, no one can live there — he could see the stars in full daylight. We cannot see them when the sun is shining, because the air catches the sunshine and sends it down from all directions, flooding the whole sky with a brighter light than the stars give."

When The Stars Come Out is a valuable addition to the juvenile books on astronomy, and will certainly appeal to Boy Scouts, Girl Scouts, Woodcrafters, and members of Junior Astronomy Clubs in these days of revival in interest in the heavenly bodies. — CLYDE FISHER

PLANTS OF THE VICINITY OF NEW YORK. By H. A. Gleason, *Pb.D. Published by the New York Botanical Garden. 1935. \$1.65*

HERE is the most compact botanical hand-book that I have ever seen. About five inches wide by about seven inches long and about a half-inch thick, it contains workable keys to all of the ferns and flowering plants found in the territory around New York City. The author states that it includes most of Long Island to the east, and extends as far as the Highlands of the Hudson on the north, the New Jersey mountains on the west, and the Pine Barrens on the south. Except for a few rare species, it will serve well for all the region within two hundred miles of New York City.

It is not intended for the trained botanist, but for anyone else who wishes to learn, by his own effort, the name of any wild flower, tree, or fern growing in the territory about New York.

This is accomplished partly by the elimination of most of the technical terms generally used in manuals of botany, and by defining the necessary ones in a brief glossary. The characters used for determining a plant

are almost always those visible to the naked eye. The common name of the plant is placed first, the scientific name being secondary. In short, the keys have been so simplified, and yet they are so carefully worked out that one can usually identify a plant in a very few minutes.

The book is really a *multum in parvo*, and because of this fact should have wide use. The author, Dr. H. A. Gleason, is head curator of the Museums and Herbarium of the New York Botanical Garden, where he has had access to the extensive local herbarium, an indispensable prerequisite. — CLYDE FISHER

BIRD PORTRAITS IN COLOR. Text by Thomas S. Roberts, M.D. Minneapolis. The University of Minnesota Press, 1934.

THIS useful book consists of the ninety-two colored plates from "The Birds of Minnesota" by the same author (1932), with a page of text for each plate. Since most of the plates figure several species, the text is necessarily brief, but considerable information about each bird is condensed into the available space. Notes on distribution, habitat, food, habits, nests and eggs, and song are discussed as space permits. Although only the birds found in Minnesota are figured, two hundred and ninety-five in number, there is mention made of many related subspecies from other parts of the country and the book may serve a wide area in eastern North America, outside the bounds of the state of Minnesota.

A brief characterization of each family precedes the account of the species of that family and a comprehensive index lists the birds under various of their vernacular names as well as by their scientific ones.

The plates, by Allan Brooks, Francis Lee Jaques, George Miksch Sutton, Walter Alois Weber, Walter J. Breckenridge, and Louis Agassiz Fuertes are rather unequal in quality and some of the colors have not been reproduced with perfect accuracy (as for instance in the crown of the ovenbird); but the average is high and the series in general presents excellent portraits of the species represented. Seasonal, sexual, and developmental variations in plumage are given more than usual attention, which fact adds much to the value of the pictures. Comment on the plates, however, belongs properly in a review of the larger work where they first appeared.

Although too large for the pocket, the volume is slender and can find a place in the equipment of many excursions where it should be useful as an aid to the identification of the birds. — J. T. Z.

RADIO ROUND THE WORLD. By A. W. Haslet; Cambridge University Press, London; Macmillan, New York; Marusen Company Ltd., Tokyo, 1934, 8 vo. \$1.50.

THIS little book of 196 pages gives the history of radio transmission and explains many a puzzling problem concerning radio waves, which are of special interest to the radio amateur, engineer, physicist, geologist and astronomer, and of general interest to the radio listener.

Those individuals who possess a radio, or listen to one, and that includes most people in the civilized world, marvel not only at the small instrument with its complex of wires, condensers, tubes, etc., but at the clearness of its reception, its range and the delight it affords of a direct communication with a distant station. When the program does not suit our taste, how easy it is to turn the dial to another position and receive a different

program, or change the coils and listen to London, Paris, Madrid, Berlin, Caracas, Guayaquil, or Buenos Aires.

Not infrequently we hear radio announcers speak of "a nation wide hook-up" or of one broadcasting station asking another to "stand by" or "take it away," as when New York is calling "Little America" at the Bay of Whales, Antarctica.

Whether the message is received through a series of relay stations or direct by short wave set, we marvel at it all, and wonder how it is possible. Sometimes the reception is not good, and we immediately ask why it is poor. This little book explains these features and tells you how it is possible for New York to communicate by air with "Little America" ten thousand miles away or for London to talk with New Zealand.

This book also tells you that the radio wave is like light yet different, and how it gets around the world. It demonstrates how its power waxes and wanes in daytime and at night, in winter and summer, and during the sun's slow cycle of changing activity. It explains the Heaviside and Appleton layers which not only appear high in the atmosphere, but change their positions in the course of the day and serve as "mirrors" for the reflection of radio waves as they are transmitted through the air. The sun's ultra-violet rays and their effect on wireless conditions as well as the absence of these rays during a total eclipse are also discussed. Mention is also made of the effect of intense magnetic action caused by the appearance on the sun's surface of sunspots. This phenomenon is cited as being responsible for two periods of silence in the radio communications with General Nobile during his Polar flight in the ill-fated airship "Italia."

It also states that man cannot hope to abolish atmospheric, and explains the why and wherefore of this phenomenon. It discusses, too, the great problem of fading, and the use of "ultra short" and "micro" waves in practical radio, such as television and the treatment of disease. The radio beacon and direction finder, which are serviceable to ships and airplanes at sea, as well as the use of radio in weather forecasting, and the significance of the radio valve or tube, receive due consideration.

In fact, this book gives us the why and wherefore of radio, which is of no little interest in this age of radio achievement. — CHESTER A. REEDS

HANDBOOK OF TRAVEL. Prepared for the Harvard Travellers Club. Edited by George Cheever Shattuck. Second Edition, Revised and Enlarged. 510 pages, 16 figures, and inserted graphic table. Harvard University Press, 1935.

INCREASING mobs of thoughtless tourists invading regions that were utter wilderness a generation ago do not alter the fact that there are still large numbers of thoughtful travelers and many out of the way places for them to visit.

This handbook, originally published in 1918 and now so extensively rewritten as to be essentially a new book, is primarily addressed to those who travel beyond the reach of train and liner schedules and to those who wish their journeys to be useful and intelligent, wherever they may go. The modern explorer, a professional thoroughly trained for a specific scientific task, will need no such assistance in his own field, but he, too, can profitably turn to the handbook for guidance in planning work in regions new to him or for making supplementary observations outside his own specialty.

As in any work by numerous authors — there are thirty-nine in this case — the quality is uneven. The chapter on llama transport appears to break the rule, otherwise well followed, that the author have personal knowledge of his subject. The omission of any consideration of map-reading is striking, and there is no helpful reference to simple compass traverses, sketch mapping, and similar operations within the powers of the average traveler and often essential to him. On the other hand, an elaborate instrumental traverse is outlined, involving the use of bulky, expensive, and delicate apparatus, beyond the powers of any but a trained surveyor (who would not turn to this work for this information), and necessitating the organization of a party definitely for surveying. At the other extreme, the section on reindeer transportation is equally out of place in the handbook, being a personal travel tale with only incidental reference to reindeer and of no conceivable assistance in making plans. Such failures to record just the sort of information that will be sought in the handbook are, however, few, and the whole work is competent, most of it excellent.

Procedures and precautions

The discussions of means of travel, forming the first section of the book, include almost every known means of transportation from walking to airplanes, with the obviously justifiable omission of trains and ocean liners. In most cases the information given is sufficiently explicit and full to permit anyone to plan his transportation intelligently and, what may be more important, to keep it going, witness, for instance, the valuable notes on preventive and curative care of pack animals. There follows a section on camping, with discussions of tents, clothes, and all sorts of camp equipment and supplies, as well as notes on hunting, fishing, and edible wild plants.

The information on photography is sound and so well condensed that it includes more that is actually useful in the field than do most manuals of photography. References to miniature cameras are accurate, but seem unjustifiably lukewarm. In the reviewer's opinion, these are the ideal cameras for just the class of traveler that will use the handbook.

The sciences of travel, geography, geology, zoölogy, botany, anthropology, and meteorology, are all ably discussed from the point of view of enabling the amateur to make original observations and collections. The importance of such work can hardly be overemphasized. At the least it adds purpose, interest, and comprehension to any traveling, and it may result in discoveries of real importance. Furthermore the planning and direction of detailed, professional scientific work depends to a larger extent than is generally realized on indications originally received from travel for other purposes or for recreation.

Most of the section on hygiene, surgery, and medicine is by the editor and it ably condenses into little more

than a hundred pages all the precautions and procedures that are likely to be useful to a traveling layman and that he could safely carry out.

Almost all the chapters include bibliographies and references to more extensive and detailed information on the same subject. In a few instances, for example geology and geography, reference is to texts much less useful in this connection than would be available field books that are not mentioned, but most of the references appear to be well chosen. The handbook may well take its place as the coördinating volume of a practical travel library. Printed on thin paper in a convenient format, it is adapted not only to assist preparations for a journey but also to go along as a guide and companion in pocket or travel kit. — G. G. S.

DIARY OF THE ALARCÓN EXPEDITION INTO TEXAS, 1718–1719. By *Fray Francisco Céliz*. Translated by Fritz Leo Hoffman. *The Quivira Society, Los Angeles, 1935. pp. 124. plates X.*

In 1933 the diary of Alarcón's expedition to Texas was discovered, buried by inaccurate filing, in the Archivo General de la Nación in Mexico City. The account deals with an expedition dispatched to the present Texas, principally to discourage French expansion and secondarily to report on the character of the country. Alarcón fulfilled his mission successfully. Setting out from the Rio Grande he reached the San Antonio River where he established the present city of San Antonio. He traced the source of the Rio Marcos, explored the coast in the vicinity of Espiritu Santo, and advanced eastward almost to the Red River.

The diarist narrates an unadorned anabasis full of river fordings, religious celebrations, and the bestowal of holy names on unholy reaches of territory. It is to be regretted that he did not have a deeper interest in the Indian, for the opportunity was offered him to record what has long since been irretrievably lost, — the life of the savage. Nevertheless, the casual mention of various tribes is of value.

Alarcón's expedition makes an interesting footnote in the history of the Southwest. — H. L. SHAPIRO

Recent American Museum Publications

NOVITATES

- No. 788. African Muscidae. — III. By C. H. Curran.
- No. 789. Two New Genera of Cricetid Rodents from the Miocene of Western United States. By Albert Elmer Wood.
- No. 790. Taxonomic Notes concerning Arvicanthine Rodents. By Robert T. Hatt.
- No. 791. Four Hitherto Unrecognized Subspecies of African Rodents. By Robert T. Hatt.
- No. 792. Spiders from the Southwestern United States, with Descriptions of New Species. By W. J. Gertsch.
- No. 793. Descriptions of the Oldest Known South American Mammals, from the Rio Chico Formation. By George Gaylord Simpson.
- No. 794. Further Notes on American Lycosidae. By W. J. Gertsch and H. K. Wallace.
- No. 795. The Tiffany Fauna, Upper Paleocene. I. — Multituberculata, Marsupialia, Insectivora, and Chiroptera. By George Gaylord Simpson.

BULLETIN

- Volume LXVIII, Art. 4. Wallace's Line, and the Distribution of Indo-Australian Mammals. By Henry C. Raven.

Recently Elected Members

A REPORT from the membership department lists the following persons who have been recently elected members of the American Museum:

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Miss Susan P. Carr

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Messrs. Robert Le Moyne Barrett, Joseph M. Hartfield.

Sustaining Member

Mrs. Harrison Eustis.

Annual Members

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Misses Adele Buchsbaum, Ella Hunting, H. Kelly, Hermione R. Ketcher, Barbara Landis, Elizabeth McCalmont, Helen B. Russell, Helen Wheeler.

Rabbi Irving Miller.

Doctors Sidney Cohn, M. Downey, T. B. Enders, A. B. Muir, Henry J. Schireson.

Messrs. Henry B. Adriance, Marston T. Bogert, Anthony Bonura, Robert Livingston Cahill, L. Sprague de Camp, G. Edward Delano, Jr., William Etkin, John J. Finuchene, Ardo Hering, Walter M. Langsdorf, William B. Loery, Edward C. Lord, John R. MacArthur, Beverly A. Norris, R. B. Ray, Samson Rosenblatt, Leo Silverstein, Maurice M. Sternberger, Vance Stewart, John D. Thees, Jr., Saul Weil.

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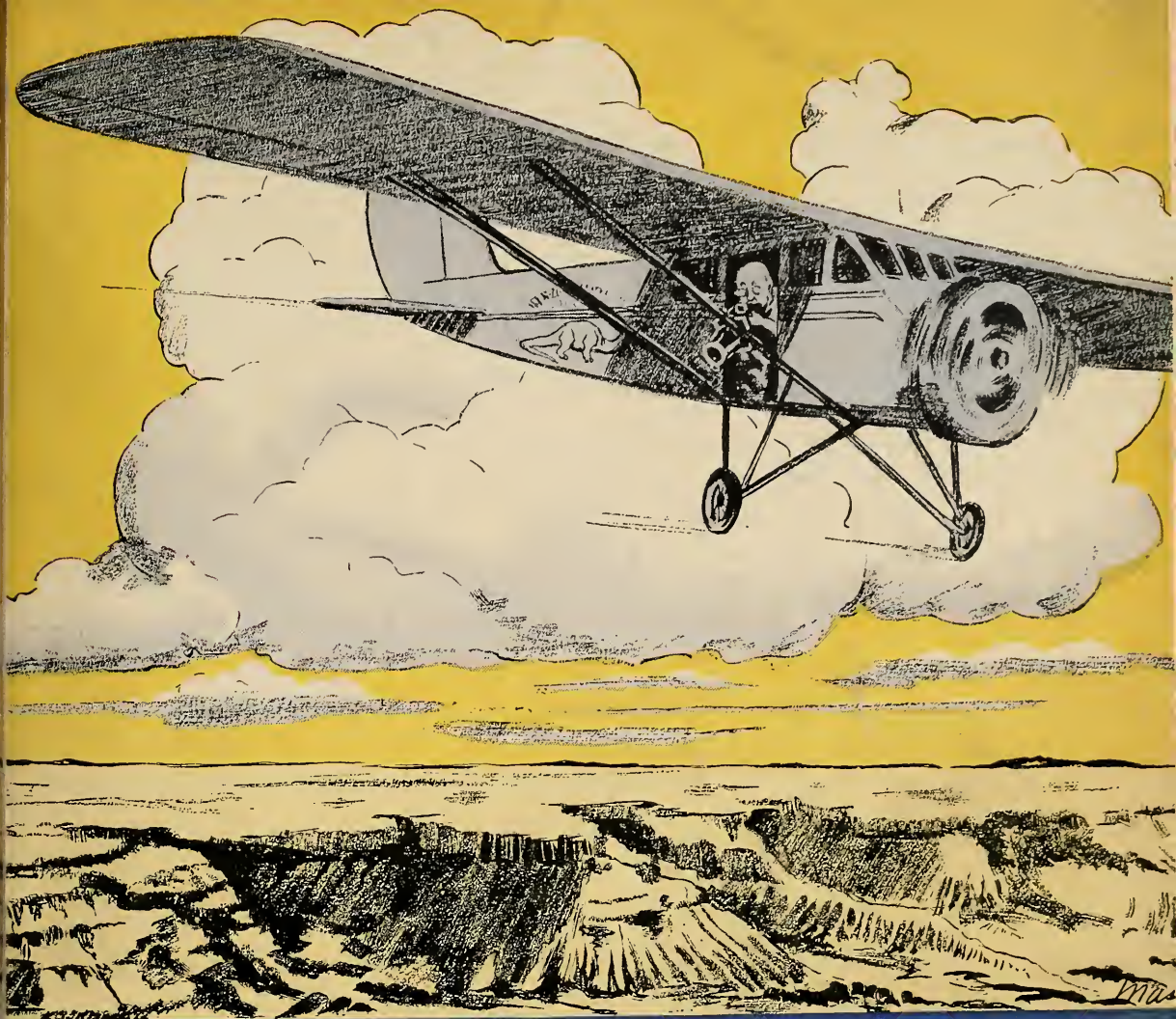
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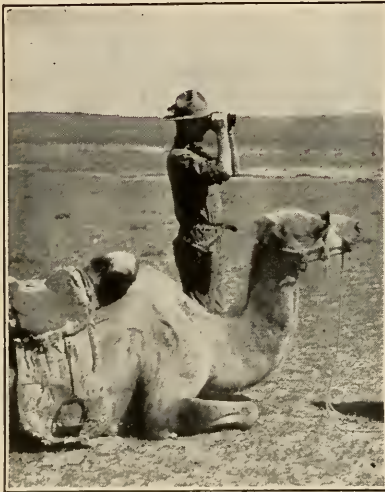
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NATURAL HISTORY

The Journal of the American Museum of Natural History

VOLUME XXXVI



SEPTEMBER 1935

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IN THE VALLEY OF THE BIG HORN

Sheep Mountain, near Greybull, Wyoming. Like a jewel on the bosom of Mother Earth this elongate lavaliereshaped mountain of white limestone rises

evenly from a crinkly sculptured base of shales and sandstones, colored red, white, blue, maroon, red, gray—the most beautiful panorama of the aërial journey

Flying for Dinosaurs

A 20,000-mile panorama. The most ambitious aerial fossil hunt ever attempted unveils new vistas of life and conditions on the American continent below the horizon of time

By BARNUM BROWN

*Curator of Fossil Reptiles,
American Museum*

[The illustrations in this article, copyrighted by Barnum Brown, are a few of the spectacular shots taken with Fairchild aerial cameras during Dr. Brown's aerial survey, in the course of which he and his parties took more than nine hundred photographs.]

Many especially promising fossil areas were discovered in Triassic, Jurassic and Cretaceous strata previously thought to be completely explored, and such areas were immediately checked by a ground survey. Complete exploration of these regions will require at least three seasons of work by field parties.

Other important discoveries made during this reconnaissance are a quarry of large dinosaur bones in a Cretaceous formation in which bones had not been previously reported; a fine ceratopsian skull and jaws; a mosasaur skeleton; an unreported meteoric crater; an unreported ceremonial way of Tenth Century age, and several new oil domes and structures not yet drilled.]

ALL good ships have appropriate names. Our ship was christened "Diplodocus" with a picture of the beast painted on the side for our talisman—also as a lure for dinosaurs under the ground.

During the last four years the writer has had frequent opportunities to test the value of airplanes in geological work. On trips between

Billings, Montana, and Denver, Colorado, when no other passengers were present, pilots would often deviate from the scheduled course, giving me an opportunity to study the Mesozoic strata where we were then working on the north flank of the Big Horn Mountains. With an intimate knowledge of the ground, I was thus able to establish the value of airplanes in fossil work.

Primarily, for an airplane to be most useful, one must have a previous knowledge of the characteristic features of the different formations to be examined. In most cases, with such information one can determine to complete satisfaction the continuance of strata, even where not exposed, or establish their lack of continuity. Rarely can one see individual fossils from the air, except occasionally with a field glass, but the features of structural geology as a whole are brought out in a way that can never be comprehended from a ground survey alone. The airplane opens up a new world to the geologist.

I had often discussed the possibilities of airplane work among associates and, when the matter was broached to officers of the Sinclair Refining Company, the proposal fell on receptive ears. In addition to funds for excavation work, this Company generously offered to supply me with an airplane for the time necessary to make required observations during the summer of 1934. I estimated we would cover about 8000 miles in the proposed aerial survey, and from previous experience calculated that the time beginning September 1 would best coördinate with excavation work at the Howe Dinosaur Quarry, so that I could carry on this investigation. Our flying base was Billings, Montana, headquarters for dinosaur field work during the past few years.

Before we left New York City, arrangements were made with the Fairchild Aërial Camera Corporation to ship us a 10-inch aërial camera, (I had negotiated unsuccessfully to secure the use of the Harvard University aërial cameras for our work), and much to my agreeable surprise, Weld Arnold appeared at our quarry the latter part of August with the complete Harvard aërial equipment, including the Fairchild 24-inch camera. This necessitated a rearrangement of the personnel but, fortunately, as circumstances developed, it gave us much greater latitude and enabled me to secure much finer photographic results than could have been obtained with the small camera alone.

I did not know who my pilot was to be, but the Sinclair people assured me he would be one of the best, and later I endorsed their judgment. Mr. D. A. McIntyre, of Tulsa, Oklahoma, was the pilot selected, and promptly on September 1 he arrived at Billings in his Lycoming powered Stinson. Knowing we would cover much mountainous country, I had stressed the necessity of having parachutes, and it was with considerable misgiving I learned from the pilot that no parachutes had been provided. He assured me that he did not feel the necessity of having them, but if required, they would be supplied later. After flying with Mac a few days, watching him maneuver his ship, I soon forgot about parachutes, and I firmly believe he could land his ship safely on any moderately flat ground lacking major obstructions.

Smoke palls retard photography

Our choice of September 1 proved to be unfortunate, as forest fires in Idaho and western Montana brought a pall of smoke over the entire region, making it practically impossible to take any reliable air shots in the Montana, Wyoming, and South Dakota areas where I wanted particularly to work. The smoke screen did not extend through the southern part of the Rocky Mountain region, and I decided to explore the Mesozoic rocks in southern Wyoming, Arizona, and New Mexico, and settle several doubtful geological problems in the South; then continue our northern exploration at the end of the season. This proved to be good judgment.

With all photographic equipment our load was more than two hundred pounds over

weight for safe flying at high elevations, and it was a problem what to sacrifice. Finally, after several trial trips over near-by mountains, all surplus film was left to be shipped when required.

In order to use the big 24-inch camera, one door of the ship was removed and the camera suspended by heavy straps from the frame of the ship. In this way the camera could be extended while shooting and withdrawn into the ship while traveling. After many trial exposures we found that the smoke pall had settled down to such intensity that it was practically impossible to get perfect results with any type of filter.

Crossing the Pryor Mountains, our early flights were made over the Howe Dinosaur Quarry, twenty-five miles northeast of Greybull, Wyoming, and the region of the Big Horn Basin. I never cease to wonder at the marvelous panorama of Sheep Mountain, with its indescribably beautiful series of colored strata on the flanks, and its diagrammatic sculpturing. It offers an exceptional opportunity to reconstruct the original folding that has been erased by erosion.

After photographing the quarry thoroughly, all of our party of excavators were given short trips in the air from the field at Greybull. The Big Horn Basin was too full of smoke for us to do more than casually examine the classic Wasatch Tertiary beds east of Cody.

An interesting feature of air work soon became apparent—that high peaks and impressive scenery as viewed from the ground, fade out into inconspicuous elevations when seen from high up in the air, while flat country of upturned strata assumes great magnitude.

Leaving the Big Horn region, we headed southward, flying over the low-lying southern rim of the Basin above Wind River Cañon. Familiar scenes spread out below us with the well known fossil fields and productive oil structures in the vicinity of Lander. The smoke screen still made photographic work unsatisfactory. Here we found new fields for future ground work and continued our flight to Rock Springs.

Maps of the various States showing regular and emergency landing fields had been secured, and with Mac's perfect control of the ship, and my knowledge of the ground over which we were flying, ordinary automobile maps were used in charting our course. We knew our

exact location during the entire flight, with one exception which I shall mention later.

Our usual height, unless in high mountainous country, or where storms interfered, was from 3000 to 5000 feet, an elevation at which I could make regional observations of the geology much better than on the surface. In these six weeks in the air we secured data that could not be duplicated in twenty years of ground work.

The Rock Springs area is one of great importance in historical geology, for here in the coal mines are found the largest tracks of dinosaurs so far discovered. Many of them found in the roofs of mines are gigantic in size; larger than could have been made by any dinosaur known from skeletons, but so far, no bones have been recorded from these middle Cretaceous strata. Where there is smoke, however, there is usually fire, and here some day will be found the largest dinosaurs that ever existed.

Newspaper accounts heralded our course. I found friends expecting us at every port, and we were able to investigate the reported discovery of fossil bones wherever landings were made. Frequently when grounded, while Mac overhauled the ship, I secured automobile or horses and prospected limited areas, sometimes covering two or three hundred miles—traveling well into the night before returning for the next day's flight.

At airports along the regular routes of travel we obtained exact information of weather conditions, but as a rule depended on Mac's maneuvering ability when we encountered storms. By this time we had shaken down to regular routine work, determining the vagaries of "Diplodocus" under all conditions.

Rock Springs, Wyoming, has a fine field, but air currents swoop down over the surrounding hills, making it a ticklish port for those not accustomed to its peculiarities. We



ROUTE OF FLIGHT

The American Museum-Sinclair Expedition in its aerial survey covered seven states and

20,000 miles from September 1 to October 15, 1934

followed the general course from Rock Springs to Salt Lake City at an elevation of 11,000 feet over the high Wasatch Mountains. Finding, however, that the Stinson labored hard with its heavy load over the regular route, we deviated considerably from the course in crossing.

Near Salt Lake City I wanted to obtain better records of the shore lines of ancient Lake Bonneville. By this time the air was sufficiently clear to enable us to make perfect pictures showing the different stages of recession of the great Pleistocene lake, which at one time covered a large part of Utah—the remnants of which are Salt Lake and fresh-water Utah Lake.

From Salt Lake City my intention was to cut eastward over the Wasatch and Uinta Mountains to the Dinosaur National Monument on the eastern border of Utah. The pass over the Wasatch Mountains, although at a high elevation, ordinarily offers no particular difficulties, but with our heavy load we circled many times in order to get elevation to clear the peaks. We finally decided that it was best to detour, following the general course of the railroad southward for some distance before taking an eastward course. We were busy, each with his own affairs—I following the map, Mac making his calculations, but in making the many circles we followed the wrong railroad. I could not understand why we did not pick up certain known points until suddenly off on the southern horizon I recognized San Rafael Reef. We were one hundred miles off our course.

An emergency landing

Gas was getting low when we realized our position and the nearest emergency field was Green River, Utah, forty miles away. Friends were there, we must land for gas, and there was no particular inconvenience, for this was one of the points selected for photographic work and geological study. We circled Green River a half dozen times, but there was no wind sock to be seen nor any sign of a landing field.

Finally I told Mac there was a fairly level stretch of sage brush four miles east of town where I thought we could negotiate a landing. Down we came on it, making a perfect three point contact—bumpy, of course, as sage brush

would be, but everything went fine for two hundred yards when suddenly the left wheel struck a gophered sage brush. With the increased weight shifting to that side, the wheel sank, breaking several spokes. Hopping along on the broken wheel for a hundred yards, like a maimed jack-rabbit, we finally came to a stop. We looked at each other without printable comment, for it was all in a day's work.

Friends at Green River saw us come down and came out to pick us up. With everything out of the ship, after a day spent in making repairs, we finally reached town where a good emergency field was found near the school-house. Evidently school children had destroyed the markers—if they ever had been placed. Where airplanes are rare and people not used to flying, few realize what a godsend to airmen in difficulties are the cross strips of a level field and a tattered wind sock.

A hairbreadth escape

On our course to the Dinosaur National Monument, a good field was marked at Price, Utah, and we approached it with assurance, but to our surprise and consternation the runways were covered with mule teams leveling the field. In spite of our circling and signaling, every man stopped in his tracks to watch our maneuverings. We had to have gas in order to reach Vernal, and land we must! One runway was covered with Russian thistles, but looked as though it had been used. It crossed a stream course that appeared to have been filled. From the air the ditch seemed to have been completely filled, and we came down on the end of that runway at sixty miles an hour, a perfect landing, but to our horror that ditch was fifteen feet deep. I would have lifted the ship, but Mac knew his business and held her to the ground. We leaped into the air twenty feet, we were told, landing on the other side of the ditch on the crippled wheel—smashing it to bits—nothing left but the hub. The ship bounded, staggered, pivoted, and finally came to a stop completely reversed. This was a major disaster, for there were no wheels in Price that could be used. It would take too long to secure another by train, and it was up to Mac to make another wheel, which he did, working night and day; using our own hub, the spokes from several Ford wheels, and parts of wheels from two old derelict ships.

While this repair was going on, an alleged airplane mechanic was instructed to overhaul the magneto. His proved to be a heavy hand, and a broken magneto point was the result. They say that accidents occur in groups of three—now our quota was complete. Finally we were in the air again headed for Vernal, but for two weeks I kept one eye on our vacillating rev-meter until the magneto mishap was eventually repaired. I learned what suspended animation or near heart failure really means.

The Dinosaur National Monument, seen from the air, is another rare sight. Here the upturned edges of Paleozoic and Mesozoic rocks lie exposed on the flanks of Split Mountain like the edges of book leaves—marvelous in coloring and extraordinary in their folding. Many million years of the earth's history are here recorded. At this historic spot many dinosaur skeletons have been excavated and more are to be uncovered so that they may be seen in their natural environment. We found the Emergency Relief Workers enthusiastic and doing a creditable piece of work under the direction of Dr. A. C. Boyle, Jr., the geologist in charge.

The Painted Desert

Finishing work at Vernal, we followed, in general, the course of Green River southward to the Grand Cañon section. In the region of the Painted Desert there is much geological data to be studied. The Triassic exposures in the Painted Desert have produced several valuable specimens in our fossil collection, and for many years it has seemed like going home when I returned to this Desert. In previous years, at Cameron, I had discussed with Hubert Richardson the possibilities of the flat desert as a landing field, so I telegraphed him to prepare a place for us to alight and to put up a wind sock.

It was a marvelous sight, as we followed the rough country southward from Green River around the La Sal Mountains, and cut through Moab, over Mexican Hat, above Monument Valley, El Capitan, and Kayenta. Soon Navajo Mountain appeared on the horizon, guiding our course southward. With a tail wind we were making fast time, and soon the well known landmarks of Red Lake, Tuba City, and the familiar terraces of the Little Colorado came into view.

Never could one forget the sight of Cameron from the air—surrounding red rocks and the swimming pool as green as copperas. Hubert, with the Navajos, had scraped the wind-blown flats north of Cameron, making one of the best landing fields found on our entire journey. One had the impression of landing on a feather bed. Hubert was there to welcome us and, on account of the perfect field, we made Cameron headquarters for several of our lateral surveys, including Meteor Crater, Petrified Forest, the modern Hopi Indian villages, the celebrated Cañon del Muerto, and Cañon de Chelley.

Farmington, New Mexico, was our next headquarters while surveying the Cretaceous and upper Triassic beds in that general region; flying over the famous ruins of Aztec and the plateau of Mesa Verde. At this point Arnold left us, returning to Harvard, taking the 24-inch camera with him, while Mac and I continued our work using the 10-inch camera.

Finishing the Cretaceous and Eocene geological investigations on the eastern side of the Hopi Indian Reservation, we flew southward over the Chaco Cañon ruins, photographing "Bonito" and several of the near-by Pueblos, until Mac cautioned me that gas was getting low, and that we must restrict further maneuvers. We headed toward Albuquerque, and soon a startling object came into view. There below us was a perfectly straight streak, estimated two miles in length and fifty feet wide—part of it crossed by the heads of cañons; plain as a city street, and it had never been reported. I felt sure it was contemporaneous with, and related to the former inhabitants of the Pueblo ruins. I secured several pictures before heading for Albuquerque to refuel and continue on to Santa Fé, where the discovery was reported.

The Folsom Bison Quarry

Our next objective was to secure aerial pictures at Folsom, New Mexico, in order to make a contour map of the Folsom Bison Quarry—one of the keystones in establishing the age of prehistoric man in America. Mount Capulin and the lava country were quickly passed; storms delayed us two days at Colorado Springs, and then on we went to Denver.

The eastern flanks of the Rocky Mountains are too well known to call for special mention, but from Denver northward we were interested in securing additional information on

Jurassic exposures around the Laramie Mountains. It was with great satisfaction that I pointed out the spot on the face of Como Bluff where in 1897 I had taken out the first dinosaur skeleton excavated by an expedition from the American Museum. The section between Laramie and Casper disclosed new data and several favorable exposures in these middle Mesozoic strata that have not yet been explored. From Casper, Wyoming, we again flew over the Big Horn Basin and grounded at Billings, finishing the first section of our aerial survey.

The last half of the aerial survey started from Billings October first, to work in northern Wyoming, Montana, and South Dakota, where smoke had previously interfered. The personnel now included D. A. McIntyre, pilot, the writer, G. Edward Lewis, and George F. Shea.

In south central and southeastern Montana, extensive deposits of upper Mesozoic strata were surveyed and partly reconnoitered on the ground.

Our chief objective in this northern region was to determine with certainty the relationship of lower Cretaceous subdivisions and establish their continuity with beds described around the Black Hills. Until the last lap of the flight the eastern flank of the Big Horn Range had been subjected to only a cursory examination, but a careful reconnaissance from Powder River to the Crow Indian Reservation happily indicates additional fertile fields for future exploration.

After flanking the Black Hills, we undertook a rapid survey of the classic Big Badlands to the east. The magnitude and sculpturing of this striking topographic feature of South Dakota was accentuated from the air. Here the Cheyenne and White rivers, with their tributaries, have so completely eroded the surface of the earth that from the air it resembles the weathered and wrinkled face of some centenarian squaw on the reservation below.

The last flight of the survey was highly exciting with a low ceiling and head winds piling up great storm clouds on the western horizon. The Big Badlands were soon left behind and our plane headed toward the Black Hills, zooming in and out of the chilly clouds, scudding along at low altitudes, the temperature a scant degree above the freezing point—keeping ice from forming on the wings and forcing the plane down. Fitful gusts of wind tossed the ship about like a feather, but after a surprisingly quick trip, we landed in Sheridan, Wyoming, to refuel. After a fifteen-minute stop we again took off for the last lap, with menacing clouds still lower.

The divide between the Big Horn and the Little Horn was cleared by a scant hundred feet and the plane literally hugged the ground, dodging squalls and circling hills the remainder of the way to Billings, where our six weeks' flight was ended.

Behind us lay 180 hours in the air, over 20,000 miles of the western United States—a highly successful aerial geological survey completed on the most ambitious scale ever attempted.

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The Stinson plane used in the aerial survey, with members of the crew during the early part of the season. Left to right, Barnum Brown, D. A. McIntyre, owner and pilot of the ship, and Weld Arnold, of Harvard University, who handled the 24-inch Fairchild camera. Later in the season G. Edward Lewis of Yale University assisted in photographic work



The party at work, flying along the cliffs of eagle sandstone, near Billings, Montana, photographed from a ship of the Wyoming Air Service

The good ship "Diplodocus" ready for the take-off, with Pilot D. A. McIntyre at the controls and Barnum Brown discussing the day's work



(Below) The great dinosaur quarry on the Howe Ranch seen from an elevation of 6000 feet. The bones and the relationship of this great accumulation to the overlying and underlying strata could be determined with the greatest clarity.

This quarry is 65 feet in length and 51 feet in width, and here lie entombed the remains of twenty huge Sauropod dinosaurs where they died en masse as the waters of the lake in which they had lived dried up. Four thousand bones were excavated at this site by the American Museum-Sinclair Expedition in 1934, and the bone mass undoubtedly continues under the hill at the right





Fleecy Reminders of an Ancient Sea

Floating islands of white misty clouds against a background of green ocean shale, with the blue dome of the sky above, made a rare combination of color indescribably beautiful which, fortu-

nately, was recorded. Frequently in the air one is met by a compelling picture, but often circumstances such as insufficient light, or violent storms make it impossible to take photographs



(Above) In the Valley of Shell Creek, five miles northeast of Greybull, the same lateral pressure that elevated Sheep Mountain, seen in the distance, has exposed the fresh-water Cloverly Cretaceous formation in a dome that is rich in fossil remains of early Cretaceous dinosaurs. The opposite half of the arch has been completely carried away

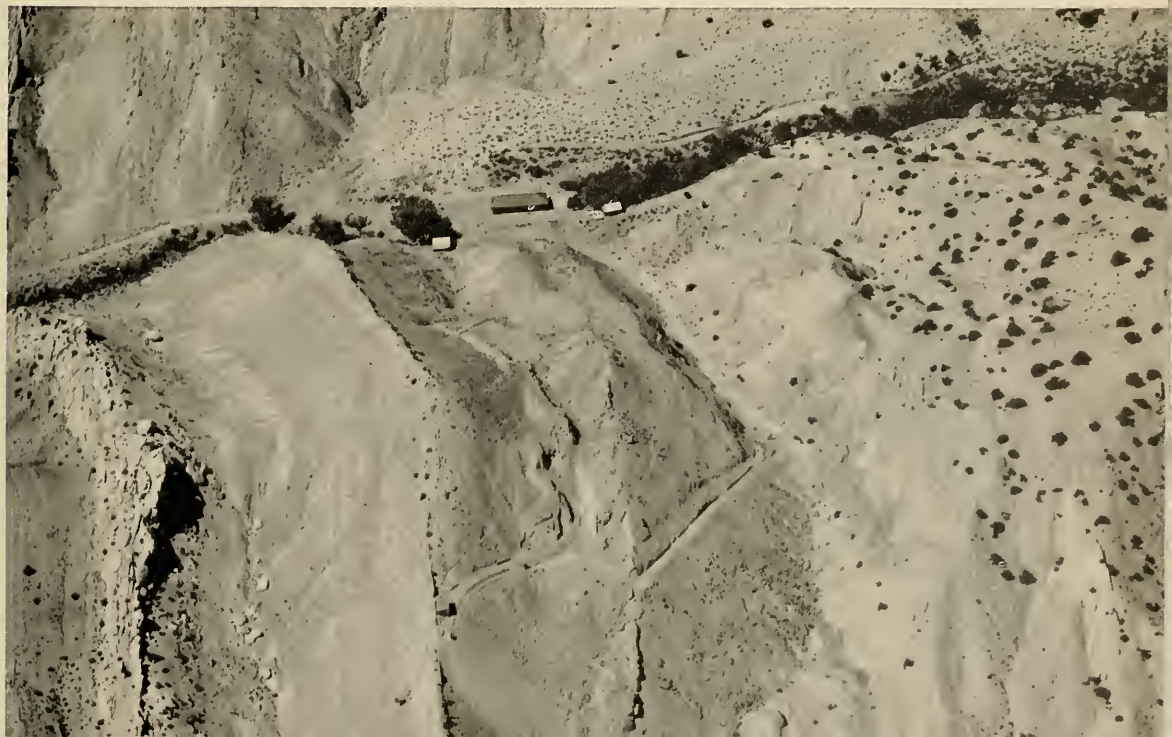
(Below) The Utah Copper Mine at Bingham, Utah, is one of the richest in the world and also one of the lowest grade, only two per cent copper showing in this mineralized mountain. Unlike most mines it is worked in open terraces. Seen from the air, the greenish-blue tone of this impregnated rock presents a rare sight—a large turquoise in matrix setting





(Above) East of Utah Lake, the scenery of the Wasatch Mountains is rugged and picturesque, Mount Timpanagos, at the left, being one of the oldest and loftiest peaks of the range. At the base of the mountain, in the foreground, are remnants of the Provo Terrace, marking the highest point of ancient Lake Bonneville

(Below) The Dinosaur National Monument near Vernal, Utah, is planned to be the most interesting of the entire series of National Parks and is to be the greatest in educational value to our touring public. Here, in the upturned strata of Jurassic rocks, are countless skeletons of large dinosaurs embedded in sandstone just as they died 140,000,000 years ago



Prominent near the Utah-Arizona line is Navajo Mountain, conspicuous for a distance of a hundred miles, a guide for airmen, and of great interest to the archaeologist. Here on the mountain-side are the remnants of ancient Pueblo buildings dating back to the early centuries.

At the left, in the valley of the San Juan, is the mammoth Rainbow Natural Bridge and in the foreground under the overhanging cliffs, 600 to 800 feet high, are natural shelters, once inhabited by the ancient basket makers, dating approximately from 1,000 to 500 B. C.

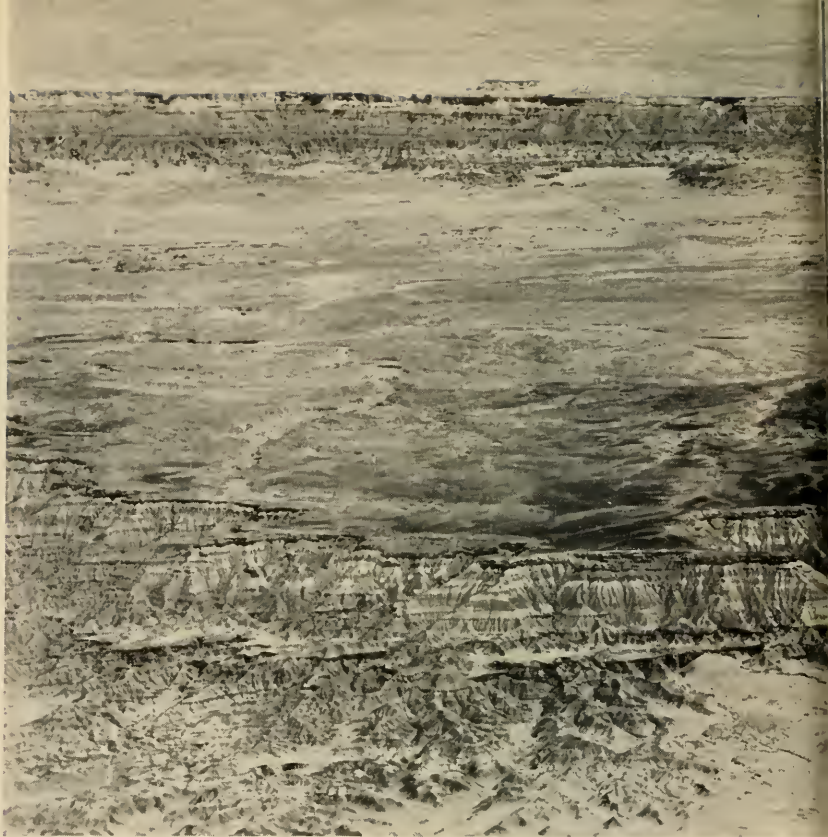




Cameron, Arizona, at the crossing of the Little Colorado River, on the main highway between Flagstaff and Lee's Ferry, is a place long to be remembered by tourists who have had the pleasure of stopping at Hubert Richardson's unique hotel. In no other place can one get a better conception of the Painted Desert, and as the sun makes its daily circuit over the distant cliffs, each sunrise and sunset presents a different series of vivid colors, rivaling those of Venice

Here come the nomadic Navajos to barter their blankets and silver work at the Little Colorado Trading Post, and here also has been the headquarters for many of the motion picture companies while filming their western dramas in the Painted Desert

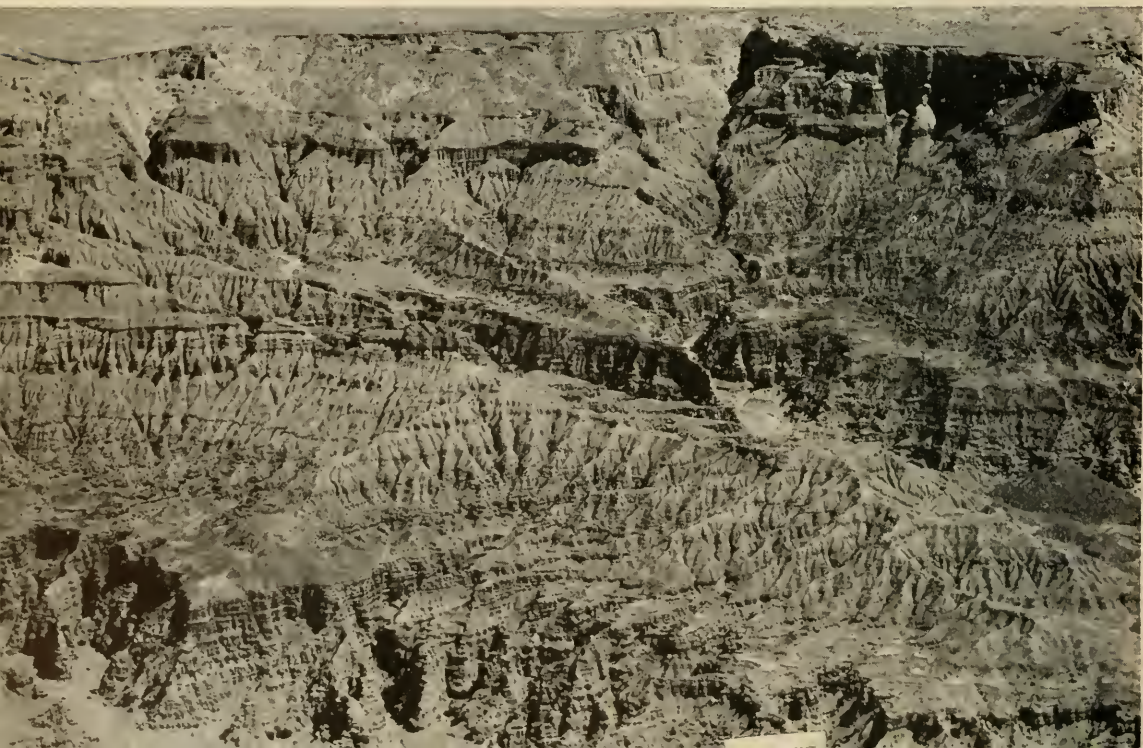
Fifteen miles north-east of Cameron, Arizona, is the border of the Painted Desert, composed of Triassic strata, rich in colors and in the remains of ancient life. Two distinct mesas or tablelands are distinguishable at this point. In each are entombed creatures of 200,000,000 years ago

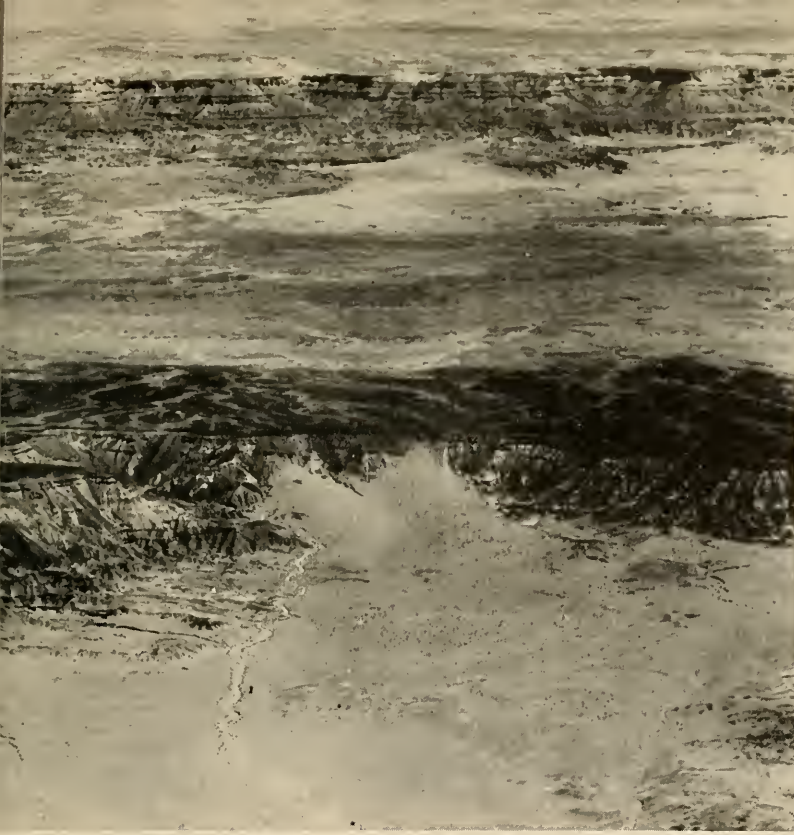


PANORAMA OF

(Below) Upper Terrace or Second Mesa. Of harder material than the lower ter-

race, the beds of rock here have been sculptured into fantastic shapes



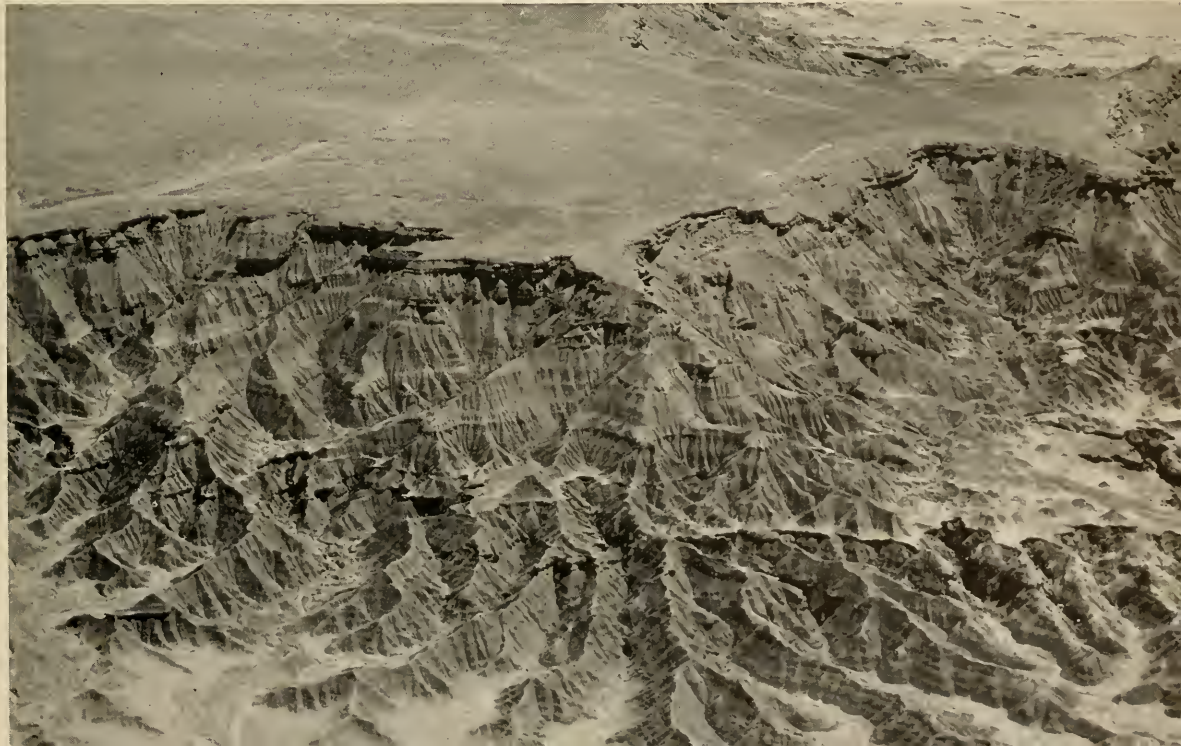


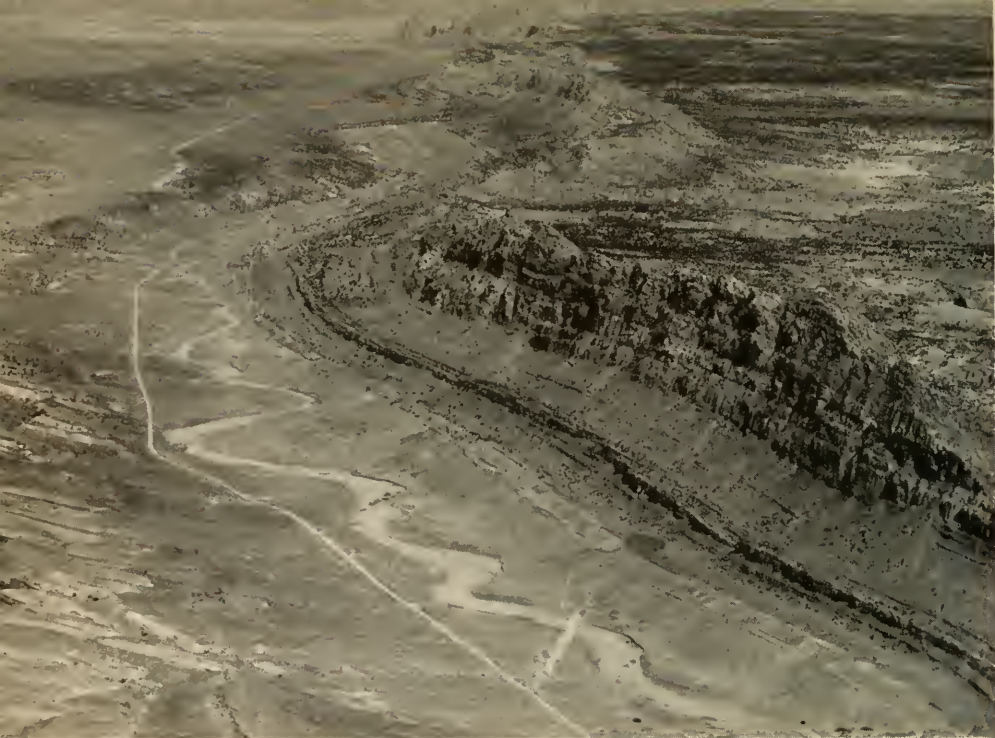
Here are found countless numbers of dinosaur tracks; bones of ancestral crocodiles; phytosaurs; thousands of logs; and many skulls and skeletons of mud-puppy-like labyrinthodonts, or prehistoric salamanders.

More gold than has been minted is disseminated through these beds, but its extraction is still a problem

PAINTED DESERT

(Below) Lower Terrace or First Mesa. The coloring is more delicate in these strata, which represent an earlier horizon. Mauve-tinted pastel shades predominate





(Above) Halfway between Cameron, Arizona, and Lee's Ferry, on the Colorado River, are the upturned edges of Triassic and Jurassic rocks, forming Echo Cliff that terminates the Painted Desert. The walls of Marble Cañon seen in the distance are the start of the Grand Cañon, which lies to the left, outside the picture. The great highway, recently completed, is a part of the magnificent system of automobile roads connecting the points of scenic interest in the Southwest





(Above) The serpentine, meandering course of Cañon Diablo and its tributaries through narrow, deep-trenched vertical cuts in the solid limestone is strikingly different from water courses through a shale or sandstone country. Comparing it with the Grand Cañon through similar limestone, one sees how the latter has been aided by elevation and spreading



(Left) Cañon del Muerto and Cañon de Chelley comprise one of the most colorful and historic areas in all of the Southwest. Beneath the overhanging cliffs in these cañons, with their 1500-foot sandstone walls, dwelt some of the earliest of the basket makers; here also are found some of the earliest Pueblo structures, and even today roving groups of Navajos cultivate their little fields of corn in the bottom of the cañons. The dark foliage on the plateau is that of sizable pine, piñon, and cedar trees. Romance mingles with tradition in these rugged cañons, alluring to the archaeologist, but forbidding to the airman



MYSTICAL CASTLES

*There are probably more unexplored
basket maker shelters in the Lukachukai
and Carrizo mountains than in any other*



section of the Southwest. Here, in these highly sculptured, fantastic cañons, long before the birth of Christ, nomadic people found shelter under the overhanging sandstone walls and wrested a precarious living from a semidesert country





(Picture on opposite page)
Aztec in the valley of the Animas River, ten miles northeast of Farmington, N. M., is one of the best preserved of the ancient Pueblo structures, and also the second largest of these ruins. The tree rings in the rafters of this ancient building show that it was under construction from 1110 to 1121 A. D. The building originally covered an area 359 by 280 feet square and was probably five stories high along the outer tier of rooms. The round, well-like rooms are the kivas, or places for ceremonial meetings. The large, grill-like structure in the open court is the House of the Great Kiva or assembly place for all the inhabitants. This photograph was made in September, 1934, during restoration



(Above) High up on the sandstone mesa bordering Chaco Cañon, near Pueblo Bonito, a long, narrow streak came into view, beginning nowhere and ending nowhere; as plain as a building from the air, but heretofore unreported. It is approximately two miles long and fifty feet wide, terminating opposite Fahada Peak, near the ancient Pueblo ruins, and was evidently a ceremonial way, or race course, used by the peoples who inhabited the near-by buildings

(Right) Nestled in the sandstone walled valley of Chaco Cañon, N. M., are some of America's most interesting ruins, the largest being Pueblo Bonito, which had sheltered at least a thousand people. Ruins of eleven of these ancient Pueblo structures stand near by



THE OLDEST TOWN IN THE UNITED STATES

Walpi, a Hopi Indian village on First Mesa in northeastern Arizona. Timbers in these buildings show that Walpi has been inhabited continuously from before 1400 A. D. to the present time. It occupies the crest of a high sandstone mesa that fingers out into the valley and rises from

the base to an elevation of 200 feet above the plain. Two near-by mesas are occupied by later Hopi Indian villages. Here for generations the timid Hopis have cultivated their corn and grazed their sheep in the valley below, returning at night to their aerie homes

Living Honey Jars

How the thrifty ant stores food and solves the problems of survival in its complex social organization

By A. C. COLE, JR.

ON BUSY city streets and walks, in velvety lawns and gardens live myriads of ants struggling for life in an ever-changing habitat. Tiny brown and black pavement ants, the larger and more fierce carpenter, shy little *Myrmica*, greedy sweet-adoring *Monomorium*—these are common city dwellers. Here nest building is difficult and the procuring of food even more so. Man's domain leaves little room for others, and those that survive human destruction are usually in some way dependent upon man or his activities.

But out in the open spaces millions upon millions of ants live and thrive in unbounded freedom—in green fields and shady woods; broad deserts and high mountains; vast plains, moist meadows, and steaming, tropical rain forests. There they find food in abundance, ample space, shade-giving plants, sand and moist soil for nest building, and rocks for protection. In the mountains and deserts live thrifty honey-bearers, bold hunters, busy seed-gatherers, crafty thieves, and prosperous fungus-growers, some in mounds, others beneath stones, and many in plants.

Mound dwellers

Tramping along the stony ridges of Colorado's Garden of the Gods or meandering on the higher hills about Prescott, Arizona, the observant nature lover or the interested wanderer will perceive rocky, conical mounds, with a single large and irregular hole in the top of each. He may even notice, especially at twilight or possibly even after dark with the aid of artificial light, the small, opaque, lemon-yellow occupants of these mounds. He may see the endless stream of legs and soft bodies twist and glide along the routes that lead to and from

the nests. These are honey ants, scientifically known as *Myrmecocystus horti-deorum*.

Perhaps the observer is curious and wishes to see behind the barrier of stones and soil, to scrutinize the inner mechanisms of the colony. A kick of the boot would destroy the mound sufficiently to expose part of its hidden galleries and disclose some of the internal architecture, but how much more interesting and profitable would be a careful removal of the masonry, pebble by pebble, one bit at a time.

Underground chambers

The ants swarm out of their subterranean chambers helpless to protect their home from the human invader. If the investigator is patient, he is only slightly annoyed by the hundreds of small legs crawling upon his hands and arms, and need pause in his operations only long enough to flick one of the more venture-some creatures from his neck or forehead. For, differing from some of their cousins of the deserts and plains, these ants do not sting or bite.

Even after the entire mound has been leveled, the investigator has had only a superficial glimpse of the home of this little insect whose real achievements lie buried deeply beneath the soil. Careful digging uncovers rude chambers, some large, some small; some with busy ants in them, others with masses of tiny, soft, white grubs. The ants which were seen running to and from the nest were the workers—sexless individuals often called neuters, but more correctly known as sterile females, comparable to the worker bees. They are the providers of the nests, the protectors of their colonies and maids-in-waiting to their queen-mother. They are almost continually active, whether on their food-gathering forays far from the nest or protecting and attending to the wants of the

colony. They are responsible for the nutrition of the helpless grubs or larvæ, from which more adults develop.

These grubs are peculiar little bundles of flesh quite unlike their grown sisters and yet so dependent upon them for care. Each larva, a composite of tender segments, tapers at the end; each is legless and has a small and hardly discernible mouth. Only a fleeting view may be had of the brood, for, as soon as the roof of the chamber is torn away and the grubs exposed to the light, their worker nurses, with powerful yet gentle mouthparts pick them up and scurry into deeper chambers of the nest to deposit their charges once more in temporary security. Even under natural conditions, when the nest is not tampered with or disturbed in any manner, the workers move the brood from chamber to chamber as may be required by changes in temperature and moisture.

Recluses from the outside world

With a trowel the examiner may dig deeper into the soil until finally his instrument penetrates the roof of a comparatively large chamber where soft tumescent bodies tumble to the floor much in the same manner as "humpty-dumpty." But, if he is fortunate and cares to make several attempts, he finally opens one side of a chamber where he finds arrayed upon the ceiling more of the clumsy, pot-bellied animals which he had discovered shortly before. These are surely not workers, he surmises; yet his assumption is somewhat incorrect, for they are in reality workers with highly specialized though peculiar tasks. Known as repletes, they are the honey-bearers or honey-storers of the colony. Their huge, awkward abdomens contrast greatly with the rest of their bodies, which are like those of the workers. They never leave the nest, for their bodies are so swollen that their legs cannot touch the ground. With bellies so gorged with "honey," they are life prisoners in their own home—recluses from the outside world.

If the observer is sufficiently interested, he should prick with a pin or something else suitable, the abdomen of one of these repletes. Immediately upon doing so the "honey"—not true honey at all but a thin, almost colorless and semitransparent liquid—gushes out, leaving the ant's abdomen deflated and limp. The liquid is rather sweet to the taste but lacks the flavor

of the honey of bees. By a regurgitation process the workers transmit from their own mouths to those of the repletes liquid food which they have procured in the course of their daily foraging. The repletes thus are specialized for the function of storing the "honey," so that it can subsequently be utilized by all members of the colony, young and old alike.

Perchance the investigator may wish to dig deeper into the nest to see whether he has overlooked anything of interest. If he is persistent enough, though his patience may be tried to its very limits, he may eventually uncover and examine the most important member of the colony—the queen, mother to all in her little domain. She is wingless, much larger than the workers, and lacks the distended abdomen of the repletes. She is an offspring of another colony of the same species. Without the queen her colony would be eliminated. Her sole duty in the nest is the deposition of eggs, and from the time her first ones hatch to the time of her death—normally a matter of several years—she is the most honored and respected member of the entire colony. She is continually protected from danger by her workers, and only rarely does she venture to the surface of the mound, crawl fearfully outside, gaze at the outer world disapprovingly, satisfy her innate feminine curiosity, and hastily retreat to her protective subterranean chambers. The workers are ever at her command, in times of peace or of war.

The nuptial flight

It may be that the observer has chanced upon the proper season of the year to see other curious members of the colony. If so, he is attracted by winged individuals which crawl about but do not fly. He may marvel at the rapidity with which they move about on their long, slender legs alone. He may wonder of what use are the wings or indeed any of the winged creatures. It may occur to him that here are the males and females, the true sexes themselves, some of which, if the wings were absent, would distinctly resemble the queen, and would, in fact, be almost indistinguishable from her. But there are forces of which the casual investigator would not be likely to have knowledge. These males and females developed from eggs long since laid by the queen. They, too, passed through the same stages as the worker, from tiny, white, legless larvæ

which hatched from eggs, through their transformations to the adult form—fully grown, fully matured. In them are vested the essentials of new life exactly as in the sexes of the human race.

And now, if the observer is persistent and visits the nest daily for a time, he may be so fortunate as to witness the wedding or mating flight of the ants. At last the males and females make use of their wings. At this time only are these important but transitory appendages enlisted into service. In great streams the ants leave the mounds, rise into the air, and gaze upon a world unknown to them. In these fantastic swirls they mate, each female with a single male. After each mating is completed, the female drops to the ground. The males, having fulfilled the sole purpose in life with which they were endowed by Mother Nature, fall lifeless to the ground, where they are scattered by the wind or ruthlessly grabbed for food by foraging ants.

Settlers of new domains

The females fare differently and are in many ways more fortunate than their short-lived mates. In them only lies the power of distribution and the propagation of the species. After they have descended to the ground, often at great distances from the mother colony, and when they have excitedly maneuvered in all directions on their new homestead, they chew off their wings, an instinctive action which appears almost purposeful. These appendages have become utterly useless and, if allowed to remain, would only handicap the ant's activity, which for a time is intense. No longer are these insects virgin females, protected and nurtured by their sterile sisters. Now each is a queen, a potential mother and a lone settler of her new domain. Freed of her wings, with feet and mandibles working furiously and bundles of muscle tense with action, she carves from the unbroken soil a small superficial chamber, the incipient beginning of her future nest. The entrance to this is marked only by a little pile of fine soil, the by-product of her labors.

In this chamber she rests and after a time deposits several dozens of minute eggs tightly massed together. It is the queen's duty to care completely for the needs of the tiny grubs which hatch. This is her first brood and from

it emerge a number of workers, her first tireless servants and providers.

Propagation and distribution

The burden removed from the queen's strong shoulders, she is now able to rest in security and to leave to her trusted offspring the duty of enlarging the nest as well as of protecting and feeding her while she lays new batches of eggs until her earthen palace contains hundreds and finally thousands of busy ants. When the proper time arrives, some of her eggs develop into males and females, and the endless processes of propagation and distribution are carried on and on.

This is the reason the observer finds the numerous colonies; this, why he may travel from the Garden of the Gods to Prescott, and from there into the lower desert plateau near Phoenix and yet see the same species.

Only seldom, however, is a mound of *M. horti-deorum* found in the desert proper; few have been able to contend with the hostile environment to the extent of thriving, and they have been unable to disperse as widely as their relatives of the mountains. In the desert they are replaced by other species of their genus, shining little *semirufus* and its larger but less colorful relation, *mimicus*. *Semirufus* and *mimicus* spend a busy life in the hot desert sands where environmental conditions are not so unfavorable for them as for *horti-deorum*.

So much for the life-history and habits of this interesting honey ant. But the honey ants represent only one group of the large ant family. Ants of other groups possess different habits, so different in fact that there is real similarity only in biological development, which is much the same throughout the entire family. Many ants live beneath the bark of trees, some in stems of plants, others within plant galls, and a large number in nests beneath stones and in the nests of other ants.

The Occident ant, for example, a fine and prosperous species of the family, is a tireless harvester that inhabits conical pebble mounds on the plains and in the semideserts of the West. It clears away plants from around the mounds, and gathers large stores of seeds during its foraging tours. It defends itself with an excruciatingly painful sting and a pair of sharp and powerful mandibles or toothlike structures surpassed in size only by those of its

closest desert relatives. There are records of the stings of this ant killing pigs and calves, and a venturesome field mouse has little chance of escaping with his life. Only the horned toads—which are lizards in reality—are able to squat on the mounds and consume great quantities of the angry inmates. The horned toad offers an impenetrable skin to the ferocious bites and merciless stings.

Other ants and their ways

Then there is the little brown ant, *Lasius*, the cornfield ant of the farmer's domain. It protects aphids, or plant lice, in return for the much prized honey-dew which they freely afford. The aphids are carefully guarded and expertly maneuvered by the workers of *Lasius*, and are placed upon the most choice roots in the ants' nest or of near-by plants. In exchange for this protection and food the plant louse exudes from its abdomen drops of sweet honey-dew which the hungry ants lap with gusto. This is a perfect communion of ant and louse, two distinct and rather distantly related members of the insect class.

Tiny *Solenopsis molesta* is an interesting insect. Known as the thief because it lives on the stores in other ants' nests, this minute yellow creature builds its small tunnels and galleries among those of its "host" ant. Its existence is dependent upon the other ants, and it is thus the veritable robber of the ant family. Strange to say, however, it is tolerated with good grace by those ants in whose homes it lives. In fact, small notice is taken of the sluggish little fellow who roams from gallery to chamber in quest of stored dainties.

Some ants (*Formica* and *Polyergus*) raid nests of other and closely related species and carry back to their colonies workers which are

subdued and used as slaves. So subservient do the captives become that they help raise the young of their captors and contribute to the general routine of their new home. Soon they come to live in complacent harmony with their surroundings and are as much at home as their subduers.

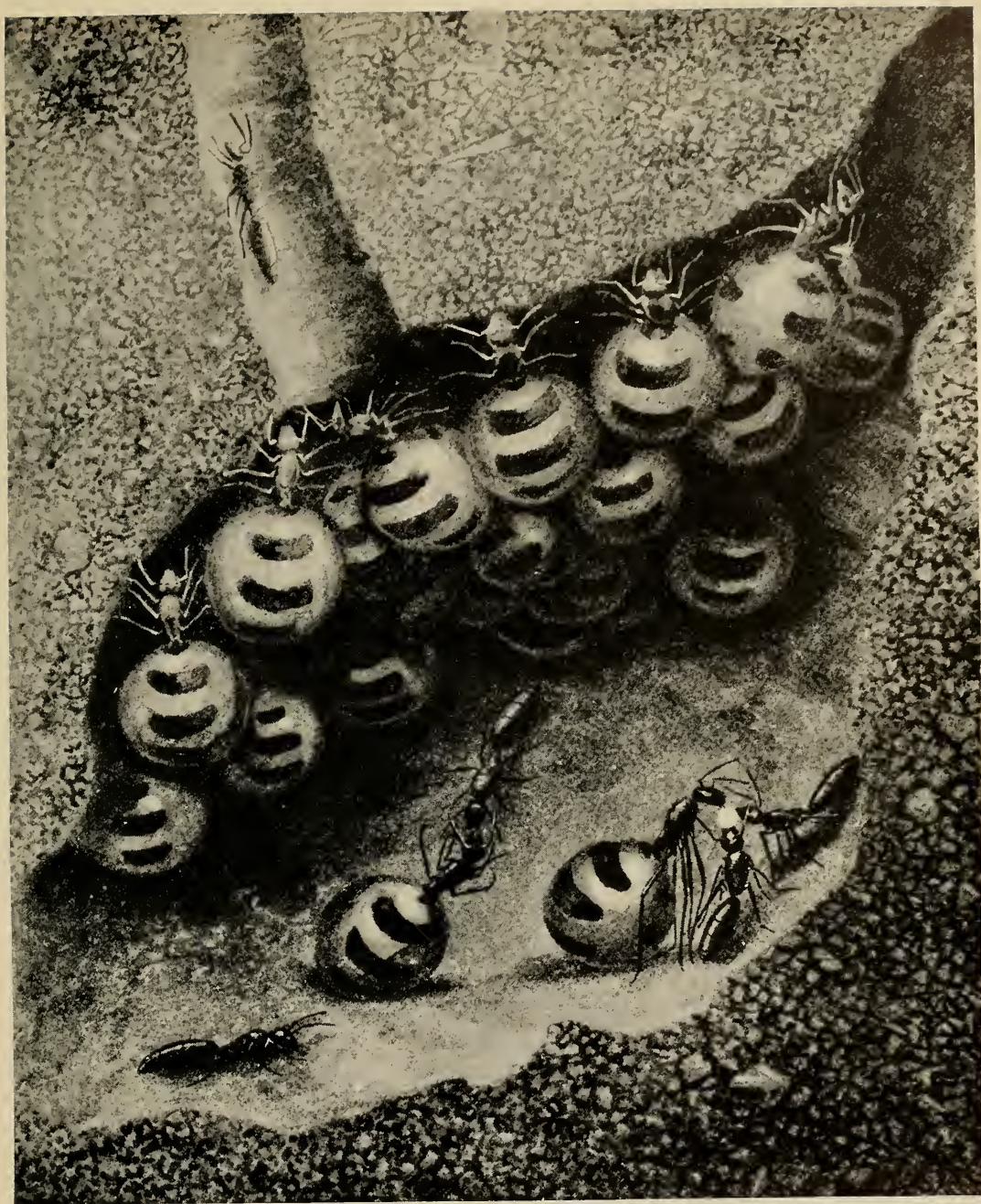
Another ant whose habits offer sufficient interest and distinction to make it worthy of biographing is grotesque *Atta*, with sharply buttressed head and thorax and spiny armature. Peculiarity in appearance and individuality in habits characterize this fungus-grower. Instead of gathering seeds, as does the Occident harvester, instead of thieving like *Solenopsis*, for example, she cuts and gathers bits of green leaves. With expert manipulation *Atta* transports the leaf particles to her nest chambers well beneath the surface of the soil. There they are thoroughly masticated and deposited upon the floors of the larger chambers. Carefully tended by the ants, these fertile bits, planted with spores, give rise to a luxuriant growth of fungus, abundant provender for the colony. So develops the food of *Atta*, and thus does this species take advantage of Nature even more than do many of her relatives.

Many ants remain to be discovered; many of their life-histories need be studied. In deserts and on mountains, in forests and on plains, new species are constantly being found, the eccentricities of their behavior divulged, and their relations and interrelations brought to light. Each new form is an asset to our knowledge of the family and a contribution to the vast study of social animals.

Much has been written of the intelligence of ants; much controversy has resulted. Be this as it may, the mere fact that ants are social insects of a high order enlivens our interest in them and in their struggle for existence.



A honey-bearer in the act of regurgitating food to workers of the ordinary form. From "Ants" by W. M. Wheeler



From "Hutchinson's Animals of All Countries"

IN THE HONEY CHAMBER

The honey-storers cling to the ceiling of the honey chamber, their honey-crop swollen out of all proportion to the rest of their body. They never leave the nest,

for they are too heavy with honey to walk about, thus becoming life prisoners in their own home for the benefit of their comrades

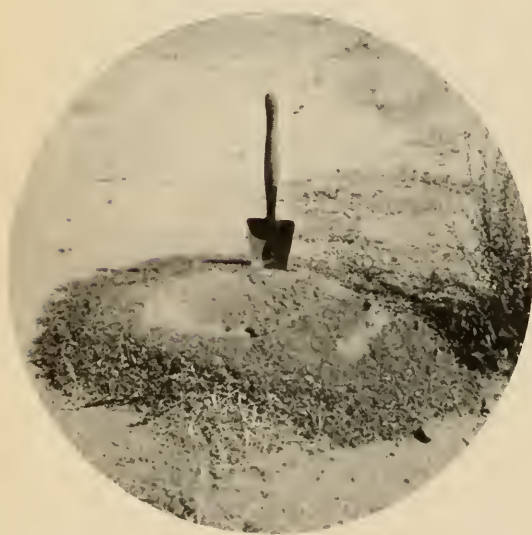


Photograph from Ewing Galloway

Nearly all of the honey ants are confined to the dry plains and deserts of North America, South Africa, and Australia.

On these rocky slopes in the Garden of the Gods, Colorado, the honey ants nest in comparative security

Homes and Habitats



*(Above) Here *Atta versicolor* has constructed her nest beneath the limb of a thorn bush in the desert near Phoenix, Arizona. In the subterranean chambers are her fungus gardens*

*(Left) A nest of *Novomessor pergandei* André in the Mojave Desert, California. The periphery of the mound is covered with chaff from harvested seeds*

(Right) *Dorymyrmex* is one of the most successful desert dwellers. Note the fine sculpturing of this mound found near Mojave

(Below) The little brown ant *Lasius* lives in small crater nests such as those shown in this photograph taken in Zion National Park



In the Arizona desert, *Atta* often cuts the small leaves from the spiny stalks of the desert shrub ocotillo at the right in the photograph below and transports them to her fungus gardens. Many ants live in the pithy trunk of the giant cactus shown at the left

Photograph from Ewing Galloway





(Above) A porcupine fish puffed up. The porcupine fishes occupy an enormous territory in the tropic seas of both the Atlantic and Pacific oceans, reaching Florida, Bermuda, and Southern California



(Left) A porcupine fish at ease. This Diodon was captured in a fine-meshed seine that was pulled along the shoals near a fine stand of live coral heads at Loggerhead Key, Florida

(Right) In the distance is Loggerhead Key, the home of the porcupine fish. This is the last of the Florida Keys and is one of the series of the Dry Tortugas. The Carnegie Institution of Washington maintains a marine laboratory on Loggerhead Key



Fishes in Armor

Protected from greedy sea marauders by a coat of sharp spines, the porcupine fish swims about in comparative safety

By MYRON GORDON

Zoological Laboratory, Cornell University

NOT long ago an ingenious wolf hunter made the headlines by designing a hunting outfit that no beast would challenge. This hunter got a keg of nails and sewed the spikes into his hunting suit at close intervals. The iron spikes stood out on his homely coat of armor like the piercing quills on an alarmed razor-back hog. Someone called the inventor the porcupine man. The idea was good. No beast could touch the man-porcupine and go away unimpressed.

Long before man got the idea of a barbed-wire-like suit for defense, long before the porcupine itself developed its pelt of quills, the porcupine fish was swimming about in comparative safety, protected from its enemies by an elaborately constructed coat of sharp spines. The spines of a porcupine fish are reconstructed scales—scales that have grown to a point. The spines are “built in”; they are a part of the porcupine fish’s external anatomy; they are warning signals to greedy sea marauders; they convey the idea of “*Verboten*.” They are effective.

Spines for self defense

Spines for self defense are almost as well developed in the plant, as in the animal kingdom. The members of the cactus family have spiny coats of infinite variety. Even a palm tree has adopted the protective principle of the spine. The porcupine palm of Antigua faces a world of enemies with a whorl of long, sharp spines that winds around the trunk in an ascending spiral. The thorns have a habit of becoming detached when disturbed. Many an animal that has come too close to this vegetable fortress has gone away licking its smarting wounds.

Fishes, in general, are past masters in the use of spines. Have you ever gone fishing for bullhead catfish and taken them off the hook? You know how careful you must be to avoid the sharp spines that are located on their pectoral and dorsal fins. Many fishes add poison to the injury they inflict. Poison glands, situated at the base of the fins, shoot a toxic secretion into the wound opened up by the lashing action of the pectoral spines.

Scales developed into long darts

In the porcupine fishes (*Diodon*) the spine idea is carried to its furthest development. Practically all their scales have been developed into long darts, and in order to maintain their streamline form for swimming purposes, their spines are neatly folded close to the body and point backward. Only when the fish is alarmed does it erect its spines. The mammalian porcupine controls the erection of its spines by skin muscles. The porcupine fish swallows a lot of water and puffs itself up like a balloon. The spines stand erect and rigid. This defensive reaction is effective if anything tries to swallow it.

A fish humpty-dumpty

When a porcupine fish is picked up, it swallows air and becomes balloon-like just the same. On the palm of your hand an inflated *Diodon* looks like an angry infant that lies helpless on its back in its crib and shows its impotent rage by pumping its lips and pounding the air with its feeble appendages. Its eyes gape wide for want of eyelids to close them. Its bloated, spherical body makes it look like a fish humpty-dumpty. Its small, soft, and flabby fins fan the air feebly and ineffectually. Its two-toothed mouth is puckered up, and its lips and teeth move continuously as it tries to gulp more and more air to puff itself up more and more.

When returned to the water and released, the *Diodon* lies on the surface for a second, expels water and air explosively, deflating itself instantly, and swims away as fast as its ridiculously small fins and tail can take it.

Women in tropical lands have a method of inflating and drying the skins of porcupine fishes. When illuminated from within, these globular skins make grotesque lanterns. The spiny globes serve in times of festivity and in war. The South Sea island warriors cut holes in the bottoms of these inflated and dried fishy ornaments to suit the size of their individual heads. When going to battle, they use the spine-covered skins as protective helmets.

Poisonous puffers

Porcupine fishes have scored successfully not only with their equipment of lances, but also with other means of defense. They have the ability to secrete a toxic substance from glands in their skin. One of the porcupine fish's closely associated family relatives, *Tetraodon*, the *muki-muki* of the Hawaiians, is regarded by those natives as the most poisonous of all fishes. The South Sea islanders will not eat the flesh of this fish, but they do dip the tips of their arrows into the poison of its gall bladder.

The versatile Francis Day, who was both the Inspector General of the Fisheries in India and Burma, and a surgeon major in the army at Madras, has contributed a few pertinent facts on poisonous puffers that ought to be recorded in this account. Day's comments (1879) have a unique flavor.

The *Tetraodons* are termed *Kuddul mah-cutchee* or sea frogs by the natives of Malabar, on account of the noise they make when captured. Although they are occasionally eaten by the lower classes, they are said to occasion indigestion, so are usually avoided, while all of them emit an odour the reverse of agreeable. The native doctors sometimes prescribe them in cases of lung affections. The Burmese in some districts consider these fishes to be poisonous, but in other localities they eat them, being careful first to remove the gall-bladder, which they assert occasions all the poison symptoms. The Andamanese eat these fishes, as I personally witnessed; they appeared rather to prefer them to some of the better kinds. At Cape of Good Hope the eating of spotted *Tetraodon* has caused so many deaths amongst the sailors in harbour, that they are specially warned against employing them as food. Due to their poisonous nature they are even objected to as manure in Malayan countries. The Japanese eat one species as a means of enabling them to commit suicide.

Porcupine fishes have a third defense. They have two extremely strong and sharp teeth. The porcupine fish's technical name, *Diodon*, means "two-toothed." (*Tetraodon*, their cousins, have four teeth, as their name implies.) Their mouths cannot open wide, but when their teeth surround something, that something is quickly separated into two parts.

You might think that even the most voracious predators of the sea would have sense enough to leave the porcupine fishes alone, with their spines, poisons, and savage teeth. But hunger is an urge so powerful on occasion, that a porcupine fish diet has been attempted. Through Darwin, according to H. M. Kyle, we get the story of an inflated porcupine fish that was found floating, alive, in the stomach of a shark. Did the *Diodon* poison its swallower? Darwin is credited with another *Diodon* story. A swallowed porcupine fish had eaten its way not only through the stomach of a shark, but the little barbed demon had also eaten its way through the shark's body wall and killed its selachian warden as it escaped.

Facing the enemy

Beebe (in *Beneath Tropic Seas*) says he saw a school of baby porcupine fishes milling about in close formation; all were puffed up, all their spines were rigidly erect. They were not puffed out because they were on parade. They were alarmed, for they saw a vicious gar eyeing them hungrily. The spiny puffers kept puffing; they kept close together; they held their spines erect like "the hollow square of a herd of musk-oxen with horns all pointed outward," facing their common enemy. Finally, one of the porcupine fishes darted out from the protected circle. The gar's "great jaws opened, snapped shut, and drew the unfortunate puffer down." The sad account stops here but, if the *Diodon* passed the gar's forest of teeth without injury, perhaps its life's story did not end with the snapping shut of the gar's jaws. Perhaps it was the beginning of the end of the gar.

A famous Egyptian species

All the porcupine fishes, *Diodon*, and most of their less spinous cousins, the puffers, *Tetraodon*, are marine, and are found in every tropic sea. A few, particularly the puffers of India, Ceylon, Malay, and Egypt, travel up the estuaries. Several species of *Tetraodon*

actually pass beyond these tidal rivers and live in fresh-water streams. An Egyptian species, *Tetraodon fahaka*, lives in the fresh waters of the Nile. The *fahaka* is a famous fish and one that must have had some important symbolic virtue, for it appears commonly in the mural paintings of the ancient Egyptians. Unmistakable likenesses of it are found in the fishing scenes drawn on the walls of the pyramids of Giza and Saqqara. The eastern half of the south wall of Ptah Hotep's tomb at Saqqara is decorated with an elaborate battle scene being fought on water. The pictures represent a cross section of the battle. Above the water line the battle royal goes on furiously. Below the water line, below the keels of the war vessels, as if in sharp contrast to the warlike scene above, the artists painted a lovely scene of peaceful aquatic life. A partly inflated *fahaka* may be recognized easily among the many aquatic creatures that seemingly live contentedly in this lower, but gentler, world.

A four-toothed river beast

One fresh-water puffer of India has recently been brought to America by an enterprising aquarium fish dealer. The scientific name of the fish, *Tetraodon fluvialis*, conveys the meaning that it is a four-toothed beast that has come

from the river. It is a little fellow; the largest ones according to Francis Day, never get more than six and one half inches long in the natural state. Some of their marine relatives, like the porcupine fish, grow thirty inches long.

Aquarium pets

The fresh-water puffers are popular in the home aquarium. They eat all kinds of fish food but prefer raw meat; they are inclined to be scrappy; they are too small to do much damage with their strong teeth when handled; they will go obligingly through the typical swelling antics of their tribe when lifted from the water and tickled under the chin. Aquarium fish keepers are excited; they have discovered another parlor trick.

The porcupine fishes (the *Diodons*) are entirely marine, and live among the living coral heads. They have rich pickings. With their strong, sharp teeth they break down the hard calcareous hiding places of worms, shrimps, and other tiny inhabitants of a heavily tenanted coral community. If pickings should become slim in one community, all they have to do is to inflate themselves with air and, with belly upward, float with the Gulf Stream until they come to new hunting grounds.

A Whale Shark in the American Museum

The skin of a fifteen-foot specimen from Acapulco, Mexico. The world's seventy-seventh specimen

By E. W. GUDGER

*Bibliographer and Associate Curator,
Department of Fishes, American Museum*

FOR twenty-three years I have been pursuing whale sharks, *Rhineodon typus*—indeed, ever since in July, 1912, I saw hanging on a long pole under a shelter at Miami, Florida, the skin of the thirty-eight-foot specimen taken at Knight's Key in June of that year. This skin was the largest, the hugest, the most enormous thing of its kind that I have ever seen. From that day to this I have hunted the whale shark (by correspondence and in books) in the Atlantic, Pacific, and Indian oceans, and of the seventy-seven recorded specimens, I have put twenty-seven on the list.

The greater number of these specimens have been recorded from three restricted regions—in the Atlantic Ocean, seven fish from the Straits of Florida; in the western Pacific, fifteen from the Philippines; and in the eastern Pacific, twenty from the west coast of Mexico. Of these latter, three are recorded from the Gulf of California; eleven from Cape San Lucas; and six from Acapulco.

In 1933 Mr. Ralph L. Smith of Mexico City sent to the American Museum photographs and descriptions of some great sharks locally called *Tigres del Mar*, "tigers of the sea," captured at Acapulco, on the southern coast of Mexico, with a request for information. The requisite facts were communicated to him with a request for more photographs and data. Mr. Smith then sent photographs and accounts of five whale sharks captured at Acapulco—in 1932 (one) and 1933 (four). These were harpooned by Pancho (Francisco) Moreno,

the chief fishing captain and guide of the port. From this extensive data, Smith and I prepared an article, "The Whale Shark at Acapulco, Mexico," which was published in the *Bulletin of the New York Zoölogical Society*. This was illustrated by splendid photographs of these sharks taken immediately after their capture.

In a footnote to the above article we made bare mention of the taking in these same waters of another (the seventy-seventh recorded) *Rhineodon* whose capture and whose skin are the *raison d'être* for this article. For an excellent photograph of this specimen and the following account of its capture, I am indebted to Mr. Charles T. Wilson of New York, a member of the American Museum, who headed the fishing party. Mr. Wilson writes:

The capture

On March 2, 1935, my friend, Angel Moreno, and I were out fishing in a speedy launch with Pancho and a crew of three (one being Pancho's son, who seems destined to follow his father's calling as harpooner of *Rhineodons*). When about five miles from the bay of Acapulco and about one thousand yards from shore (just off the Pie de la Cuesta, where the other whale sharks had been taken), Pancho sighted our quarry.

We immediately headed the boat about and within one minute Pancho had made a successful thrust of the harpoon and the excitement began. Several hundred feet of rope went out quickly, the launch was speeded up to go along with it, and at every opportunity to take in slack we pulled it in.

The strike was made about three o'clock in the afternoon, and about half-past six we succeeded in pulling the boat up to the giant shark. However, it turned to dive, and as its tail rose out of water, Pancho, who (from past experience) was ready for such a manœuvre, very deftly threw a rope lasso

around the tail and made it fast. We then decided to bring the huge fish into port alive if possible, and all of us, crew and fishermen, slackening on the harpoon line, laid hold on the lasso, but we could not do a thing with our captive. It went its way and we went with it. All we could do was to let it drag the launch and, whenever possible, we took up slack.

Following these tactics, in about an hour we succeeded in somewhat tiring out the shark. Next the lasso around the tail was tied to the stern of the launch, and an attempt was made to tow our captive tail foremost. However, it turned on its back (as I understand sharks do under such circumstances) and its large front fins winged out and acted as brakes to our progress. It was like trying to tow a house.

Slackening up on the lasso fast to the tail, we got launch and fish close together again, and Pancho succeeded in securing the fish with a great hook in its mouth. Then slackening up on the other lines, we fastened the line from the hook to the stern post of the launch and towed the whale shark head foremost into the bay. It righted itself and came along without offering much resistance (perhaps it feebly swam with us), but we were all pretty well tired out when we reached shore about half-past nine at night.

Our captive was secured by the lines from harpoon and hook to stakes driven in the sand, and a watchman was left on guard. The next morning, since there was no derrick to lift our prize up for inspection and photography, we got it up on the beach by the use of planks and rollers, and several photographs were taken.

This great fish was not only photographed but, at Mr. Wilson's suggestion, Pancho skinned it and put the skin away in salt. Before leaving Acapulco, Mr. Wilson gave the skin of this whale shark to Pancho. Pancho later contracted to sell it to a Mexican gentleman who wished to acquire it for a museum in his city. However, this plan was not carried to completion—to our eventual gain. The subsequent history of this skin follows:

I heard from Mr. Smith in Mexico City on March 11 of the capture of this shark and the chance of getting its skin. He was empowered to act as agent of the American Museum and through his kindness the skin was purchased for us from Pancho. Next Mr. W. H. Hudson of Acapulco kindly saw to its preparation, packing, and shipping. Finally, early on the morning of April 22, I had a hurry call from the Ward Steamship Line—"We have on our wharf a powerfully smelly shark skin consigned to you. If you love us please get it away at once if not sooner."

This we did, and the skin is now in our department of preparation being tanned—the first stage in anticipation of mounting. Thus the American Museum eventually will have a fine mounted skin of this, the seventy-seventh

recorded specimen of the whale shark, which is at once the largest fish and the most markedly colored shark that swims the seas.

When Mr. Wilson heard how it had come to the American Museum, he generously sent me a check covering the total cost of the skin delivered into our hands.

Scarcity of mounted skins

The department of fishes in the Museum has long wished for a skin of this particular species for mounting, and twice has failed by a narrow margin to get one. In June, 1919, a thirty-one-foot specimen was captured at Cape Sable, Florida, and its skin removed. An effort was made by a member of the Museum to purchase it for us, but the price asked was so exorbitant that the purchase was not consummated. Subsequently the skin went to pieces. Another whale shark was captured in June, 1923, at Marathon near Long Key, Florida. Mr. L. L. Mowbray (now director of the Bermuda Aquarium) was at Miami and took over the matter of obtaining the skin for the Museum. Of his tremendous efforts to tow the fish to Key West, where it could be hauled out on a ship's railway for skinning, and of his defeat by the unprecedently high temperature of the sea water, record has been made in *NATURAL HISTORY* for March-April, 1930.

Mounted skins of the whale shark are few and far between. In Europe there are three (two of them old and poor mounts): one in the British Museum in London; another is in the Muséum d'Histoire Naturelle, Paris; and a third in Stockholm. There are two in India—in the Madras, and Colombo (Ceylon) museums. There was formerly a mounted skin in the University of San Tomas in the Philippines, but it has gone to pieces. I have known of three skins mounted for commercial display, but they have all disappeared. In none of these mounts has the fish been adequately presented. An unmounted skin has been preserved since 1902 in the United States National Museum.

The Acapulco whale sharks have furnished two skins for museums. One of these (about seventeen feet long) was purchased and sent to Sweden. Here it was excellently prepared and is to be seen and studied in the Naturhistoriska Riksmuseum, Stockholm. Our fifteen-foot skin is the other and, when mounted, it

will be the only specimen on display in the New World. As a guide in mounting this skin, we fortunately have the beautiful photograph of the fish itself, which is reproduced herein.

It must be noted again that twenty whale sharks have been recorded from the west coast of Mexico. Some of these were very large—estimated at fifty or more feet—but the captured ones were much smaller. One taken in the Gulf of California measured only twenty feet. I have photographs of all six taken at Acapulco. I do not have measurements for these, but judging by the heights of the bystanders, it is evident that the sharks are all relatively small—fifteen to eighteen feet long. From this data the interesting conclusion can be drawn that *Rhineodon typus* breeds on the west coast of Mexico. Whether this great fish lays eggs (as some few sharks do) or brings forth its young alive (as is true of most sharks) is not known.

Whale shark behavior

Only one scientific man has ever dissected a whale shark—Sir Andrew Smith, its discoverer, 107 years ago—and his account of his specimen captured at the Cape of Good Hope contains no reference to the reproductive organs. Presumably his fifteen-foot fish was immature. Some day, somewhere, some ichthyologist will be so fortunate as to be present at the capture of an adult female, and by dissection will establish the mode of breeding. He will be a lucky man, one long envied by his fellows. When this fortunate dissection is made, it is my judgment that the whale shark will be found to be viviparous—*i.e.*, a live-bearer. The young when born must be of good size, too large to be hatched from a shelled egg extruded into the water. The just-born young must be at least three to five feet long—perhaps as much as eight or ten. *Quien sabe!*

Little is known about the habits and behavior of the whale shark. It is a whale in size and in its manner of feeding. In size it is huge—it has been measured up to forty-five feet and estimated to reach sixty by scientific men whose word cannot be gainsaid. Like a whale, it feeds by swimming along at the surface with its huge mouth open. Into this go small fishes, crabs, jellyfishes, and other surface-swimming creatures, also floating algæ. These are sieved out by the gill-rakers as the great volume of water

flows out through the long and wide gill-slits, and they are then passed down the throat—which in the specimen dissected would about take a baseball or a man's fist.

By the general public, sharks are deemed bloodthirsty creatures, and large ones are sure to be characterized as man-eaters. The whale shark is the largest shark but, far from attacking man, it is absolutely harmless. It might bump into a boat and do damage, and more likely might, in a flurry brought about by pain and fright, thresh out with its great tail (comparable in size to the "flukes" of a whale) and stove in a boat. Conceivably one of the largest size by a stroke of its huge tail might make kindling wood of a boat. Ordinarily, however, even when harpooned, it makes no particular fight, but by swimming at the surface or by diving merely seeks to get away. This was the behavior of each of the six specimens taken by Pancho at Acapulco.

The huge terminal mouth in an average-sized (thirty-foot) specimen would easily accommodate a small man, but the teeth of such a fish are only about one-eighth of an inch long. What they lack in size, however, they make up in number—about 3000 in each jaw. Some idea of the size and number may be had from the annexed picture of a fragment of a tooth band (natural size). These teeth recall those of the old-fashioned wool "cards" which I saw my mother use to card wool when I was a little boy. They also recall the teeth of a file; hence, the shark is named *Rhineodon* = *rhine*, a file; *odon*, tooth = file-toothed. Surely this great fish is correctly named.

The whale shark has two trivial local names based on its unusual markings—the most extraordinary known on any shark. Two specimens have been recorded from off Havana, Cuba, and there it is called *pez dama*, "checkerboard fish." The photograph opposite explains this name. Along the dorsal ridge is a distinct keel, and three others run lengthwise on each side. These are crossed by vertical yellow or yellowish-white bars, and in the squares made by the intersection of keels and bars are found large yellow spots.

Again, the vertical bars and the large spots (also arranged in vertical rows) have led to the common appellation at Acapulco—*Tigre del Mar*. But, as has been shown above, our great fish is the mildest-mannered shark that swims the seas.



Pancho in action. He has the reputation of being the most skillful harpooner in Acapulco. Here he is shown at the most decisive moment in the chase. Photograph by courtesy of Dr. M. A. McIver



A bit of the side of the "pez dama" or "checkerboard fish." The pattern of squares and spots makes clear the reason for the name given to this whale shark in Cuban waters. The photograph is of a Florida specimen



Photograph, courtesy of C. T. Wilson

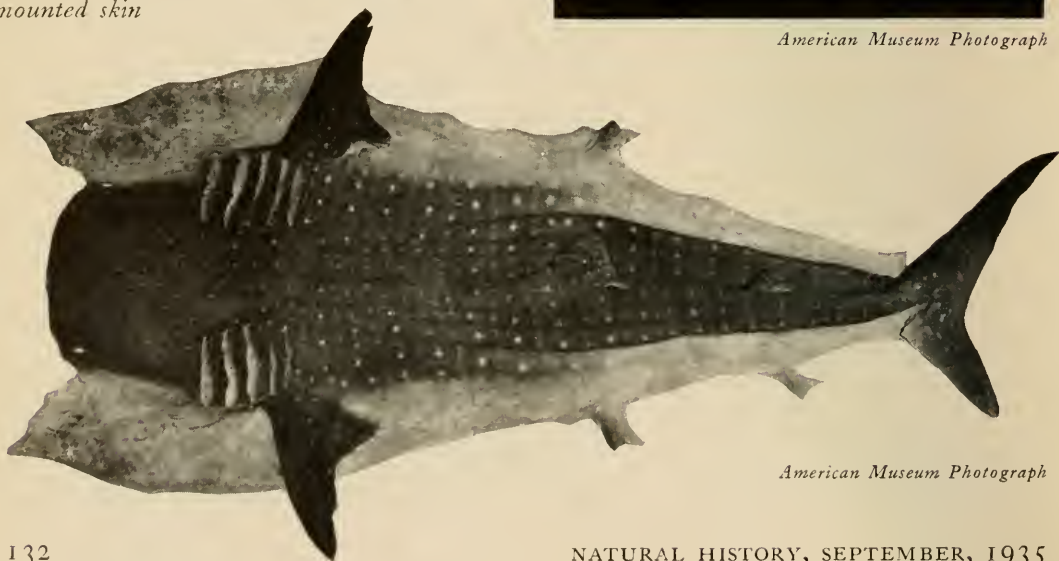
(Above) The "Tigre Del Mar" on the Beach at Acapulco. This shark was so large (fifteen feet long) that it was necessary to lay down heavy boards and drag the fish on rollers up on shore where it could be photographed and skinned

(Right) Teeth of the whale shark, slightly enlarged. This largest shark has the smallest teeth



American Museum Photograph

(Below) The skin of the sixth Acapulco sea tiger. This photograph was made to show the exact location of the spots and bars, because these will largely disappear in the tanning process; now they can be reproduced accurately on the mounted skin



American Museum Photograph

To the Strange "Buttons"

The story of the Bowdoin-MacMillan Arctic Expedition of 1934 to Cape Mugford, Labrador, and the Button Islands of the Northwest Territories

By ALFRED O. GROSS

Professor of Biology, Bowdoin College

IN the swirling, ice-laden waters of Hudson Straits, beyond Cape Chidley at the extreme northern end of Labrador, lie the "Buttons." These isolated, rugged islands were discovered by Sir Thomas Button as early as 1614 when he passed through the straits on his way to the discovery of Southampton Island and the exploration of the western coast of Hudson Bay. In all the years since that time they have stood as a challenge to all who visited that region.

The excessive tides which rush in and out of the straits, the blinding fogs, prevalent storms, and often impenetrable pack ice have made landing there a hazardous procedure. Every boat that has gone through the straits has wisely given these islands a wide berth. Even the Canadian Government tactfully cautioned our expedition not to attempt to land for fear that we might meet with disaster.

Who but an inquisitive naturalist or adventurer would ever care to risk a landing on those bleak and forbidding shores? To either of these, however, the urge might well be strong to go there.

First there was a certain mystery concerning these islands. Sailors had reported that, when they were passing them, strange sounds emanated from deep recesses in the high cliffs. What could be the source of these sounds? Furthermore, many speculations had been ventured as to the life that existed on the islands. Eskimos claimed that in years past the polar bear and walrus bred there. Did these great arctic mammals still exist there? There were hosts of questions, moreover, concerning the

abundant bird life, for which the islands are especially notable. Where, for instance, could be the nesting places of the fulmars, large gull-like birds, which abound in the straits between the Buttons and Cape Chidley?

It was to answer these questions and to open up other biological secrets surrounding the locality that the Bowdoin-MacMillan Expedition of 1934 made the islands one of its main objectives.

Personnel of the expedition

Commander Donald B. MacMillan, loyal Bowdoin alumnus and famous arctic explorer, said he could land a party on the islands; and his staunch schooner the "Bowdoin" was made ready for the expedition. Seven Bowdoin College students volunteered their services to assist in the biological work and in navigating the boat under his command.

Dr. David Potter, professor of botany at Clark University, and two of his students joined us with the purpose of making a collection of plants of the Labrador coast. From the casual records of previous expeditions it was expected that the high mountains of northern Labrador and especially those in the region of Cape Mugford would yield a wealth of important botanical material, including remnants of preglacial forms of plants.

With these objectives the "Bowdoin" sailed from Portland, Maine, on June 16, 1934, with a personnel of fifteen men, including three professional seamen, a first mate, an engineer and a cook.

In addition to the crew there was one distinguished passenger, Arcturus, a huge, snowy owl, which through the Massachusetts Audu-

bon Society, sought passage to his home in the northland. Arcturus had been wounded by a hunter near Boston after his migratory flight to New England. He had been nursed to good health by the warden of the Audubon Society, but the warm days of June were taxing his constitution, and certainly Labrador would be more agreeable to him than New England during the hot summer months. This unusual request was granted not only because the Massachusetts Audubon Society desired it, but also because we all welcomed Arcturus as a mascot. He became an important member of the party and there was a feeling of regret when we left him on the shores of Anetalak Bay above Nain, Labrador.

The Gulf of Saint Lawrence

With favorable weather the "Bowdoin" made a fast run along the jagged Maine shore, thence across the Bay of Fundy and up the Nova Scotia coast to the Gut of Canso. At Port Hawkesbury we took on the final supply of oil for the Diesel engine and then struck northward into the Gulf of Saint Lawrence.

Little ice was seen in the Straits of Belle Isle, but the next day after setting our course northward toward Battle Harbour we met no less than fifty beautiful icebergs. Some of them were enormous in size, with cathedral-like spires reaching upward to heights of a hundred feet or more. Some of the flat-topped bergs were literally covered with kittiwakes, which found these floating, crystal masses convenient resting places in the midst of their fishing grounds.

On the outer runs we met with shearwaters. These interesting birds have reversed the usual procedure of migrating from the south to breed in a more northern latitude. They breed in the south Atlantic and spend their summer vacation, a time when the cares of raising a brood are cast aside, in Arctic America.

Battle Harbour, our first stop on the Newfoundland Labrador and the real beginning of our expedition, has figured prominently in many explorations to the North. Almost every boat stops there to send its last farewell from the powerful radio station. We recalled that it was just twenty-five years since Admiral Robert E. Peary had telegraphed the first news of his discovery of the North Pole.

Battle Harbour was formerly the site of an important hospital of the Grenfell Association, but today only the blackened stones and bricks of the foundations remain of the buildings, which were burned November 2, 1930.

That the hospital is sorely missed is evident to anyone who stops there. Soon after we anchored, two natives came aboard for medical attention. We also visited a boy suffering with a severe ulcerated tooth. He was the son of a fisherman who lived at the head of a cove about a mile from Battle Harbour. The family were living under the most wretched conditions. The house was constructed of rough boards, and pieces of tin and bits of sod were used to stop the raw wind and cold rain. Inside, a box served as a table, on which stood a dingy old lamp and a well-worn copy of the Bible. Two broken chairs and a dilapidated bureau constituted the only other furniture. The beds were merely grass-stuffed mattresses on the floor. A rusty, smoky stove kept the occupants warm and served for their simple cooking.

The parents expressed deep gratitude for the relief we had given their boy. Our trip over the rugged hills helped us to understand the enthusiasm the Grenfell workers have in serving the people of that desolate coast. It is a hard life that these people live, and it is a great satisfaction to anyone to be able to aid them.

At West Turnavik the expedition accomplished one of its objectives in banding several hundred arctic terns. It has long been known that these terns, which breed in large numbers on some of the low-lying islands, winter in the Antarctic Archipelago beyond the South Atlantic, but just what route they follow in making that long journey was not known until recently.

Arctic terns

In 1928 Dr. Oliver Austin, Jr., banded a number of terns with tabulated aluminum bands supplied by the United States Biological Survey. He received returns from Europe; and one of the banded birds was found in South Africa. These observations indicate that the migration is not by way of the Americas but across the Atlantic to Europe, southward along the coast of Africa to Cape of Good Hope, and thence to the Antarctic. The round trip between the Antarctic and these islands is a flight of approximately twenty thousand miles.

We hope that the large number of terns which our own expedition banded will establish in detail the migration route of this remarkable bird.

Our main objectives lay far to the north, and our party pushed on without delay. At Hopedale, where we were welcomed by Dr. W. W. Perrett, we would have enjoyed a stay of many days. Doctor Perrett is the Moravian missionary, to whom Mrs. Anne Lindbergh referred in her article in the *National Geographic*. The story we heard from him of the privations suffered by the inhabitants of this isolated village was most distressing.

Too much credit cannot be given the Moravian missionaries, whose splendid work has been the salvation of the people of the Labrador coast. They have protected the interests of the Eskimos against the white man, who too often in the past has taken advantage of them, and have improved their living conditions in general.

Hopedale is like an oasis in that barren coast, and it was with regret that we left it.

An unusual welcome

At Nain, as at Hopedale, our boat was the first to arrive that year, and we were received with an unusual welcome. Practically the whole village assembled on the wharf, and in their native tongue sang songs of welcome. The sun had just dipped behind the mountains and a beautiful sunset glow added a bit of color to the touching scene.

As soon as the clang of the anchor had ceased, a fleet of small boats landed a swarm of happy Eskimos on board the "Bowdoin." There were loud greetings of "*Awk-sha-nai*" (Hello, or Welcome), and there was scarcely standing room on the limited deck space. Commander MacMillan stood at the door of his cabin and like a Santa Claus dealt out boxes of huge gum drops, candies, and presents. After fifteen expeditions to the land of the Eskimos, MacMillan well understands how to make the natives happy. No wonder the cheery "*Awk-sha-nais*" when "Captain Mac" came to pay them another visit. Near the Moravian mission is a school which MacMillan established and which he continues to maintain.

On Sunday the little chapel at Nain was filled to its capacity. Practically every native man, woman, and child in the community was

there, for they consider it a great privilege, not merely a religious duty, to attend the services. All entered heartily into the singing, accompanied by the little organ. This part of the service was amplified by the howls and cries of several hundred Eskimo dogs, which constituted a real source of competition for the human voices. It was difficult to determine whether the response of the dogs was one of appreciation or annoyance.

At Nain, as well as at other villages, the members of the expedition bartered for seal-skins and articles such as parkas and boots, to be used by themselves or to be taken back as gifts to their friends. Lawrence Flint, one of the Bowdoin students, discovered a fine thirty-foot, walrus-skin dog whip. It was just what he desired as an addition to his already extensive collection of whips. The Eskimo owner made it known that he wanted Flint's pants, and there being little time left before sailing, Flint removed his pants and exchanged them for the coveted prize. The return of the funny white man to the boat-landing was through a gauntlet of black eyes and a barrage of grinning faces.

The next day we were at Cape Mugford, with the great summits of the Bishop's Mitre, Brave Mountain, and other peaks of the Kaulajet range standing at majestic attention as our little ship sailed by. Dr. David Potter, the botanist of the expedition, and his two assistants were put ashore with their tents and equipment to begin their work in this important area, which was one of the major objectives of the expedition.

Labrador coast plants

Doctor Potter succeeded in collecting more than 20,000 plants along the Labrador coast, one of the most comprehensive collections ever taken from that region.

After landing his party, we pushed on toward the Button Islands. Good weather enabled us to arrive on July 11 at Grenfell Tickle, which cuts through the northern Tip of Labrador, connecting the Atlantic with Ungava Bay. We hoped by this passage to reach Port Burwell, or Killinek as it is known to the Eskimos, where we were required to report to the Canadian Mounted Police. It was necessary to present our explorer's permit, and to take on a Canadian representative, as required of all expedi-

tions entering the Northwest Territories, of which the Button Islands are a part.

When more than halfway through the passage, however, we encountered the drift-ice pouring eastward, driven by a strong ebb tide. Loaded with hard, blue blocks of ice from the Polar Sea, it was a tide which the best ship in the world could not have stemmed. We retreated and sought a safe harbor at the entrance to the Tickle.

The next morning Commander MacMillan undertook to reach Port Burwell by rounding Cape Chidley to the north.

From Cape Chidley, we could see the dreaded Buttons, a mass of rugged islands with sheer cliffs hundreds of feet high. At last the main objective of the expedition was in sight, but we still had to touch at Port Burwell.

Soon after passing into Gray Straits we were confronted with great fields of pack ice and an opposing tide of eight knots, which again forced us to seek a harbor on the unexplored and uncharted coast. Easing along within a few yards of the big, black cliffs, the "Bowdoin" finally turned into the quiet waters of one of the best harbors in northern Labrador, a place which we hope to have named "Bowdoin Harbor."

The next day a "pea soup" fog, for which Cape Chidley is notorious, held us in the harbor. It was not until July 14 after several futile attempts that we succeeded in reaching Port Burwell.

Except for the factor of the Hudson's Bay Post and the two Canadian Mounted police, the population of Port Burwell, numbering about seventy-five persons, is entirely Eskimo.

Human parasitology

The Eskimos at Killinek are more primitive than those we found at Hopedale and Nain. In winter they live in snow igloos built wherever the best hunting and trapping are to be found, but during the more moderate weather of summer they congregate in villages along the coast, living in tents of their own construction.

The United States Bureau of Entomology had expressed the desire that we secure parasites of the Eskimos, a project which I assigned to Howard Vogel, Jr. At "Killinek" three natives were supplied with vials of preservative in which to collect the lice, known to them as *Koo-miks*. The next morning the vials, filled

to capacity, were returned to us by the beaming natives, with the interesting information that "they had every *Koo-mik* in Killinek." If this statement were true, it was a good service to the community as well as an accomplishment in the interests of human parasitology.

When we attempted to leave Port Burwell for the final run to the Button Islands, the "Bowdoin" through the failure of the engines to function properly was thrust upon a rocky ledge near a cliff of the inner harbor. The thirty-foot tide was running out rapidly, and in less than an hour the "Bowdoin" was high and dry on the rocks. With the return of the tide, however, we were floated off with no harm done beyond the inconvenience of a six-hour delay. This experience well illustrated the wisdom of maneuvering about uncharted coasts and harbors only during the lower stages of the tide. To be cast on a rock at high tide would mean disaster.

On to the "Buttons"

Early on the morning of July 24, five weeks out of Portland, Maine, we were on the last leg of the journey to the Buttons. The weather was clear and calm and a comparatively small amount of ice remained in the straits. Our approach was so arranged as to arrive at the islands at dead low water, a time when the tidal currents are at a minimum.

We had with us an Eskimo from Port Burwell by the name of Ah-yah-o, who was familiarly known to the Post as Bobbie. Bobbie had once made a trip to the Buttons to hunt seal. He knew the islands, the channels, the possible camping places, and the water supply, better than any other human being. He had even served as guide for an aerial expedition which had photographed the islands two years before. His intimate knowledge of the Cape Chidley region had on one occasion been the means of saving the lives of an exploring party. We were most fortunate to have his services as guide. He could not speak English, but he was very intelligent and could understand and anticipate almost our every want.

Bobbie took the wheel of the "Bowdoin" and piloted us through the narrow eight-mile channel between Lawson and MacColl Islands to the head of a cove on the southern exposure of Lacy Island, which was to be our camping site and headquarters while on the Buttons.

While the islands are almost devoid of vegetation, the channels and especially the coves and bays leading to them were teeming with animal life. On every side the curious seals popped their heads out of the water in apparent bewilderment of the strange craft encroaching upon their domain. Thousands of birds arose or scuttled across our bow. The kittiwakes and fulmars were to be seen in every part of the islands, but we looked in vain for their nesting rookeries. Kittiwakes later were found nesting on the Knight Group of islands south of the Buttons. Frequently, as we rounded an island or point of land, we surprised a mother eider duck with her brood of downy young. Several honking red-breasted loons flew high overhead like so many airplanes out in honor of our arrival. It was still summer, yet countless numbers of red-breasted phalaropes and many other shore birds had already arrived at the Buttons on their way south from their breeding places beyond the Arctic circle.

This lively trip through the whirlpool channels was indeed an auspicious introduction to our ornithological conquest of the islands.

The "Bowdoin" lingered just long enough to put our party of six men, including Bobbie, ashore on Lacy Island. And her departure was none too soon, for an hour later the tide was running rampant and whirlpools of ice were swirling in the channel in front of our camp.

When we bade good-bye to the men on the "Bowdoin" no one could predict when they would return for us, as conditions in that region are most uncertain. Should the ship meet with disaster by storm or be crushed in the ice, we had planned to return to Killinek, the only human settlement in all that vast section, by means of a dory left with us for that purpose.

Bird collecting

Our tents were pitched on a small area of high level ground near a brook of pure water fed by the melting snow on the hills beyond. Fortunately for our comfort the wind-swept islands were free of mosquitoes and black flies, which ordinarily make life in the far north an intolerable existence.

There are no trees, not even tiny shrubs, that could be used as fuel; hence we had to depend on two Primus oil stoves for our cooking. Later, however, we found pieces of driftwood, probably from Ungava or Hudson Bay,

which had been carried by the tides and thrown high on the rocks by the storms. Every bit of this wood we could find was collected and used as fuel during the chill days that followed.

Lanterns and flash lights were not needed in that northern latitude, since the sun stays above the horizon except for a short time each day, and when it sets, a bright glow remains in the sky. We were therefore able to carry on our work at any time during the twenty-four hours. I asked Bobbie how he knew without any timepiece when it was time to eat or sleep. He explained that he ate when he was hungry and went to bed when he was tired. We also found it best to follow this simple and sensible routine.

Ponds and pools teem with life

The first evening a beautiful arctic fox came to within fifty yards of our camp. Evidently its curiosity had been aroused by the sight of our tents, which were certainly new to its experience, and it had come from its hillside lair to investigate. The moment we stirred, however, the fox wheeled about and galloped over the snow on the hillside until it reached a barren, rocky ledge far above us. At this safe vantage point it paused, rested on its haunches, and gazed at us intently. We were as interested in the fox as it was in us. It was delightful to know we were all fellow-creatures, a part of the biology of the islands.

We found no lemming or other rodents, the usual food of the foxes, but the many masses of feathers along the shore and among the rocks of the hills gave evidence that the fox and his fellows fared well on this their island kingdom. Everywhere we could see signs of this kind, which tell a grim story of the struggle for existence in the Arctic.

On high, inaccessible cliffs of Lawson Island we found the breeding places of the glaucous gulls, large pure-white birds which nest only in the far north. The fulmars were also present in great numbers in the channels and inlets about the islands, but if these birds nest in that region, their breeding places are yet to be found.

Mr. Robert Wait, assistant in zoölogy, busied himself in the collecting of invertebrates, and made many interesting discoveries concerning the occurrence and distribution of these organisms. He found the little ponds and tidal

pools teeming with life. There is great opportunity for further work in this neglected field of Arctic biology.

On the second day, the party on the Buttons nearly met with disaster. A Primus stove exploded, spurting burning oil on the canvas of the supply and cook tent, which immediately burst into flames. The level-headedness and quick action of two of the men in pulling the burning tent away from the camp site prevented the destruction of our entire equipment housed in this and four other tents.

Seal steaks and polar bears

Bobbie killed five seals, three of which he succeeded in bringing to camp. The seal steaks broiled on a driftwood fire were excellent, and the livers proved a rare delicacy. Even if the "Bowdoin" were to be long delayed in coming for us, we were assured that we would be well supplied with food. Bobbie, armed with his rifle and spear, often sat for hours on the rocks in front of our camp, a picture of patience as he awaited his chance to kill. All Eskimos seem to have a lust for killing; they have no conception of conservation. To them every bird, every seal, exists merely for them to kill. They have neither feeling nor mercy for their victims.

On a grass-covered area at the western end of Lacy Island were tracks, droppings, skulls, and other evidence of polar bear. The Buttons, therefore, as the Eskimo had reported, are a rendezvous for this great white king of the north. We were not so fortunate, or unfortunate, as to meet with one of these beasts during our survey of the islands.

In this same section of the island we discovered ruins of ancient Eskimo igloos. Nearby were heaps of large boulders which proved to be the graves of the people who had been laid to rest near their homes. In some of the graves time and the elements had bared the skeletons, and alongside the remains were deposits of spears and bone weapons used by these primitive people in their hunt for the walrus and polar bear. Similar graves and igloos were discovered on MacColl Island.

Near one of the Eskimo graves, well protected by an overhanging stone, was a nest

containing five young of the American pipit. This delicate little warbler-like bird, whose nest we frequently discovered elsewhere among the rocks and in the tundra, winters in the United States, but migrates to the far north to build its nest and to rear its young. The pipit is eminently successful, for it is the most abundant species of land birds found in this region.

The ancestors of the pipits were the associates of the Eskimos who once lived there. One can readily picture an alert little native boy watching one of these birds and perhaps matching his skill against it in his first lessons in hunting.

The snow bunting, a striking white and black bird of the sparrow family, nests in the cracks of the cliffs. Some of the nests were placed so deep as to defy all attempts to extricate them. Several which we were able to examine were made on a well-defined pattern, with a thick foundation of soggy moss and a cup of fine grasses beautifully lined with the pure-white breast feathers of the ptarmigan. I can think of no bird that better typifies the land of ice and snow than does this hardy little bunting.

A too-brief sojourn

Our sojourn on the islands seemed all too brief, for they are rich in biological interest.

But what about those queer noises that were reported by the sailors aboard ships passing the Buttons? We came to the conclusion that they were either a product of the imagination or else are produced by the terrific tides rushing between the rocks, or by the ocean swell pounding in the cavernous thunder holes which occur along the cliffs exposed to the sea. Sounds of this sort are quite pronounced during certain conditions of the tides and winds, and perhaps are enough to kindle the curiosity and speculation of any person possessed with a vivid imagination.

In the midst of our interesting work we heard a siren whistle echoing and re-echoing from cliff to cliff. It was the "Bowdoin" back from Cape Mugford with Doctor Potter and his assistants. We were glad to know of their safe return, but it meant the end of our reconnaissance of the Buttons.

(Right) Silhouette of the "Bowdoin" cruising off the Gannet Islands, Labrador, during the Bowdoin-MacMillan Expedition of 1934. Photograph by W. R. Esson



(Right) Eskimos came in their sealskin kyaks to inspect the "Bowdoin" anchored in the harbor at Port Burwell, or Killinek, as it is known to them



(Above) Clark Harbor, so named by the Expedition, is well protected by the high mountains and many islands. Aërial photographs were a great aid in exploring hitherto unknown regions in the search for plants and birds

(Upper Right) Cape Chidley, the "Cape Horn" of the North, on a quiet, clear day. Ice, fog, tides, and storms frequently combine to make this region a terror to navigation



(Right) A crystal mountain from the Arctic. Hundreds of these silent sentinels guarded the coast of Labrador. Photograph by W. R. Esson





(Above) Left to right: W. B. Brierly, Robert Brooks Wait, Jr., Dr. Alfred Gross (seated), George H. Crosby, H. H. Vogel, Jr., and Commander MacMillan



(Left) "Arcturus," mascot of the expedition, was a passenger on the "Bowdoin" from Boston to Labrador

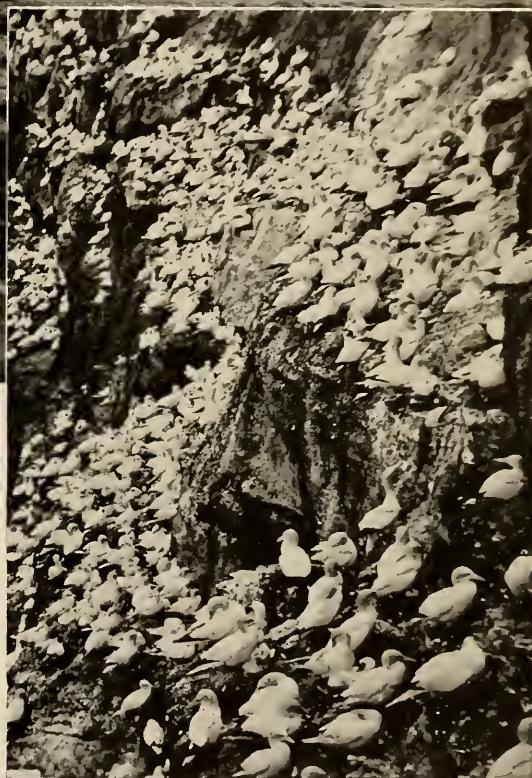
(Below) "Bobbie," who served as guide for the expedition, cooking seal chops on a heated stone



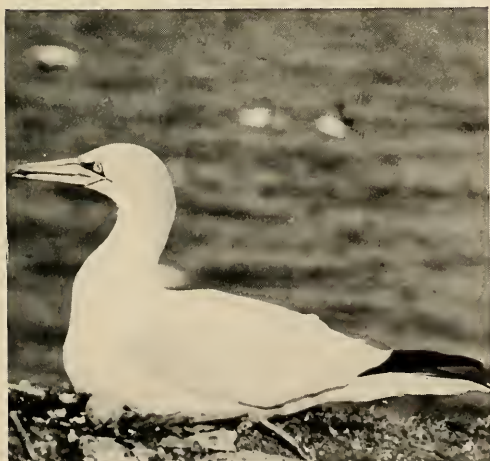


(Above) Bird Rock, the sentinel outpost of the Magdalenes. Photograph by W. R. Esson

Bird Rock



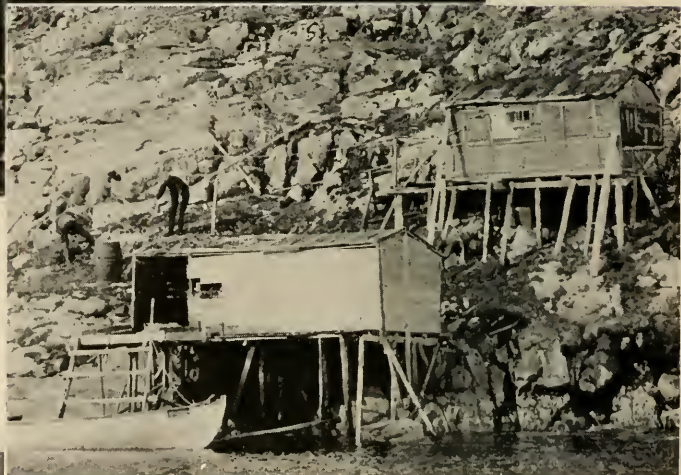
(Above) A bit of the vast gannet rookery. It is marvelous that the eggs and young do not roll off the narrow, slanting shelves, to be crushed on the rocks below



(Left) One of the thousands of beautiful gannets nesting on Bird Rock. The single egg can be seen at the bird's left



(Above) All the salmon are chilled and packed in ice from icebergs which are grounded on the reefs and shoals about this fishing village



(Above) A fisherman's home and drying shed at Battle Harbour. Most of the fisherman's income goes toward maintaining a fishing boat and gear



(Left) An Eskimo home at Nain, Labrador. The natives living near the missions use wood in the construction of their houses



(Above) A fine example of the pure-blooded Eskimos at Killinek. He is a brave hunter and a good provider for his family



(Above) Eskimo babies cry just like any other babies



(Right) Sometimes a husky's curiosity gets him into trouble



(Above) When the fog thickens and the ice packs and crushes in the rushing tides, it is time to seek a harbor for protection

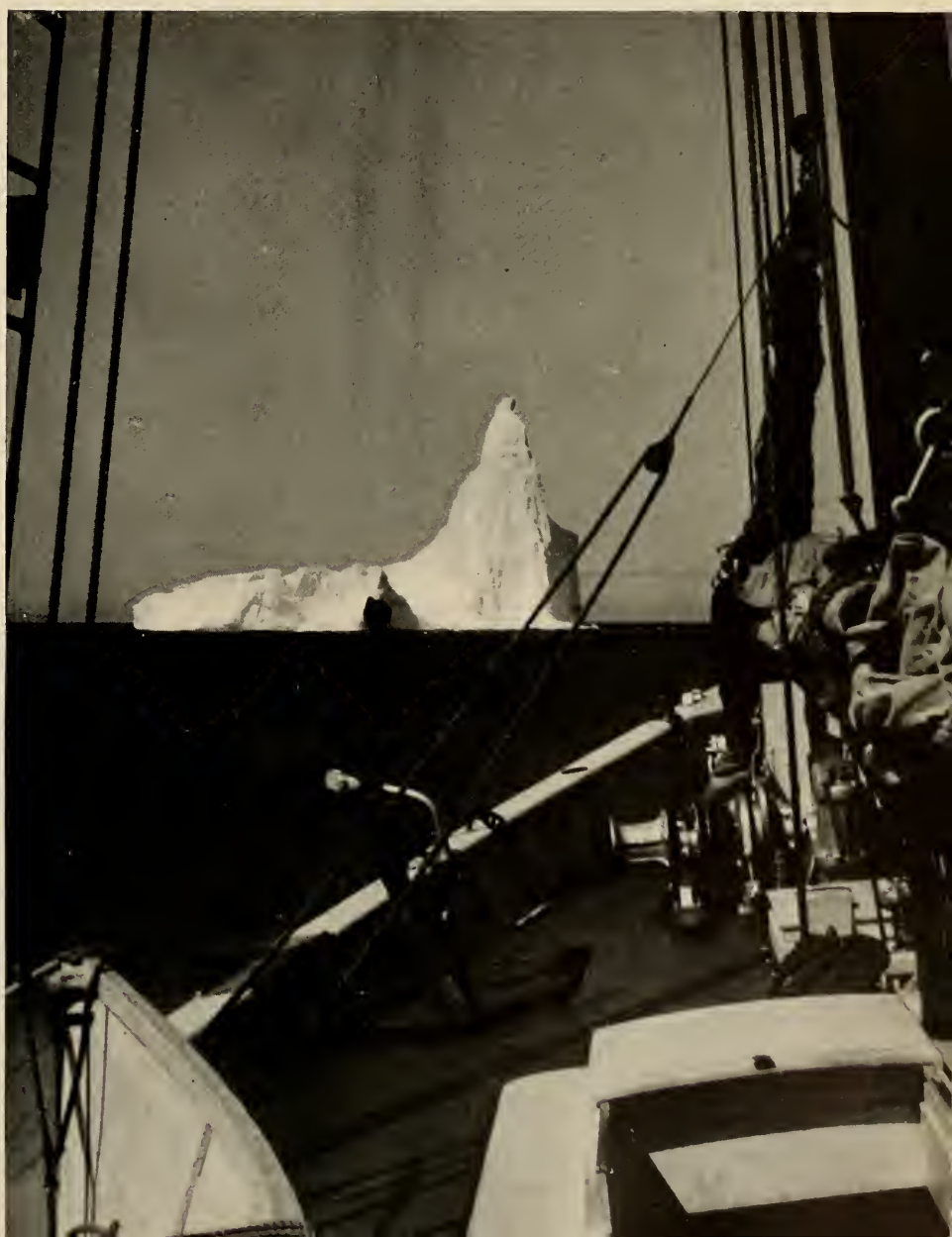
(Right) The "Bowdoin" on the rocks. When the engine failed to reverse at Port Burwell, the boat was thrust on the rocks, where it remained until lashed off by the incoming tide. Photograph by S. B. Gray





(Left) Here the "Bowdoin" is held fast by an ice pan which blocked the harbor at Port Burwell. The next day with a shift of wind and tide the ice pan left as mysteriously as it came. Photograph by S. B. Gray

(Below) A cathedral-like giant towers off the "Bowdoin's" port bow. The tip of the spire was more than 200 feet above the surface of the water. Photograph by W. R. Esson





(Above) These young eiders are only a few hours old, yet they are ready to go as soon as the mother bird utters the command

(Left) This stately female eider is very solicitous for the safety of her young buried deep in the thick down of the nest

FAMILY

(Below) The plumage of these murres is immaculate after a long immersion in the water—a striking contrast to the filthy conditions that exist around their nesting places





(Above) These downy young herring gulls, after toddling through wet grass, climbed on to a fallen tree trunk to dry themselves in the warm sun



(Right) The mother gull, alarmed by the noise of the camera shutter inside the blind, sounds a sharp note of caution

GROUPS

(Below) The legs of razor-billed auks, as in the case of many sea birds, are placed in an extreme posterior position awkward for locomotion on land





The puffin is the "sea parrot" of Labrador, but to the Eskimos it is "siggoluktok"—ugly-billed one



(Above) Black fishermen. Comorants nest in large colonies on some of the highest cliffs of rocky islands of the Gulf of Saint Lawrence



The snow bunting's nest is lined with the white breast feathers of the ptarmigan

Konrad Gesner Was Right

A profile of "The Father of Modern Zoölogy," who made many discoveries of present-day importance though he lived when scientists classed the hippopotamus as a fish and believed that the unicorn walked the earth

By WILLY LEY

[Readers of NATURAL HISTORY Magazine may be interested to know that a more comprehensive account of this pioneer natural historian has been presented by the author of this article in a book entitled, "Konrad Gesner, Leben and Werk."]

THE family of sciences that today is termed "natural history" came into being about 400 years ago, or rather, was then recreated and given new life.

This period—the last half of the fifteenth and the first half of the sixteenth centuries—was one of the most important the world has ever seen. It was dawn after the Dark Ages, new activity after the long sleep of mankind that had followed the breakdown of classical civilization. After being guided and governed by religion during that quiescent era, mankind rose, not to reject religion as a guide, but to deny it as a government.

Towards intellectual progress Dante, Petrarca and Boccaccio had started what was later called the Renaissance; shortly afterwards Erasmus of Rotterdam became the first humanist. In Germany, the greatest of all Reformers, Dr. Martinus Luther, had, in 1520, burned the papal decrees and thus set in motion forces which were to enable scientific minds to investigate and to work unhindered by the Church. Physically the size of the earth had been doubled by Columbus, by Vasco da Gama who had circumnavigated Africa and explored the Indian Ocean, by Balboa who in 1513 dis-

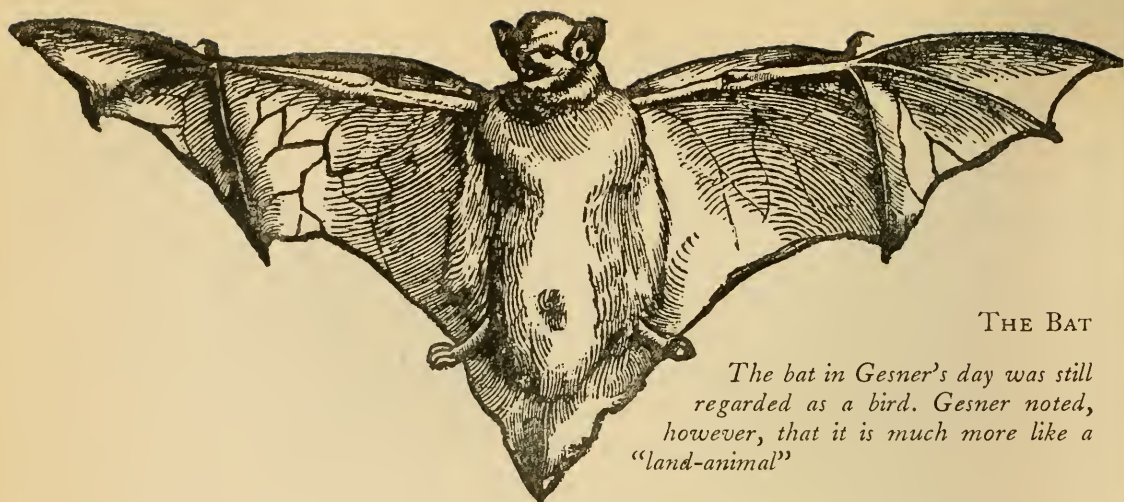
covered the Pacific Ocean, and by Cortez and Pizarro who conquered Mexico and Peru.

In those troublous times, when discoveries of all kinds were being reported by the dozen from all corners of the world by means of the newly invented printing press, scientists, mostly living rather poorly in their picturesque old towns, struggled to create natural history anew. The works of the great naturalists of Greece and Rome had been preserved (but also distorted) by the Arabs; and the Arabs themselves had added a few discoveries of somewhat doubtful value and truth. The task of the men of science was now to sift this material, to restore the ancient authors and to collect the new discoveries that poured in from everywhere. A clear survey of the wealth of nature, based on this new and rediscovered knowledge, was their goal.

This task was so difficult that every one who succeeded in contributing to the restoration of natural sciences deserves to be termed a great man. But greatest of them all, an outstanding figure even among these illustrious pioneers, was undoubtedly Konrad Gesner von Zürich.

He was a German-Swiss, born on March 26, 1516, in the city of Zürich in Switzerland. His father, a poor furrier, was a fanatic follower of Zwingli, the Swiss Reformer. Both Zwingli and his follower Urs Gesner, the father of Konrad, died in 1531 in the battle of Kappel, when Konrad was just fifteen years of age.

The youth was severely handicapped by poverty and ill health not only at this period but throughout his life, yet he persevered in professional and private study until he became one of the greatest natural historians.



THE BAT

The bat in Gesner's day was still regarded as a bird. Gesner noted, however, that it is much more like a "land-animal"

For a short time he lectured as professor of the Greek language and literature at Lausanne. In March, 1541, he returned to his native city of Zürich as a *Doctor Medicinae*, having successfully disputed with his teachers the question whether the brain or heart is the source and control of the senses and motion. ("*An cerebrum sit, principium sensus et motus, an cor?*")

In Zürich he established himself as physician and continued his studies. In 1554 the magistrates of the city appointed him city physician and public professor of natural sciences and philosophy. Ten years later the Emperor Ferdinand V granted armorial bearings to him and his family, and a coin showing Gesner's portrait on one side and his bearings on the other was stamped. This coin is the only contemporary portrait of him that is known.

In the same year the plague swept Switzerland, and the inhabitants of Zürich were stricken in large numbers. Gesner fought the epidemic successfully; but it broke out again

the following year, and the city physician himself was this time among the victims. Gesner's friends persisted in the hope that he would be able to cure himself; but from the very onset of his illness Gesner himself was convinced that, with his stamina greatly reduced by overwork, he could not survive. He further seems to have placed a fatalistic belief in a dream he had had some time before. He dreamed that a poisonous snake had bitten him and took it as an omen that once an illness caught him he would never recover.

His last days were governed by the determination to put his rather cryptic botanical notes so far as possible into form for publication. During this time he worked incessantly in the little museum he had created. It was the first museum of natural history in Switzerland, and formed part of his house.

Gesner's last night is described in his first biography, written by his friend Josias Simmler.

"Now it was the fifth day of his illness and the *doctores* present had not yet given up hope and it really seemed as if he felt a little better. Therefore, when his friends asked him whether they should stay with him over night, he replied that they should not inconvenience themselves, and after having said his prayers went to bed."

That same night, feeling death was near, Gesner asked to be taken into his museum where he had spent the greater part of his life. There he passed quietly away a few minutes before midnight, December 13, 1565, at the age of only 49 years and 9 months.



FATHER NILE

Father Nile and his typical animals, the hippopotamus and the crocodile

Gesner had completed only two of the four series of books he had planned. The first series, in 1545, was the famous *Bibliotheca universalis*, which was the first bibliography ever printed. It contained all the books in Latin, Greek, and Hebrew printed up to that time. Further, it included almost all classical Greek and Latin works that were still unprinted.

The second series of Gesner's great plan was the *Historia Animalium*, four heavy tomes, comprising more than 4500 pages in folio, illustrated by approximately a thousand wood-cuts. This likewise appeared volume by volume.

Gesner was known as the "German Pliny" and, later, the "Father of Modern Zoölogy," though he left his greatest work still unfinished. This work, one of the first encyclopedias of plants and plant life, met with a rather adventurous fate.

When Gesner was near death he asked the other physician of Zürich, Dr. Caspar Wolf, to promise to continue and finish this great work and have it published. Wolf, though fearing that he might not have the necessary knowledge, promised. When he examined the first chapters (about 100 pages in print), the 1500 wood-cuts, and the copious notes, he found the task even more difficult than he had imagined. He managed to finish the first eighty chapters, but then gave up, and with the consent of Gesner's heirs sold all the material to Joachim Camerarius in Nuremberg.

Camerarius also tried to finish the work but met with difficulties he could not master. He

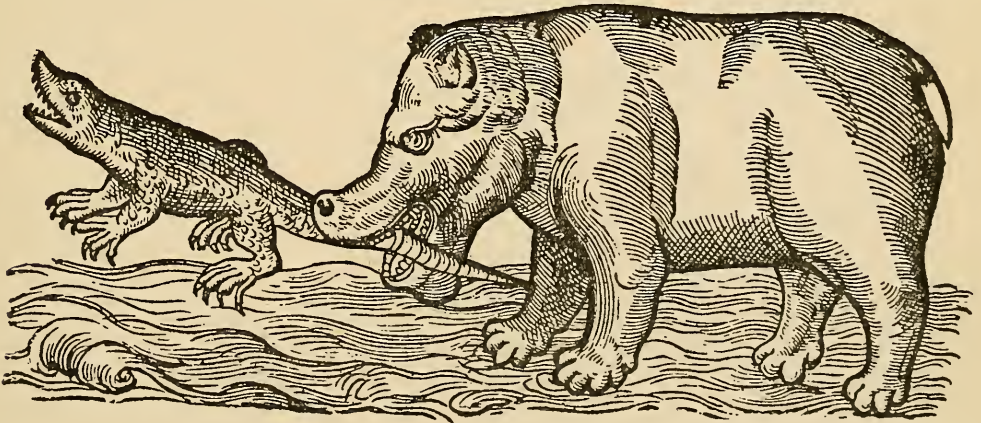


FOREST-DEVIL.

The "forest-devil" as conceived by Gesner's artist. The reports regarding this creature probably refer to a roaming maniac

used the most beautiful of the wood-cuts to illustrate a few of his own botanical works but in general he did not touch the wealth of Gesner's collections. Many years later, in 1744, the head physician of Nuremberg, Dr. Christoph Jacob Trew, purchased them and turned them over to Dr. Casimir Christoph Schmiedel who spent several years in editing the botanical studies of Gesner. They finally were published in Nuremberg in 1753 and 1759 under the title *Opera Botanica Conradi Gesneri* in two big folio volumes.

This publication proved that Gesner had been greater as a botanist than as a zoölogist, though he is chiefly remembered as the Father of Zoölogy. In his zoölogical books he pub-



THE HIPPOPOTAMUS

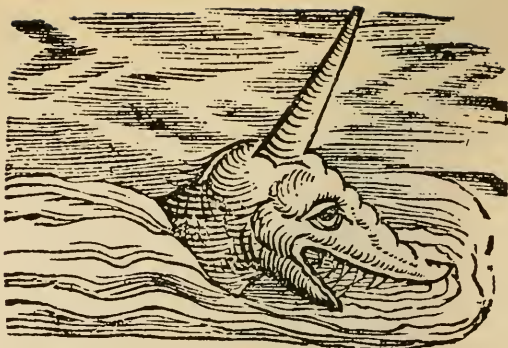
One of the earliest illustrations of the hippopotamus. Its habits being unknown to the

zoölogists of Gesner's time, the artist imagined that it ate crocodiles

lished everything that was known about animals up to the time of publication. The books are essentially a careful and exhaustive collection of facts. The volumes deal with land animals, birds, water animals, and "snakes" (reptiles in general), in the order mentioned. But within each volume the order is merely alphabetical. Here Gesner failed to arrive at any scientific system. But in the field of botany he did devise a system, and this was centuries before the Swedish scientist Karl von Linné published his epoch-making volumes about systematics.

Gesner's principle was the same as that worked out, probably independently, by Linné. It consisted in the division of plants into a number of orders, each order comprising its families, species and subspecies. Blossoms, their petals and stamens were recognized as the principal means of judging relations. It is tragic that Gesner should have died before he could publish this great discovery. Without the parts of his plant book which were edited and published by Schmiedel we should hardly know that he made it.

Though Gesner failed to make a comparable discovery in zoölogy, he is still rightly termed the greatest zoölogist of his time. Some passages in his books indicate that he was aware of relationships that were not known to exist at that time. In the opinion of his contemporaries the bat, for example, was a flying thing and therefore a bird. Consequently it found a place in his Bird Book, but Gesner does not fail to note that the bat is much more like a

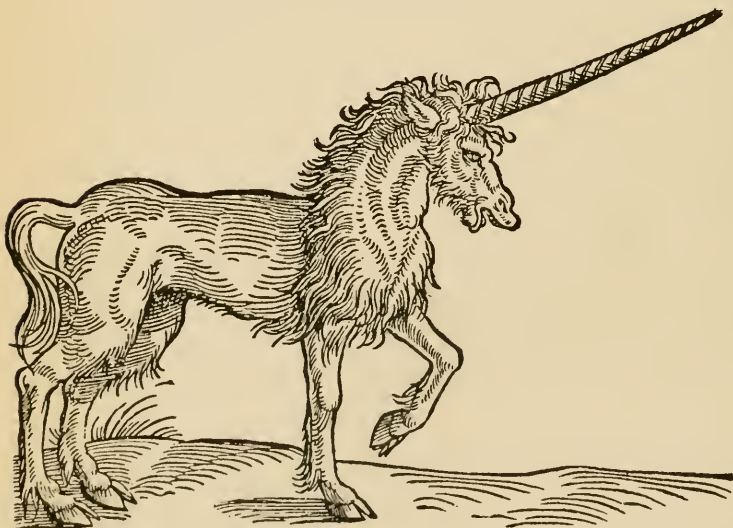


THE NARWHAL

Gesner took this picture from Olaus Magnus, not knowing that this animal produced most of the tusks supposed to be unicorn horns

"land-animal" (we would say, mammal). He deduces that it possibly forms a link between birds and mammals. This, of course, is a mistake; the bat is simply a flying mammal. But it shows that Gesner had ideas about possible relationships which had not previously been dreamed of.

He encountered a similar inconsistency when, in writing his "Fish Book" he came to the hippopotamus. This animal was almost unknown to zoölogists of his time, and many were even doubtful about its existence. Gesner identified it at once as the animal he had seen represented on Roman coins. All reports, classical as well as contemporary, agreed that it was a water creature, and Gesner therefore gave it a place not in the first, but in the third volume,



THE UNICORN

Gesner wondered why this animal if it existed never had appeared in the Roman arenas, where every kind of beast, even the hippo, had been exhibited

the one about fishes and other marine animals. But here, too, he made a remark which indicated that he was not content with so primitive a "filing system." What a system it was that would put an obviously terrestrial animal among the fishes!

He mentioned that he had received from a friend some teeth that were unmistakably from a hippopotamus. The incredible fact to him was that the friend had found them in a riverbed near his native Zürich. They were, of course, fossil teeth, remnants from the Tertiary age; but as geology did not exist in Gesner's time he was forced to compromise: "whether these teeth came from hippos, dragons or other cruel animals we will not decide now."

His works, the originals as well as the contemporary translations, are admittedly not free of error. They even contain a few of the myths and fables of the ancients. But Gesner, though he felt obliged to include such things, generally made it a point to express his doubts.

He reasoned, for example, that all the stories of half-men and tree-men, dwarfs and "forest-devils" were only misconceptions of monkeys and apes. He denied the story of the basilisk, and did not believe in the existence of sirens in the sea, or in the legendary bird roc, or the winged horse Pegasus. He ridiculed the seven-headed hydra and put the responsibility for the truth of the "sea wonders" on their reporter Olaus Magnus.

Sometimes he was uncertain. Dragons seemed to be fairly well authenticated, and he had seen "little ones"—probably tropical liz-

ards, among them the variety from Java known even today as "flying dragons." While admitting that dragons possibly existed, he stated nevertheless that what was sold in the pharmacies under the name of "dragon blood" was not dragon blood and often not blood at all.

The question of the unicorn proved especially bothersome. All the ancient books mentioned it, to be sure, and unicorn horn was sold at exorbitant prices in every pharmacy. But nobody had ever seen the animal alive. Gesner published all available descriptions of the creature, and went so far as to say:

"Let us agree that India, Syria, and the Land of the Black People produce them, and let us believe in the narratives of the explorers as to where the horns come from."

It nevertheless worried him that the Romans had never had a unicorn in their arenas, where every possible kind of a beast was to be found.

In reality the "horns" were narwhal tusks. Gesner did not know this, though he had the picture of a narwhal after Olaus Magnus. Probably because he did not credit Olaus Magnus, this explanation did not occur to him.

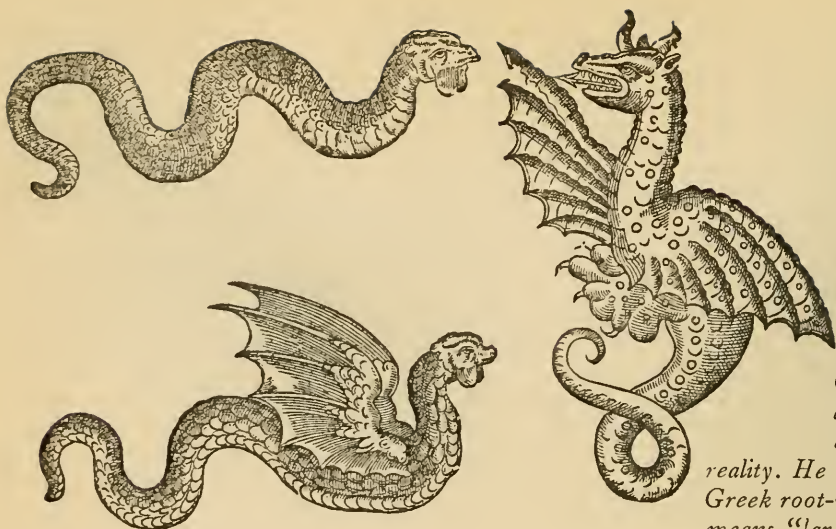
Of the creditable series of original zoölogical discoveries which Gesner made and published, a considerable number were not accepted as authentic until after being disputed by his successors.

The most famous case of this sort is his "*Waldraup*" or wood-crow. Gesner lengthily described this bird, then existing not only in Switzerland but also in other neighboring



SEVEN-HEADED HYDRA

Gesner ridiculed belief in this purely legendary creature



DRAGONS

Gesner depicts these dragons but is uncertain about their reality. He emphasizes that the Greek root-word drakon simply means "large snake"

European countries. He reported that he had found its stomach to contain bugs, beetles, and worms harmful to crops, which indicates that he knew the bird well. For this reason other authors of scientific books accepted the *Waldrapp* as existing, though they did not know it from personal observation.

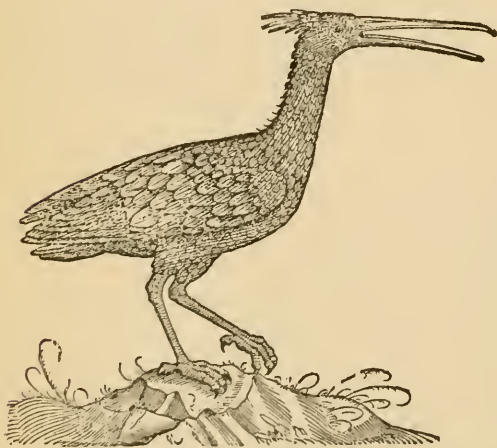
The *Waldrapp* was a continental bird. English scientists following soon after Gesner had to rely on his authority concerning it. Ray calls it "Gesner's Wood-Crow"; Albin calls

it the "Wood-Crow from Switzerland"; and Sir Thomas Lowther even possessed a specimen of the bird in his collection.

This combined evidence convinced Linné that he should give a place to the wood-crow in his system, though he did not have direct knowledge. Because Gesner had reported that the wood-crow lived in secluded places, Linné introduced "*Upupa eremita*" as the scientific name, "eremita" meaning "hermit." A few years later he restored the original designation, "*Corvus sylvaticus*"—wood crow. Linné's uncertainty shows that he did not know the bird, and neither did the other naturalists of his period.

In 1805 Bechstein, the greatest authority of his day in ornithology, declared the wood-crow to be an error and omitted it from his *Natural History of Germany*. By then the bird was extinct in nature as well as in books, and a long time passed before the truth was discovered.

About thirty years later Professor Wageler discovered in Egypt a new variety of ibis, called *Ibis comata* or *Geronticus comatus*. By mistake this bird was included in Dresser's great "History of the Birds of Europe." This was wrong, for *Ibis comata* was not a European bird. But it was also right, because this ibis was Gesner's wood-crow, now extinct in Europe, but still living in Northern Africa. Yet it took seventeen more years to find out that wood-crow and *Ibis comata* were the same bird. Gesner's *Waldrapp* was rediscovered, its author vindicated—Gesner was right.



GESNER'S WALDRAPP OR WOOD-CROW

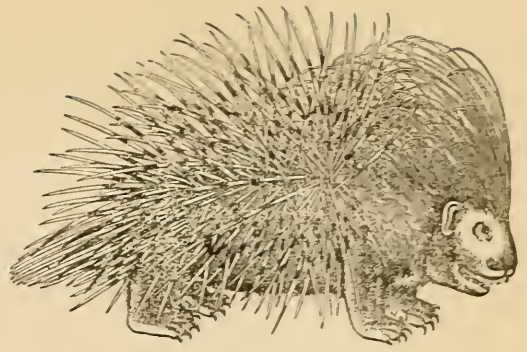
When Gesner's successors were unable to find this bird, they believed that he had been deceived, but he was vindicated when it was rediscovered three centuries later

Another case of a belated vindication of Gesner is that of the porcupine. Gesner stated, probably for the first time, that the porcupine defended itself by "shooting" its quills. Later this idea was laughed at (Buffon was the first to doubt it), and all books declared that porcupines did *not* shoot their quills, in spite of the common belief. More than 300 years after Gesner, Professor Dr. Vosseler, director of the Hamburg Zoölogical Park, repeatedly found quills not simply in the cage of the porcupines but in the neighborhood, sometimes as far as fifteen feet away and occasionally even sticking into the cloth with which the cage was covered. The truth is, of course, that the quills are only loosely attached to the skin of the porcupine and that a few are always likely to drop out when the animal erects them very quickly in defense of a real or imaginary danger. When swung around violently in anger or fear they may fly out and possibly hit an enemy. Gesner's report proved an exaggeration of observed facts, yet essentially he was right.

Gesner was the first to mention the humming bird; he gave the first description of the canary bird; he discovered the Alpenflüevogel.

Incidentally, in one of his smaller books he made the first mention of a pencil. His illustration, which is the oldest known picture of a pencil, shows a mechanical variety, indicating that the refillable pencil is the older form.

Though only a short medical book by Gesner appeared, which is simply a collection of prescriptions, it would be unfair not to mention the fact that he won high repute as a physician. From a passage in one of his letters we can even

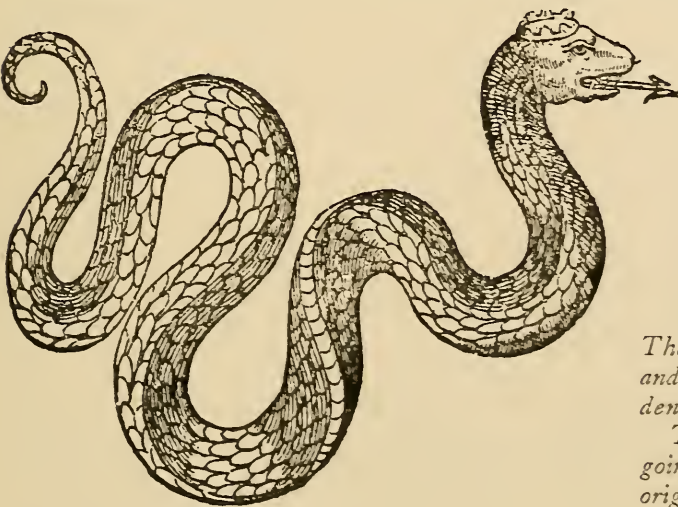


THE PORCUPINE

Gesner defended the belief that the porcupine can shoot its quills

deduce that he discovered what was later called autosuggestion. Discussing the value of a few especially favored and highly priced medicines, he expressed his opinion that the so-called "liquid gold" must be useless. It was prepared by pouring boiling wine over gold, under the assumption that the wine dissolved a part of the metal. Gesner declared that gold cannot be dissolved in wine, and that the medicament could not therefore cure an illness, or "if it cures, it is the wine, the other ingredients, or the belief of the patient."

Although this passage sounds wholly natural to us, for centuries it was laughed at by the physicians. How ridiculous that belief could cure! We know now that in some cases it can, and once more the Father of Zoölogy, even when speaking as city physician of Zürich, was right.



THE BASILISK

The basilisk was pictured with a crown and called the king of animals. Gesner denied its existence.

This picture, as well as all the foregoing ones, are taken from Gesner's original works

Buffalo Hunt—1935

Airplane, pack horse, and dog sledge carry a modern museum expedition to the last refuge of the wood buffalo

By GEORGE G. GOODWIN

*Assistant Curator, Department of Mammalogy,
American Museum*

ON the morning of August 13, 1934, between dawn and sunrise, not a breath of air stirred the mirror surface of Cooking Lake. Without a breeze our overloaded plane could not rise into the air for its flight into the northern wilderness.

In advance of the sun a veil of mist was rising from the glazed water. Shrill cries of shore birds sounded across the lake from the low gravel beach. Then, with the first glint of the sunlight, fleecy clouds turned to gold, and the necessary breeze rippled across the glassy surface.

With open throttle our plane zoomed across the water and rose. The reaching tree tops fell below and we flashed upward into the open sky. We swung northward, and climbed. The air was crystal clear in the direction of our objective, Pine Lake.

The major purpose of our expedition into subarctic Canada was to obtain typical specimens of wood buffalo for the American Museum of Natural History, and a group for the National Museum of Canada.

The flight to Pine Lake

The exact relationship of this race of animals has been under dispute. Most authorities regard it as a valid species, distinct from the more familiar plains bison, from which it is segregated by natural boundaries in the form of gigantic rivers, lakes, and huge areas of almost impassable muskeg. Some zoölogists believe, indeed,

that the wood buffalo is more closely related to the European bison than to the typical American variety.

With the wind singing wildly through the struts of the plane, we passed over the low flood plains of the Athabasca, Peace, and Slave rivers, vast areas of delta marshes and abandoned river channels. At about three o'clock we saw the glint of water through the scattered clouds, a strip of silver between the dark spruce trees. Nosing downward, we alighted almost without a bump on Pine Lake.

Here was our immediate destination. The facilities of modern invention had enabled us to land in the heart of the early summer range of the wood buffalo, a desolate waste which a few years ago could not have been reached without months of tedious travel. But the task of securing our specimens was nevertheless a difficult one.

Lying about fifty miles south of Fort Smith, Pine Lake stands a little higher than the salt plains to the east. Its thick forests afford protection for the buffalo from the myriad insect pests which infest the country in June and July.

We scouted through the woods on horseback and found recent signs of buffalos, particularly in the form of "wallows," most of which were in open spaces in the forest. These wallows are saucer-shaped depressions about ten feet in diameter, where the creatures have rooted up the turf and rolled in the dirt to facilitate the shedding of their hair and to dust their hides with loose soil as protection against the flies. The high hump on the backs of these animals, unlike that of the plains buffalo, seems to obstruct this operation. We later saw a number of old bulls in the act of rolling, but they never

seemed to succeed in turning completely over. They also enjoy rubbing their shoulders and necks against tree stumps, and take particular satisfaction in tearing small spruce trees to shreds.

Our horses were restless, and shied at every shadow that looked like a buffalo. We presently learned that it was never safe to take chances where there was possibility of an encounter, for, rounding a sharp bend, we unexpectedly met an old bull apparently retracing his migration route. The old warrior was not to be deterred from his course. Rooting up a cloud of earth, he charged directly through the center of our outfit, scattering us to right and left, then continued on his way.

When on the move, wood buffalo pay little heed to anything in front of them, and when they charge, if a man falters, he is liable to have small chance of avoiding their mad rush in the willows and thick timber. On the other hand, they appear timid of any possible danger from the rear. Once on the run they seem consumed with terror, and plunge headlong into the forest.

Their eyesight is not good, but their senses of smell and hearing are keen and unless one stalks them stealthily upwind, there is little chance of getting within rifle range. A band of five or six young animals that started about

a thousand yards downwind from us, went crashing through the forest at an amazing rate; and though we followed them some distance, we finally lost them.

From the general scarcity of the creatures here we concluded that, with the worst of the fly season over, they must be moving toward the salt plains, where more abundant forage was available. So we determined to proceed in that direction.

About three o'clock a thunder storm which had been threatening all morning broke. The rain came down in a steady torrent, and we pushed on through dripping trees until a suitable place to camp was located near a freshwater marsh.

Stampeding buffalo

The following day we continued toward the salt plains. We alternately passed through thick forest and muskeg, the horses floundering with difficulty through the frequent mud holes.

A big garter snake a yard or more in length slithered across the trail at one point. It was apparently the first of its kind to be reported in this region.

Soon we were out of the timber. Thereafter strips of grassy meadow between areas of willows offered good cover and better travel.



THE WOOD BUFFALO PARK

This isolated preserve shelters some 2000 of the once abundant wood buffalo. Specimens of the animal and information regarding its habits

were an objective of the Snyder-Canadian Expedition. The dotted line marks the route flown by the expedition

At the edge of a water hole we spied a small herd of buffalo feeding. Hiding in the thick brush, we studied their movements as they grazed, and noted that they were idling toward us. Then from the right along the lake shore came an old bull, traveling rapidly. His shoulders, which reached well above the willows, must have been close to seven feet in height. Presently he halted, suspicious, and remained back among the willows, out of rifle range. Then the herd got our scent and stampeded. Their motion as they galloped off might best be described as a series of bounces, with all four legs operating together quite stiffly. The big bull likewise made off and, though we tried to follow him, he succeeded in quickly putting distance between us.

There was good grazing here, where the open meadows were broken only by occasional clumps of spruce and pine and extensive thickets of willows. And here we struck the main artery of the migration route. It led toward the salt plains in a single path beaten hard by trampling hoofs and branching out in the muddy sections into seven or eight deeply trodden furrows. Following it, we frequently noted tracks of big timber wolves. Once we saw a coyote slink away through the brush.

A splendid specimen

The buffalo we had seen were still keeping close to the woods, and we discovered no fresh signs of them on the open salt plains. Swinging back to the edge of the timber, therefore, we were rewarded by the sight of a fine big bull just emerging. But he saw us at the same instant and made off across a salt creek, disappearing into the woods beyond recovery.

Entering the willows again, we presently made out the dark outline of a huge brown hump above the thickets. Fortunately we were downwind, and dismounting, we were able to push our way closer through the dense bushes. He was a magnificent creature, which, if the difficulties of transportation did not defeat us, would make a splendid museum specimen. After careful maneuvering we finally secured him, and ascertained that he measured six feet six inches at the shoulders.

It was now late in the evening and, though the days were long, it was all we could do to remove the skin before dark. The hide around the neck and horns was an inch thick and the

four of us had a struggle to turn the animal over.

We constructed a travois of dry spruce poles upon which to drag the animal away, but this proved a complete failure. The horse to which we hitched it bucked, jumped, and kicked until free of all impediments.

Salting the skin overnight and drying it out the following day reduced the weight sufficiently to permit our packing it on our strongest horse. The skeleton was divided among the rest of the animals, and thus we were able to get back to our base camp.

Days were slipping by and the chances of getting a complete series of wood buffalo in the time at our disposal were not promising. Packing a light outfit, we set out again to follow the migration route. The weather was overcast. The first day a few old bulls, usually in pairs, were seen. But these were plains buffalo which had been imported from the herds at Wainwright to replenish the diminishing woodland species, and were not what we were after.

While we were eating lunch on the bank of a fresh-water lake, the roar of a bull drifted down the breeze. At intervals of a few minutes the sound recurred. As it was distinct only when the wind was exactly right, we knew that the distance must be considerable. A dense wet mist enveloped the trees and willows, blotting out all the surrounding landscape. We worked upwind, guided by the often repeated roar, and drew quite close before the gigantic forms of a whole herd loomed up through the mist. When the fog cleared, we counted thirty animals, feeding on an open meadow. The old herd-bull was wandering restlessly about, apparently expecting a rival, which presently burst into view.

The battle

With a roar the intruder challenged the herd-bull, and a furious battle ensued. The two charged, backed off, and charged, time and again. The rival was younger and, if not more powerful, was more agile. The old warrior, realizing his opponent's superiority, at last resigned himself to defeat and made a sedate exit into the forest. The conqueror then challenged each young bull in turn and settled down to rule. To our extreme disappointment, however, not one wood buffalo was included here—they were all plains animals.

The sound emitted by an old bull is like the deep guttural roar of a lion. To realize its full force one must hear it in the dead of night as we did from our lonely camp at the edge of the salt plain. The roar came suddenly, not twenty-five yards from the canvas shelter beneath which we slept. We all sat bolt upright, for an old bull which has been deprived of his harem, like the one we had recently observed, does not make an ideal partner for a midnight tryst. By the glow of two broad streaks of northern lights we discerned two aged bulls, apparently out to fight a duel. Fortunately they were too much interested in sizing each other up to molest us. But again the animals were plains buffalo.

Of wood buffalo we had secured only one. Day after day we combed the forest and salt plains, but without success. To make matters worse, the expedition had a date with a pack outfit a thousand miles away in the peaks of the Rocky Mountains in British Columbia. Somewhat disheartened but intent upon returning in a few weeks to complete the series, we at last had to depart for the Rockies by plane.

Early snow storms delayed our return, but we managed to land back at Pine Lake on September 23. Many of the smaller lakes were now frozen over. The ground was crusted with frost, and the chill of winter was in the air.

Packing our outfit on horses, we traveled eastward toward the salt plains, and camped at night on the bank of a creek. Early the following morning we scoured the grassy meadows.

When we spied three young buffalo sunning themselves on a bank we felt that luck was with us, but they dashed off through the water and were lost.

More group material

It was on a marshy plain broken by areas of willow trees that we met with real success. The herd which we sighted there and studied through our field glasses were unquestionably wood buffalo and included several fine specimens. Leaving our horses with the warden, we made a wide detour to leeward. Then wading through wet marsh behind an islet of spruce trees and willows, we succeeded in approaching within range. Our patience was rewarded by the acquisition of four specimens: two cows and two bull calves.

Sudden activity then threw us on our guard. The herd leader sighted us in the open and, apparently excited by the smell of blood, made a direct charge. Our desire to secure photographs of the animal in action caused us to wait longer than was altogether safe, and the ferocious creature gave us a few tense seconds before we could bring it down. The rest of the herd, deprived of their leader, swerved and plunged into the forest. While skinning the specimens we had secured, we saw several bears rear up on their hind legs in the surrounding tall grass to see what was going on.

Winter flying

We still needed one more old bull to complete our series. Snow was beginning to fall, and we were reminded that the season was well advanced. A few more days were all we could expect before the freeze-up. And when once the rivers froze, there would be no hope of flying out before the onset of winter. The chances of securing the other bull were too slim to hazard. So we reluctantly returned to where our plane awaited us at the Government Hay Camp on the Slave River, resolved to come back equipped for winter flying and winter travel.

It was March before we could return, with renewed determination to get that last bull. Our plane landed us on the ice of the Slave River on the 25th. The north was still in the grip of winter. The temperature registered 30° below, and a stinging wind driving a fine, powdery snow greeted us as we landed. Ranger Mike Dempsey met us with dog teams.

Two days of fast sled travel brought us to the edge of the salt plains, great expanses of wind-swept tundra. We made a long trip to the north. The snow was soft and deep, and travel through the underbrush on snowshoes was difficult. But where the crust on the snow was strong enough to hold the dogs we made good time.

Rounding a clump of pine trees, we saw two big bulls rooting under the snow for grass. We left the dogs and started through the bush. But we had gone only a few yards from the sledges when the dogs started to howl, and away went the buffalo. They plowed off through the deep snowdrifts with perfect ease. We followed in their wake for several miles; but it was impossible to keep up. They were

... traveling at a gallop when last we saw them.

The next trip was down the salt creek. The sledges ran smoothly on the even snow, and we were able to cover considerable distance this day. We saw about ten buffalo at one bend in the river, but there was not a really big bull in the lot, so we let them go.

The long trek to camp revealed nothing of particular interest. The wind was rising, and it bit into our faces severely when crossing open spaces. That evening a pair of mock suns, or sun dogs, appeared distinctly above and below the sun. This spectacle is caused by the presence of ice crystals in the air. The wind began to whistle through the pines and dark clouds were gathering in the north.

The following morning a stiff wind was driving fine, dry snow, and as the day progressed a blizzard developed. While it raged we had to remain in camp. The temperature ranged between 10 and 30 below, but our tent fortunately was of strong canvas, and though we were cold, we were none the worse for the experience. Later I learned that the wind had reached a velocity of sixty miles an hour, and the plane which was at Fort Ray had to be fastened down by eight one-hundred-gallon cans of gasoline.

Mike told us that he had seen two wolves run into a herd of buffalo, but the latter paid not the slightest attention to them and continued to graze. This astonished him as it is generally believed that the wolves frequently kill buffalo. An examination of the food eaten by six wolves killed at this time showed not a trace of buffalo meat.

Good hunting weather

After the storm the sun came out and the sky was blue and clear. The temperature dropped to 35 below, and prospects for good hunting weather were favorable. We left camp at about 7:00 a. m. and made a wide circle over the salt plains. But we saw no signs of buffalo here. The biting north wind had apparently driven them into shelter.

Striking off toward the timber, the dogs became interested in a particular growth of willows and spruce trees some five hundred yards away. They frequently looked in that direction, and as we passed on the leeward side, they seemed loath to leave it behind. Some

creature was undoubtedly hiding in that cover, and we finally determined to investigate.

Entering the brush some distance beyond, we worked along to the spot indicated by the dogs. Here we found fresh tracks of a big bull that had been rooting under the snow. There were spots of blood where the animal had cut its muzzle on the sharp crust. Crossing a low ridge and straining our eyes through the thickets, we saw a big, dark shadow not more than thirty paces away. It was a magnificent bull buffalo of the woodland variety. Here at last was the animal that would complete our series.

The end of the hunt

Our suspense after such a long search can well be imagined. Experience had taught us how difficult it often is to bring down one of these animals; and we knew that if we lost this specimen we might not find another equal to it without tedious efforts involving repeated disappointment. Steady yet instantaneous nerves tempered with more than ordinary patience are the primary requisites in big game hunting. In maneuvering to secure this animal, the need of success caused us to take every precaution. The shot was fired with breathless anxiety; and in a moment, that tense interlude during which the hunter is uncertain whether his quarry is unable to charge, was safely passed.

Measurements proved that he had stood six feet seven and one-half inches at the shoulders. As so often seems to happen, the specimen was secured at sun-down, greatly increasing the difficulties of skinning it. The intense cold froze the hide as we peeled it off. Working by the light of towering log fires, we were kept busy far into the night.

Three campaigns into this wilderness had been necessary to attain our objective, but the results amply rewarded all our exertions. We had secured the quota of animals which were to be divided between the American Museum of Natural History and the National Museum of Canada, so that each would receive a group comprising a bull, a cow, and a calf. It is not easy to hunt this animal, owing to its scarcity and the inhospitable nature of the country. But our patience was the more rewarded because the individuals we selected were magnificent representatives of their race, perfect in every respect.

In Quest of Wood Buffalo



An airplane sped the Snyder-Canadian Expedition to a desolate region which a few years ago could not have been reached without months of tedious travel

The wood buffalo is larger, darker in color, and shaggier than the plains bison. Most authorities regard it as a separate species, but as a pure race it is probably disappearing. (Copyright photograph by F. H. Kitto, Department of the Interior, Ottawa)





(Above) A member of the expedition scouting through the subarctic forests. Buffalo tracks were plentiful, and the horses shied at every shadow



In winter the range of the wood buffalo lies white under subzero temperatures, and dogsleds are the only mode of travel



Day after day the expedition with light equipment combed the forests and salt plains



(Above) The wood buffalo is difficult to obtain because of its keen scent and hearing. When the party had secured all but one of the desired animals, the onset of winter interrupted their quest

(Below) Equipped for winter travel, the expedition renewed its campaign. After landing on the ice of the Slave River, the party continued the journey by dog-sled





The buffalo root for forage through the crusted snow with their muzzles

The last specimen collected by the expedition was a magnificent bull standing six feet seven and one half inches at the shoulders



Salamanders

Modern representatives of the first back-boned animals to live on land

By CHARLES E. MOHR

*Naturalist, Public Museum, Reading,
Pennsylvania*

SALAMANDERS—creatures of fire or of icy coldness, amphibians or reptiles, poisonous animals or harmless?

From ancient times they have been creatures of controversy; even today they are the subject of false notions and absurd superstitions. What are these salamanders?

The name itself is less familiar than the animal, for every youngster who has turned over a rock on the hillside or who has peered into the depths of a spring or under the stones in the creek knows what "lizards" are. For he has caught the slippery, squirming things, and proudly borne them home in a commandeered milk bottle or discarded tin can, only to have his mother throw up her hands in alarm and warn him that they will jump down his throat and live in his stomach. Or, if a wiser and more tolerant parent expressed no alarm at the sight of the "spring lizards," the youngsters would soon discover that the little animals had dried up and died.

Salamanders vs. lizards

This tendency of the skin to dry is characteristic of salamanders and illustrates the chief difference between the common "spring lizard," or salamander, and the true lizard. All salamanders have moist, glandular, and scaleless skin; whereas all lizards are scaled, their skin being hard and dry. Salamanders, requiring moisture to live, frequent springs, wet moss, and bark, or the damp earth under boards and stones. Lizards, on the contrary, avoid water and are found most often in dry, sandy places, or clambering up the trunk or branches of trees, hunting a spot where they

can bask undisturbed in the warm rays of the summer sun. Salamanders are amphibians, related to the frog and toad, and like them pass through two distinct life stages after hatching out of the egg—larval and adult. Lizards are reptiles and show their relationship to the snake, the turtle, and the alligator in numerous characteristics, particularly in the absence of a larval stage in their development. They are hatched as miniature adults.

A knowledge of the habits of salamanders explains the first paradox that their name suggests. That is, the relation between the superstitious belief in the salamander as an animal born of fire and its known aversion to anything hot and dry. The mythical fire-haunting salamanders are best represented by the European "fire salamanders," *Salamandra salamandra*.

Fire salamanders

For centuries past peasants and nobles alike have been startled by seeing this creature come crawling out of the fire as they threw logs on to the blazing hearth. That they actually saw salamanders is not to be doubted; but their assumption that the salamander made its home in the fire and that it could withstand flame was erroneous. Obviously, the salamanders had hidden themselves under the bark of the log or in the dark dampness of its crannies while it lay in the forest and thus were brought indoors as wood was gathered. When placed in the fireplace, they were driven out by the heat, which was no more pleasant to the unfortunate fire salamander than it would be to a human.

The term salamander has been borrowed for technical use to describe instruments used in fire, such as the metal drum in which coals are heated for drying plaster, and for the slag

remaining in the metallurgist's furnace after the fires are drawn.

In contrast to legend is the fact that salamanders are among the animals most tolerant of cold. For there are blind cave salamanders which spend their adult life in the cold and darkness of subterranean streams, and others which dwell in the ice-fed waters of mountain streams. I have seen salamanders migrate even through the snow to the icy waters of woodland ponds to lay their eggs among pieces of floating ice.

A crucial stage in evolution

Hardy creatures, these salamanders; and of ancient and honorable lineage. They represent a crucial stage in the evolutionary development of the higher back-boned animals. The amphibians became indeed the masters of the earth, the dominant form of life in the coal forests of the Carboniferous period. And only after millions of years did they give ground to the larger and apparently better adapted reptiles. The salamanders living today represent merely a remnant of their fossil ancestors. In Stejneger and Barbour's "Check-list of North American Amphibians and Reptiles" just eighty-six species are listed for this continent north of Mexico.

Just how crucial the transformation from fish to salamander must have been, may be realized if one compares the anatomical features of the two. As Noble points out, however, the ancestors of the salamanders could not have been fish of the type of our modern ones, considering the tremendous changes of structure which would be necessary for the transformation of the modern fish into a salamander. For instance, the gills would have to be replaced by lungs, with a nasal passage developing to take in air when the mouth is closed. The fins and body would have to become adapted to land locomotion and the skin modified to prevent drying. Then, too, specialized glands would be needed to keep the mouth and eyes moist, with softer eyelids developing out of folds of the skin. The sense organs would also be modified, those of the lateral line disappearing as the auditory, optic, and olfactory centers became more highly specialized. Finally, the eyes would have to be raised above the surface of the skull if they were to be at all efficient.

Obviously such a transformation could not have been a sudden one. And there is considerable fossil evidence which indicates that all the fishlike forms from which the large and numerous ancient salamanders developed probably were considerably different from modern fishes.

Among the most unusual modern salamanders are the extraordinarily large *Siren* of the southeastern states, an eel-shaped animal with branched external gills and a single pair of limbs; *Amphiuma*, the "Congo-eel," which superficially resembles the last form but lacks external gills while possessing two reduced pairs of legs; and the flat-bodied, stout-limbed hellbender, *Cryptobranchus*, also without external gills.

This latter creature, the hellbender, is a large, aquatic salamander of the mountain streams of the eastern states. It has a bad reputation among fisherman and has little competition for the title of the ugliest salamander. Though it reaches a length of eighteen inches, it is nevertheless dwarfed by its Japanese relative, the giant *Megalobatrachus*, the world's largest amphibian, which attains a length of at least four feet.

Still another group includes the gilled mud-puppy, *Necturus*, which may be thought of as a permanent larva although it becomes sexually mature and reproduces. This peculiar condition is called neotony, and is explained by the conjecture that the adult stage has been lost during geological history, the larval stage assuming the reproductive function.

Scarcely less remarkable than the "permanent larvæ" are those salamanders which develop on land and so require the passage of the whole larval life within the egg.

The red-backed salamander

By far the most common of the terrestrial species in the east is the red-backed salamander, *Plethodon cinereus*. While these salamanders are most frequently seen in wooded areas where rotten logs and stumps provide food and shelter, they may be found almost as often on mountain slopes or under rocks in abandoned fields.

I have found eggs of the red-backed salamander as early as the middle of June, but the egg-laying may continue into September. Most commonly the eggs are found in a cavity in a rotten log. The female usually lays three

to thirteen eggs and attaches them to the roof of the tiny chamber. As each egg is laid separately and adheres to those previously laid, the fused outer capsule serves to hold the eggs together, the mass usually taking the form of a bunch of grapes. The female coils around the eggs, probably as a means of keeping them moist.

The developing embryos have large external gills which are usually lost before hatching. By this time they have the same form as the adult, although they are only three quarters of an inch long. The adult itself is seldom more than three inches in length.

Many salamanders manage to escape observation because of their small size, practically all of the commoner species being less than eight inches in length. The larger of these are further protected by spending their larval life in the water where their inconspicuous coloration makes them practically invisible. Salamanders elude observation chiefly by hiding away in the daytime, or almost continuously as in the case of the larger terrestrial species which are seldom seen except during the breeding season. At night the smaller species may be seen in numbers on the forest floor or in low bushes, but during the day they hide away under logs or stones, in bark or moss, or in cool, dark holes, under the overhanging banks of streams.

Blind salamanders

Some salamanders shun the light to such an extent that they have lost the use of their eyes. This is true of the blind cave salamander, *Typhlotriton spelaeus*, of the Ozark Mountains in Missouri.¹ This cave-dwelling amphibian is characterized by translucent skin which is practically without pigmentation. Strangely enough, the larvæ of *Typhlotriton* are densely pigmented and have well developed eyes. After two years of larval life in the springs or colder streams, they resort to the caves to transform into adults. A number of destructive changes accompany metamorphosis—the eyeballs withdraw somewhat into the head, the retina degenerates, and the eyelids fuse together, although the dark eyeballs still show through them. Laboratory experiments with *Typhlotriton* larvæ brought to the American Museum of Natural History from the Ozarks,

¹An article on the blind cave salamander was published in *NATURAL HISTORY* for September-October, 1927.

demonstrated the amazing fact that individuals undergoing metamorphosis in the light retained serviceable eyes. The lids never fused nor did the retina degenerate. On the contrary, the eyes developed more fully. Further, these individuals were distinctly darker than those which transformed in darkness. These investigations show that the apparently unfavorable cave environment has produced no permanent effect on the eyes or coloration of this salamander, for, while this loss of sight has occurred in every generation, perhaps for centuries, there is no evidence of this environmental effect becoming inherited.

The dusky salamander

Another species in which the larval life has its origin in a habitat differing from the normal haunts of the adult, is the common dusky salamander, *Desmognathus fuscus fuscus*. The salamanders are abundant in the wet leaves about springs, and along the smaller woodland streams. During dry spells they are likely to be concentrated in the muddy pools of partly dried creek beds. They burrow in the soft, loose earth, working through rotten logs and débris of the forest floor, and come eventually to water.

The egg-laying season may start in June but greatest activity occurs about the middle of July, and eggs may be found throughout the summer since they take about eight weeks to hatch. The eggs are found in a variety of situations, but the greater number including the ones illustrated, are located within a foot of the water, frequently under flat stones in the damp earth near a spring. The egg clusters are usually small, numbering from twelve to twenty, but occasionally they are considerably larger. The cluster shown in this article, taken the day before the larvæ hatched, contained forty-two eggs, all of them developing. The outer envelope of each egg forms a stalk by which it is attached to the main stalk of the mass.

When the young hatch, they do not go immediately to the water. About two weeks pass before the larval dusky salamander takes up completely aquatic life, developing a tail fin and gills. They transform into adults during the following spring.

Most salamanders do not lay their eggs wherever they happen to be at the onset of the breeding season, but migrate to the places best suited for the purpose. This is well illustrated in the case of the four-toed salamander, *Hemidactylum scutatum*. The breeding habits of this form are unique in that they represent a transition between the purely aquatic development of the more primitive salamanders and the land-breeding habits of the dusky and the red-backed. The four-toed salamander usually passes the winter, and in fact all of the year except the breeding season, in woods comparatively distant from water. Early April finds the female salamanders on the move, headed in the direction of a marsh or a pond. Here they take to the water, and swim until they locate some tiny island knoll or a spot along shore where sphagnum or other mossy or grassy hummock provides a growth sufficiently loose for them to weave in and out among the strands, laying eggs as they go.

The eggs are more numerous than those of the related red-backed salamander, but there are probably not more than forty eggs laid by a single female. Nests of several hundred are sometimes found, but these undoubtedly represent the sets of many individuals. As the larvæ hatch, they are able to drop into the water a few inches below. After about six weeks the larvæ transform and take up the terrestrial life of the adult.

Regeneration of lost parts

The tail of the four-toed salamander is modified seemingly in anticipation of being lost, for it readily breaks off at the base. This probably represents a protective device. At any rate, on several occasions I have turned my attention to the twitching tail of a salamander at which I had snatched, only to find that the tail-less salamander had taken advantage of the momentary delay to escape. Similarly, it is true of other terrestrial salamanders that they will leave part of the tail in the hand which attempts to seize them. The lost parts are regenerated, however, an adaption that seems highly important to aquatic larvæ and terrestrial adults which not infrequently lose a leg or a tail in the struggle for existence.

The breeding habits of salamanders are often extraordinary in character. There is usually a well defined courtship of the female by the male, after which the male deposits a sperma-

tophore, a gelatinous-stalked sac of sperm cells which is later taken into the cloaca of the female, fertilization of the eggs ensuing. Unfortunately the details of breeding are rarely witnessed. The habits of the terrestrial species are very incompletely known.

The pond breeders

The pond-breeders, particularly the ambystomids, offer the greatest opportunity for observation. The life history of the spotted salamander, *Ambystoma maculatum*, has been most completely studied, but recently I have had unusual opportunities for observing and recording the activities of Jefferson's salamander, *Ambystoma jeffersonianum*, which I will describe briefly.

Jefferson's salamander is a rarer and slightly smaller species than the spotted, seldom reaching a length greater than seven inches. Despite the fact that it ranges from Hudson Bay to Virginia and from the Atlantic Coast to Arkansas, the retiring habits of this species have made it one of the rarest in most localities. Unlike the terrestrial salamanders which guard their eggs and developing larvæ until they hatch, Jefferson's salamander deposits its eggs and then disappears, abruptly and completely. In fact, in certain parts of its range the salamander practically never is seen except for about a week each year during the breeding season. No doubt these salamanders have extensive burrows underground where they find sufficient food, so that few causes other than those related to breeding are sufficient to bring them to the surface.

In the eastern states Jefferson's salamander emerges from hibernation when the first warm rains of late March thaw the frozen hillsides of its woodland retreat. At times I have seen them migrating at night through patches of snow to reach the woodland ponds where they lay their eggs. Normally, however, evidence of winter is limited to remnants of rotting ice in portions of the pool. Prolonged warm rains at night sometimes stimulate large migrations, and I have seen as many as two hundred adults in a single pond.

Once in the water, the bizarre courtship ceremony, the *Liebesspiel*, begins. The males, which are about as numerous as the females at the beginning of the migration, court them,

prodding and rubbing them with their heads, finally swimming over and grasping them behind the shoulders, in what one observer aptly termed a "piggy-back ride." This ritual apparently serves the purpose of stimulating the female to pick up the spermatophore which the male deposits near by. The spermatophores are quite small, about six millimeters in height, and because they are transparent except for the tiny white sperm sac on top, escape the notice of all but the most patient searchers.

Egg-laying

Egg-laying usually occurs during the second night following the *Liebesspiel*. A visit to a pond on such a night would reveal dozens of female salamanders clasping overhanging branches in the water or clinging to the stems of dead water plants. As many as a dozen individuals may be laying eggs at one time on the branches of a single water plant. One female may produce three hundred eggs, although half that number is more nearly the average. The eggs normally are deposited in masses of ten to forty, with an average of about twenty. They are within a gelatinous mass which is quite small at the moment of deposition, but within a few hours it absorbs a large quantity of water and fuses with other masses adhering to the same branch.

The larvæ, which need no guardian, develop rapidly, hatching from the egg capsule at the end of four weeks. As might be expected of aquatic larvæ, they show adaptations to pond life. They are equipped with external gills,

broad bodies, and tail fins; in addition they have a curious pair of rodlike balancing organs which are formed even before the legs. The legs soon appear, however, the front limbs developing first, a character that readily distinguishes them from the early stages of the wood frog larvæ which occupy the same pools.

Since ponds usually dry up before the end of the summer, metamorphosis is governed somewhat by climatic factors. They are usually ready for terrestrial life by July, metamorphosis consisting principally of the loss of the branched external gills, a change in the structure of the skin, as well as certain skeletal modifications.

Valuable scientific observations

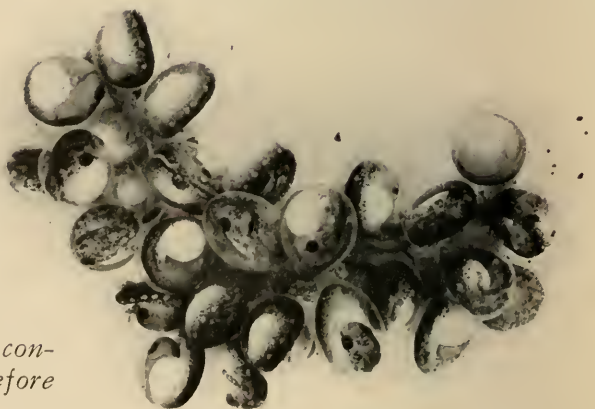
While the recital of facts regarding the life history of some of the most common salamanders may seem complete, there are many gaps in our knowledge that remain to be filled. Observations on the breeding habits of even the commonest salamander may prove of definite scientific value. Local naturalists can gather valuable data, since even locality records, when exact, are important in piecing together a picture of the distribution of a species. In addition, notes on habits including information as to the dates of appearance and disappearance and of egg-laying should be of interest to naturalists in the local field.

It is probably true that no other vertebrate group provides a more fascinating and fertile field for observation with the material so close at hand than do the salamanders.

The Dusky Salamander



The eggs are laid on land, usually within a foot of the water, frequently under flat stones in the damp earth near a spring. The female ($3\frac{1}{2}$ inches long) stays with the eggs until they hatch, a period of two months



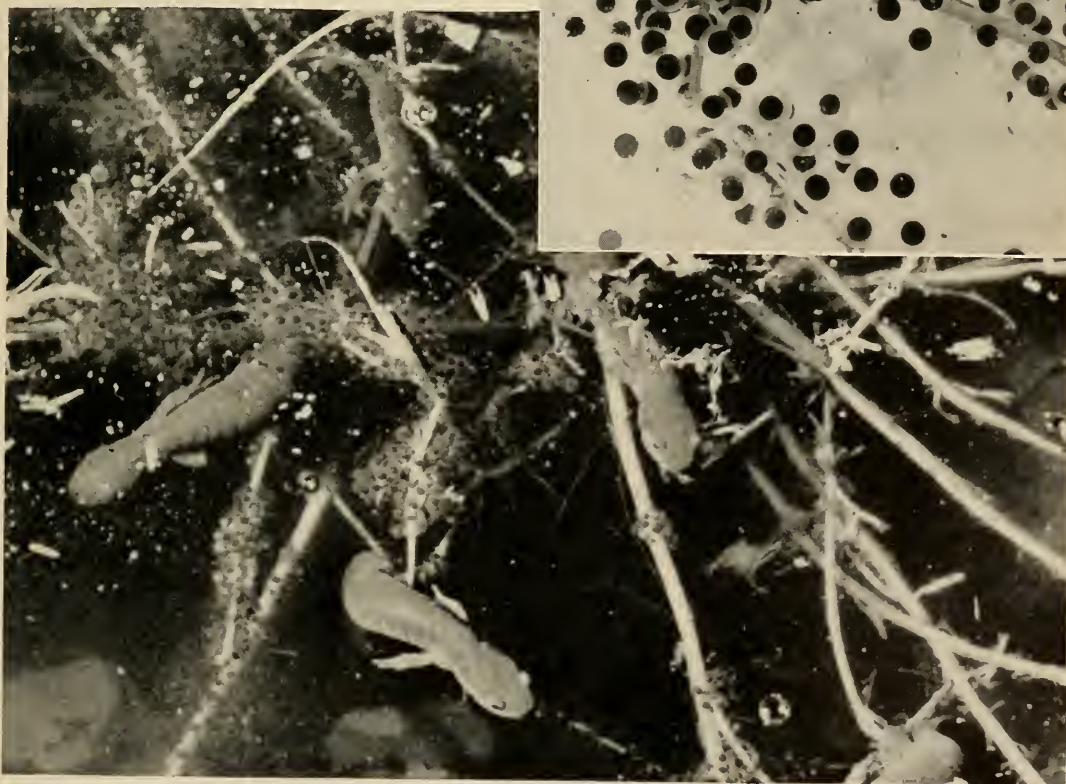
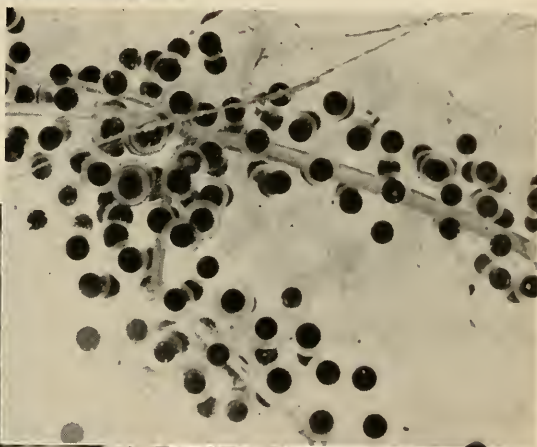
An egg cluster with forty-two closely constrained half-inch long larvæ, a day before they hatched

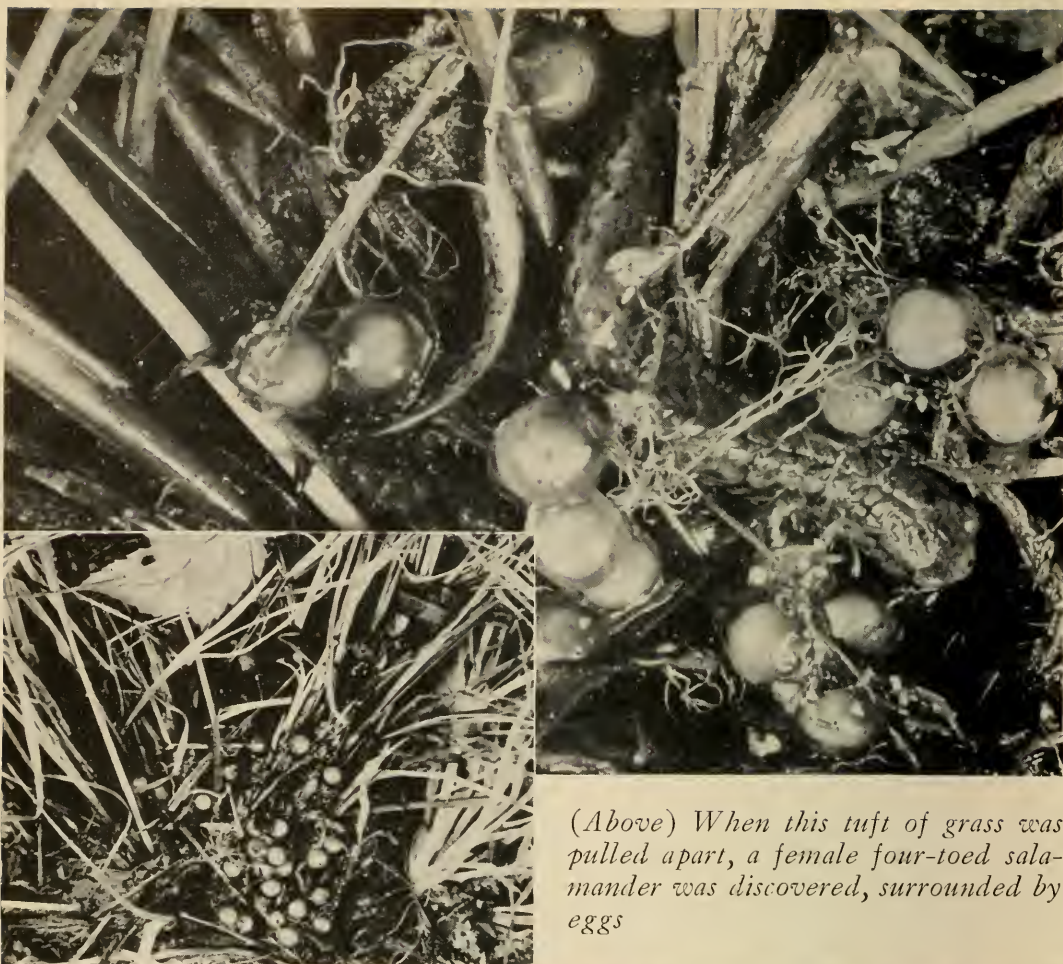


The red-backed salamander commonly lays her eggs in a cavity in a rotten log. She attaches them to the roof of the tiny chamber, the cluster usually taking the form of a bunch of grapes. (A detail from an exhibit in the American Museum)

(Below) Hundreds of eggs of the Jefferson salamander may be found attached to the leaves of dead water plants

(Below) Here a group of female Jefferson salamanders are laying eggs in a woodland pond at night





(Above) When this tuft of grass was pulled apart, a female four-toed salamander was discovered, surrounded by eggs

(Above) A typical egg mass exposed in a bunch of grass a few inches above water level



(Right) The blind cave salamander of the Ozark Mountains has shunned the light to such an extent that it has lost the use of its eyes



Among the more unusual modern salamanders is the stout-limbed hellbender, (shown top) a large, aquatic form found in mountain streams of the eastern United States. Although it reaches a length of eighteen inches, it is dwarfed

by its Japanese relative, the giant Megalobatrachus, the world's largest amphibian, which attains a length of at least four feet. This photograph and the one below showing the hellbender's egg mass, are from a group in the American Museum

Science in the Field and in the Laboratory

Astronomy, Education, Appointments, Research, American Museum Activities

Edited by A. KATHERINE BERGER

Opening of the Hayden Planetarium

The opening of the Hayden Planetarium is now almost at hand. This eagerly awaited event, it is officially announced, will take place on October 1. On that day and thereafter the people of New York City will see the wonders of the heavens as only the new Zeiss Projection Planetarium can show them.

The unbelievably complicated projector, comprising in itself more than 120 stereopticons—which will throw upon the artificial dome of the sky stars and planets, sun and moon, comets and meteors—is nearly assembled and will be completely so by September 15.

Already the supplementary exhibits are being installed in this latest and most modern of astronomical museums. The curious and beautiful Aztec calendar stone of mosaic is in place. So also is the first of the astronomical photographs—a series of large, illuminated transparencies of celestial objects.

Several large meteorites, those fragments of stone and iron which hurtle to earth from outer space, have been moved to their new home from their former resting-place near the Seventy-seventh Street entrance to the Museum. Here was an engineering feat of no mean proportions, for the giant Ahnighito meteorite, brought by Peary from Greenland, weighs $36\frac{1}{2}$ tons!

Soon will follow the rest of the meteorites; the collections of sun-dials, astrolabes, and astronomical paintings; and the Copernican Planetarium, that valuable adjunct of the Projection Planetarium, which presents dramatically in model form the principal members of the solar system. These and other attractions—for a general admission fee of 25 cents—will await the visitor on October 1.

Amateur Astronomers Association

The first meeting of the Amateur Astronomers Association for the years 1935-36 will be held on the evening of Wednesday, October 2, when Dr. Clyde Fisher will speak on "The Hayden Planeta-

rium." This meeting will be held in the large auditorium of the American Museum of Natural History at 8:15 o'clock. Those interested are most cordially invited to attend.

The Junior Astronomy Club

With all regular activities suspended for the summer, the members of the Junior Astronomy Club have applied themselves in the observational branch of their science.

The first fall issue of the *Junior Astronomy News*, monthly club journal, will contain reports of observations made in and around New York City; and in addition will carry notes on the club's associate members who are scattered throughout forty-two states. Record of meteor showers and of the lunar eclipse of July 15 will form the major portion of the reports.

Club members are looking forward eagerly to the second edition of the *Handbook of the Heavens* which will be published in late September by Whit-telsey House of McGraw-Hill.

Dr. Clyde Fisher, curator of astronomy and in charge of the new Hayden Planetarium, will address the club members at their first meeting in early November.

Lectures for teachers

The American Museum of Natural History will continue its coöperation with the colleges and universities this fall on an extended scale. Three free courses will be offered teachers in coöperation with the College of the City of New York, as follows:

Methods of Teaching Geography in an Activity Program, by Mrs. Grace F. Ramsey; Mechanics of Visual Instruction, by Mr. L. Wales Holden; Nature Study, by Miss Farida A. Wiley.

In addition to the above courses, City College will offer a pay course at the Museum, making extensive use of Museum materials and exhibits—Health Education: Recent Advances in Physiology, by Dr. G. Kingsley Noble.

Two free fall courses will be given in coöperation with Hunter College: Nature Study for City

Teachers, by Miss Farida A. Wiley; Mechanics of Visual Instruction, by Mr. L. Wales Holden.

Hunter College and N. Y. University will also offer pay courses at the Museum in Astronomy, by Dr. Clyde Fisher.

College or university credit will be allowed for all the above courses, as well as alertness credit by the Board of Education.

Annual Members of the Museum will be admitted without charge to any Museum courses that are free to teachers.

Education for the blind

On August 5 a group of twenty-five blind girls from the New York Institute for the Education of the Blind enjoyed a talk on the evolution of the boat, followed by a tour of some of the Museum halls, under Miss Newgarden. The girls, who were full of enthusiasm, greatly enjoyed "seeing" with their fingers various models of primitive craft, as well as actual, full-size canoes. Doctor Beebe's bathysphere and the great diving bell in the Hall of Ocean Life were carefully examined with fingers. The only disappointment in the visit seemed to be that Colonel Lindbergh's plane was hung too high to permit handling.

Visitors from abroad

On Thursday, June 27 Mr. Sievers and Mr. Saunders guided a group of eighteen German students and their American friends through the American Museum. This group was sponsored by the West Side YMCA and consisted of twelve boys and six girls, winners of the scholastic competition conducted by the German Government. The students averaged about seventeen years in age.

To Africa for wild life studies

Mrs. Mary L. Jobe Akeley sailed last June to visit the Transvaal and southern Rhodesia for the purpose of making a wild-life survey and to collect material for the American Museum. She also plans to visit Swaziland and Zululand, where she will make motion pictures of animal life and the ceremonials of primitive tribes.

She will organize her own safari and for the most part will travel alone and live in the open with a tent for shelter.

Appointment

Doctor Robert T. Hatt, a member of the American Museum staff since 1928, has resigned to become director of the Cranbrook Institute of Science, Bloomfield Hills, Michigan.

The Cranbrook Institute is one of a group of cultural institutions founded by Mr. George G. Booth, a short distance from Detroit. Associated and on adjacent campuses, covering a three-hundred

acre tract, are Brookside School, Kingswood School, Cranbrook School, Christ Church, Cranbrook Institute of Science, and Cranbrook Academy of Art. The latter, of which the internationally known architect, Eliel Saarinen is chairman, consists of a museum and studios for both creative work and instruction. Here are eminent artists and craftsmen working in sculpture, ceramics, silver working, textile design and weaving, printing, binding, and other fields.

The Institute of Science, but five years old and the youngest organization in the group, has an excellent museum with exhibits in botany, zoölogy, ethnology, and mineralogy. A whole room is devoted to exhibits of luminescence in minerals, and is perhaps the best installation of its kind in the country. An astronomical observatory is equipped with a six-inch equatorial telescope used for research and instruction. The library is particularly well developed in the fields of the natural history of the Great Lakes region. A spacious auditorium, a small zoo, laboratories for research and educational purposes, and shops for construction round out the physical equipment. The staff of Cranbrook Institute is concerned with research, the development of the museum, and the conduct of classes in the natural sciences for the benefit of members of the Institute, pupils of the three Cranbrook schools, and the general public.

At the American Museum, Doctor Hatt has been occupied with researches and reports on the African mammal fauna, anatomical specializations in animals, and the life-histories of North American rodents. An expedition to investigate the cave faunas in the Sierra of Yucatan was conducted by Doctor and Mrs. Hatt and yielded much of unique interest concerning the past and present faunas of this little known region.

Summer research work at the American Museum

Dr. William K. Gregory and G. Miles Conrad have compiled charts depicting the phylogeny of several groups of teleost fishes, namely, the deep-sea fishes of the orders Isospondyli and Iniomi, the Pediculate, or angler-fishes, and the tropical Characin fishes. In connection with the studies on the Characins, an interlocking hinge was found between the two halves of the lower jaw in *Hydrocyon*. This hinge permits the widening of the mouth-gape horizontally as well as vertically. The development of this curious device has been studied in detail and comparisons made between it and the conditions in other Characins.

Dr. E. Grace White, of Wilson College, has completed three papers dealing with the Elasmobranch fishes (the sharks and rays). The first is entitled, "The Heart Valves of the Elasmobranch Fishes"; the second, "A Classification and Phy-

logeny of the Elasmobranch Fishes"; the third deals with "Some Transitional Elasmobranchs connecting the Catuloidea with the Carcharinoidea."

Frederick Shelden, of Rensselaer Polytechnic Institute, has been studying the musculature and osteology of the pelvic region in the Nematognathi, or catfishes, with a view to correlating the anatomy with the diverse uses to which the hind "limbs" are put.

Dr. William K. Gregory and Dr. Milo Hellman are studying the jaws and teeth of fossil anthropoids and man, a continuation of their work on the dentition of *Dryopithecus*, which was published in the *Anthropological Papers* of the American Museum in 1926.

Captain John R. Embich has been working on fossil fishes found in the Palæozoic beds of Pennsylvania.

Dr. David L. Poe has been making dissections of brains of various vertebrates in Mr. H. C. Raven's laboratory.

Miss Barbara E. Sims of Bryn Mawr College joined the group of summer students in Doctor Gregory's classroom on August 12. She will work on special problems under Doctor Gregory's direction.

To study ancient Peking man

Dr. George Pinkley, James Arthur research assistant of the department of comparative anatomy in the American Museum, having completed his work in the laboratory of Prof. J. L. Shellshear at the Medical College, University of Hong Kong, has now proceeded, accompanied by Mrs. Pinkley, to Peiping, where among other things he will have an opportunity to examine the brain cast and other remains of Peking man (*Sinanthropus pekinensis*).

The Dean Memorial Library

Dr. Bashford Dean, former curator of fishes in the American Museum, left to the department of ichthyology his invaluable collection of bound reprints of articles on fishes and all his books on ichthyology. He also bequeathed a sum of money, the income from which was to be devoted to the upkeep of this library. These books are housed in a room in the department of fishes, and this by the action of the Board of Trustees in 1925 is set apart as the Bashford Dean Research Room in Ichthyology.

To Dr. E. W. Gudger, as bibliographer in ichthyology, there come great numbers of fish reprints

for his card catalogue continuing the published *Bibliography of Fishes*. These are checked up, sorted, bound, and added to the Dean Library. Thus this library has quite doubled in size in the past ten years.

Miss Margaret Storey of Stanford University has from time to time during the past three years worked on this library under Doctor Gudger's direction, and she has just spent most of the month of July on these books. Bookplates have been put in, numbers painted on the backs, the covers have been treated with a leather preservative, and all the books have been shifted and space left for the additions to each series.

She has prepared for the binder 28 volumes of reprints, and also 2 volumes of reviews of Volume III of the *Bibliography of Fishes* and of letters of congratulation received when the various volumes were published. She has also selected and prepared for mailing to scientific men and particularly to ichthyologists a large collection of reprints of Doctor Dean's articles sent by Mrs. Dean for that purpose.

The Book Shop

The policy for the sale of books at the American Museum has been changed. Besides books by Museum authors, there will be others by authors of good standing on subjects allied to Museum interests. Particular attention is being paid to children's books.

Lists of books will be issued at regular intervals which the shop will send upon request. Books will be sent by mail, the charge for postage being additional. For information, apply to the Book Shop at the American Museum.

Honors

Dr. Barnum Brown, curator of fossil reptiles at the American Museum, has been elected a Fellow of the Royal Geographical Society at London, England, in recognition of his contributions to palæontological, geographical, and archæological science.

Dr. E. W. Gudger, bibliographer and associate curator in the department of fishes, American Museum, was officially elected to a life membership in the North Carolina Academy of Science at its 1935 annual meeting in Greensboro, "in recognition of many years of active service with a spirit of loyalty to the Academy and the State." Doctor Gudger has been a member of the Academy for twenty-nine years.

Reviews of New Books

Psychology, Birds, Fishes, Reptiles, Animal Pets, Plants, Exploration

THE REPTILES OF CHINA. By Clifford H. Pope. Vol. X, *Natural History of Central Asia. American Museum of Natural History. Set in type by G. P. Putnam's Sons, N. Y. 1935.*

THE REPTILES OF CHINA by Clifford H. Pope has just been issued by the American Museum. It represents Volume X of the *Natural History of Central Asia*. Volumes I, II, and IV have already been published, while the manuscript for two more volumes are in hand. This series of quarto volumes will represent the final reports on the extensive surveys and large collections secured by the Central Asiatic Expeditions under the leadership of Dr. Roy Chapman Andrews.

Preliminary reports on the reptiles secured by the expedition have been published from time to time. The present volume represents a comprehensive and critical treatment of all the known snakes, turtles, and crocodilians from China, together with an annotated check list of the lizards. Mr. Pope was a member of the expedition from 1921 to 1926. More recently he visited the principal museums in this country and abroad with a view to straightening out the confused relationships of some of the species. The present volume brings together the observations he made in the field and in the museums, and correlates these data with the previously published information on the reptiles of China.

The 130 species and subspecies of snakes, 22 turtles, and 1 crocodilian considered are described and figured. A summary of their distribution and habits is presented. Critical remarks on the material examined or previously described are given for most of the forms. At the close of the section dealing with the snakes a series of tables is presented summarizing the information available on the habitat preferences, feeding habits, breeding habits, sexual dimorphism, and variation in dentition of the various species. Students of Chinese herpetology will also appreciate the appended list of species known from the various provinces of China. Since keys to the genera and species are both numerous and complete, the volume will remain not only an exhaustive treatise on the herpetology of China but a handy reference book for the quick identification of any Chinese reptiles which may come to hand. Unfortunately, a similar, up-to-date source book does not exist for the herpetology of America.—G. K. N.

MANUAL OF THE SOUTHEASTERN FLORA. By John Kunkel Small, Ph.D. Published by the Author, New York Botanical Garden, New York City. 1933.

DR. SMALL, who was for so many years head curator of herbariums at the New York Botanical Garden, has entirely rewritten his extensive *Flora of the Southeastern United States*, which after going through two editions has become quite rare.

This new work consists of descriptions of the seed plants growing naturally in Florida, Alabama, Mississippi, Eastern Louisiana, Tennessee, North Carolina, South Carolina, and Georgia, and will be welcomed by all students of the flowering plants of this section of the United States.

Doctor Small has gone over this field most thoroughly, for he is a rare combination of indefatigable field naturalist and herbarium research student. He knows the plants of the southeastern states better than any living person. In fact his books have been the outstanding authority since the days of Chapman.

There is no other volume which attempts to describe systematically all of the flowering plants of this region. Its completeness will be a great satisfaction to any student who is trying to become familiar with the plants. And I have always liked Doctor Small's dichotomous keys, that is, keys which call for decision between only two points or steps at a time.

The book is copiously illustrated by excellent line-drawings. With the exception of those of the grasses, and of the sedges of the genus *Carex*, the drawings have been made by Miss Mary E. Eaton. In order to facilitate the tracing and determination of genera and species, a drawing showing a flower and a fruit of the first species under each genus is given.

This *Manual* is the result of thirty-five years' study of the systematic botany of the Southeastern States, more than two decades of which were interspersed with intensive field work.

As a companion volume to this one we may look forward to an exhaustive treatise on the seed plants of the Southern States west of the Mississippi. The forthcoming work, which is well along toward completion, will be titled *Manual of the South Central Flora*.—CLYDE FISHER

THE HAWKS OF NORTH AMERICA. *Their Field Identification and Feeding Habits.* By John Richard May. The National Association of Audubon Societies. New York. 1935. \$1.25.

SINCE Dr. A. K. Fisher's classical report on "The Hawks and Owls of the United States in their Relation to Agriculture" (Bulletin 3, U. S. Department of Agriculture, Division of Ornithology and Mammalogy, 1893), there has been no comprehensive work devoted to North American hawks and their economic significance.

Beginning long before the date of Doctor Fisher's work, there has been an ever increasing persecution of the birds of this family in this country. Part of this, no doubt, has been due to some ignorance of the economic status of hawks in general; part, to some inability to distinguish the various species which might, at least at times, be justly condemned, or to a disinclination to restrict punitive measures to such individuals as might be caught in their depredations; and part, to some complete indifference on the matter so long as the birds furnished interesting targets for the gun.

In any event, the numbers of these birds are fast decreasing, and if Doctor May's timely volume proves to be of service in stimulating public interest in their preservation, it will have served a useful purpose. If such preservation is not effected, it may not be long before the public must needs depend on books of this sort and on museums of natural history for a knowledge of the appearance and habits of many of the hawks, for they will be so depleted in numbers that a sight of them in life will be an infrequent event.

The modest price at which this volume is sold must not be taken as a criterion of its merits. Aside from its value as an economic study, the book supplies a convenient means for the identification of the hawks of North America north of the Mexican boundary but including Lower California. Thirty-seven fine plates in color by Allan Brooks show the various species in different plumages, and four plates in black-and-white by Roger Tory Peterson delineate the characteristic pattern and outline of the different birds as seen overhead in flight. The text supplies descriptions of each of the geographical races, or subspecies, only one of which is illustrated on the plates, with a statement of the range of each. There is a map for each of the species (except a few casual visitors) showing the breeding range (or both present and former breeding ranges), and the winter distribution where this is different.

There is a general discussion of the habits of each species as a whole and of its food, with a table giving the results of examinations of many stomachs and crops. Lists of the various vernacular names are helpful in view of much confusion in the application of such terms as "hen hawk,"

"pigeon hawk," and other such names. Unfortunately, there is no general index, but the table of contents and the list of plates each occupy but a single page, making it not difficult to find the account or colored figure of any species when its accepted name is known. If it is desired to find one for which only the name "hen hawk," for example, is known to the reader, a rather long search through the text will be necessary.

Appendix I gives a short summary of the various state laws relating to hawks, and Appendix II contains a good reference bibliography on the subject matter of the volume.

Doctor May's book should be in the hands of all persons interested in hawks as well as in those of hunters and conservationists who should be interested in these fast-disappearing birds.—J.T.Z.

WILD BIRDS AT HOME. By Francis Hobart Herrick. D. Appleton-Century Co. New York. 1935. 8vo. xxiv, 345 pp. Many inserted half-tones.

OLIVE Thorne Miller was among the first intensive students of the home life of wild birds in America. She had no blind or "hide-up," as English ornithologists call it, but she had a camp chair, patience, and a sympathetic interest in the ways of birds. Burroughs had no liking for this type of contact with birds. "Bird reporting," he called it, which is just what it is. To him a bird was a field companion to be lived with and enjoyed, but not to be systematically and persistently spied on.

Mrs. Miller's period of greatest activity was the decade from 1885 to 1895. At the beginning of the succeeding century Professor Herrick placed this type of bird study on a more scientific basis in his *Home Life of Wild Birds* (1902). One of the few ornithologists of this period who was also a trained biologist, his work was of much value to the bird "observer" or "watcher" whose sole training was a love of birds and a speaking acquaintance with his local species.

In this book Professor Herrick made effective use of the camera, then but lately added to the ornithologists' equipment, and somewhat shocked the "bird hunter with a camera," to whom the photograph was an end in itself, by bringing the nest to the camera instead of overcoming the difficulties imposed by the situation in which the bird had placed it and, like a good sport, photographing it *in situ*.

But the liberties that Professor Herrick took with a nest and its contents without disturbing their owners was part of his story.

In this new book all these methods of photography are brought up to date, and we are told *what* to observe as well as *how* to observe. Direct instructions are followed by actual demonstrations in detailed biographies of numbers of familiar species, and there are also chapters on "Birds"

Nests," "Life and Instincts," etc. In short, here is an indispensable book for one who would study the ways of wild birds at home.—F. M. C.

THE BACK-YARD ZOO. By Daniel Pratt Mannix, Coward-McCann, Inc., New York, 265 pages, \$2.

THERE are many "Back-Yard Zoos" in this country. Natural history museums throughout the land are constantly bombarded with questions from far and wide: "What shall I feed a baby skunk," "How shall I care for a bear cub," or "Please send complete instructions for the care and feeding of katydids!"

If Mr. Mannix's book enjoys the wide circulation it deserves, there will doubtless be many additional "zoos" of this type. Numbered among his pets were skunks, porcupines, fish, crows, armadillos, opossums, Gila monsters, and raccoons. A note in the front of the book says that the stories "have been written simply to amuse. They are not meant to be scientifically correct and should not be read as zoölogical treatises." Nevertheless, Mr. Mannix has succeeded very well indeed in following a truthful picture as he proceeds to enlarge upon the activities of his fellow conspirators.

It is clear from the book that the various animals caused uneasy moments to more than one person, particularly armadillos. These "armor-plated" residents of Texas wandered into a neighbor's yard one morning and proceeded to disturb the garden soil slightly, much to the agitation of the gardener. However, when it was discovered that the animals had been eating Japanese beetles and other noxious insects, they were eventually given the run of the garden, and Mr. Mannix was invited to place them in his friend's greenhouse for the winter.

Children and their parents alike will enjoy the friendly and straightforward method employed throughout the book to relate various stories and to tell clearly of the adventures of the principal characters.

It is very evident that the creatures were well cared for, and that the author took no chances with the welfare of his pets. He relates one incident that shows this very conclusively. In giving his Gila monster some water, Mr. Mannix first warmed the ice water in a paper cup with his hands before permitting the lizard to enjoy it.

All of these articles were originally published in the *St. Nicholas Magazine*, and we can only hope that we shall see more material of this type.

—W. H. C.

THE EMPIRE OF THE SNAKES. By F. G. Carnochan and H. C. Adamson. F. A. Stokes Company, New York City.

THERE are a few authentic records of people who have partly immunized themselves against the venom of poisonous snakes by taking

intentionally or otherwise, small quantities of the poison into their systems. Fred Carnochan, while a member of the Smithsonian-Chrysler Expedition to Tanganyika, was thrown in contact with a tribe of African natives who seem to practise immunization on a large scale. This is not so much to avoid the dangers of snake bite as to give prestige to the immunized. A very elaborate culture has been built up around the ceremonies of immunization. The essential ingredients in the treatment appear to be the ground dried heads of boomslangs, cobras, puff adders, and mambas, which, when mixed with lion fat, are rubbed into a series of slashes made in the skin. Carnochan himself took the treatment, which is by no means painless. Its efficacy must be judged from the variety of hazardous incidents which Carnochan reports.

Carnochan became so much interested in these natives who could apparently handle poisonous snakes with impunity that he returned to Africa to learn more of their secrets. The greater part of the book which has been brought together from Carnochan's notes by Mr. Adamson, deals with the lives of the African natives as Carnochan learned to know them during this period. We read of a plant which, when ground up and painted on the skin, renders it as "tough as the hide of a giraffe." When applied to the skin "not even the sharp teeth of the mamba can go through it." Carnochan is a trained observer who on all his expeditions studies and collects plant and animal life intelligently. On this expedition he became particularly interested in the drugs which could be made from native plants. Once he made a "voluntary visit to the realm of living dead" when he imbibed a paralyzing drug made from the root of an unknown plant.

Carnochan's experiences with flowers that kill fish, stones that detect lies, and plants that prevent death from cobra bite are dramatically recorded against a background of everyday life among the Wanyamwesi. There is the romance of his kitchen boy, the beliefs and superstitions of the natives, the death of the great-granddaughter of the Emperor of the Snakes. The book is one that tells a very realistic story of African native life. It is one which will provoke further observation and study of the snake poisons and native drugs of Africa.—G. K. N.

THE TARAHUMARA, AN INDIAN TRIBE OF NORTHERN MEXICO. By Wendell C. Bennett and Robert M. Zingg. Chicago, University of Chicago Press. *Publications in Anthropology, Ethnological Series.* 412 pages, illus. \$4.00

THIS compact volume, by two of America's youngest and most competent research anthropologists, is primarily a reference work for specialists. As such it contains a wealth of carefully checked material (gathered in the field) divided into two sections. In the First Part Doctor Zingg

(research associate in anthropology in the University of Chicago) describes the Material Culture of the Tarahumara. Painstakingly but without imagination he tells us how these Indians live and under what physical conditions; what domestic animals they use; what foods they eat and how their crops are raised. There are chapters on primitive industries (lumbering, woodwork, weaving), on housekeeping, costume and handicraft. A long account of the animals and plants of the region is more an essay in taxonomy than the integrated ecological study it might have been.

Doctor Bennett (an associate curator in anthropology at the American Museum of Natural History) carries the story on through the social life of this interesting tribe of some 40,000 living members. He gives us a mass of information on economics, government, law and property concepts; on the family, religion, education, sports, fiestas; on marriage, death, and native philosophy. A chapter on "peyote," favorite drug of the Tarahumara Indians, is tantalizingly brief and suggests again to this reviewer what a stirring book could be written on Pharmacy, Ancient and Modern.

The volume concludes with an excellent terminal essay which attempts to generalize from the detailed data and to construct a rounded-out picture of the Tarahumara. Incidentally, a "Summary Table of Classified Tarahumara Traits" provides a model which may well be followed by all research ethnologists; and the excellent schematic analysis of the Sonoran Uto-Aztec Culture amply proves with what care the authors planned, and carried out, their exacting labors.

The general reader, however, will be disappointed and inclined to lay the book aside as another "can't-see-the-forest-for-the-trees" affair. This will be a pity, for the authors cannot reasonably be blamed for failing to do what was probably not their intention. Nevertheless, it is unfortunate that such rich material was not organized more effectively, with less attention to minutiae (which can never be completely exhausted in any case) and a more balanced regard for the subject as a whole. Perhaps the authors, with this conscientious research job safely "on the record," will soon show us—each in his own way—how Anthropology can be induced to dance as well as plod: and without sacrifice of either dignity or authority.

—HAROLD WARD

MEN AGAINST THE CLOUDS. By Richard L. Burdsall and Arthur B. Emmons, 3rd. Harper & Brothers, N. Y. 292 pp., \$3.50.

SUPPOSE you found yourself alone on a remote Tibetan mountain with both your hands and your feet frozen, watching your two comrades disappear in the enshrouding clouds as they push on for the last 1500 feet to the tip of a five-mile high

peak, with an excellent chance of never seeing them again—what would be your thoughts and sensations?

Of this and similar situations is the thrilling account of the Sikong Expedition in *Men Against the Clouds* by Richard L. Burdsall and Arthur B. Emmons, 3rd. It is the amazing story of four young Americans—three of them still in college—who undertook to climb the mighty Minya Konka, the holy snow-clad peak which stands between the Red Basin of Szechwan in Western China and the high Tibetan grasslands beyond.

For centuries in almost complete obscurity, shrouded with mystery, the towering Minya Konka is the highest peak ever scaled by an American expedition, and the second highest ever conquered.

Few white men had ever gazed upon its breathtaking heights. Their accounts are meager indeed. In 1879 the expedition of Count Bela Szechenyi, from a distance of thirty-five miles, estimated the height of the Minya Konka to be 24,934 feet. Subsequent maps, however, either omitted the mountain entirely or located it incorrectly, giving no altitude. In 1929 Dr. Joseph F. Rock, of the National Geographic Society, reached the foot of the peak and computed it to be 25,600 feet. Theodore and Kermit Roosevelt skirted the vicinity of the peak in 1930 and estimated the height as possibly 30,000 feet.

Careful barometric measurements by the Sikong Expedition set the altitude definitely at 24,891 feet.

Traversing almost two thousand miles of China before they reached the Sino-Tibetan border and the foothills of the Minya Konka, these four adventurers scorned the elaborate preparations for successive high altitude camps, communications, and specially chosen native bearers which mark the organization of a conservative high mountain scaling expedition. All of them experienced mountain climbers, with enviable achievements already to their credit, they matched sheer determination and daring against awful nature—and won!

The book is profusely illustrated with numerous photographs, maps and charts made by members of the expedition, together with valuable appendices on big game hunting, mountaineering, and surveying.

It has been my pleasure to meet three of the members of the Sikong Expedition. They are quiet, unassuming fellows; yet their achievement stands as one of the most daring ventures of modern times.

With a background of several years of travel in China and Tibet, I can personally recommend *Men Against the Clouds* as more than a thrilling book of travel and high adventure—it is an important contribution to the field of exploration.

—HARRISON FORMAN

THE STORY OF AN AFRICAN CHIEF. By Prince Nyabongo, Charles Scribner's Sons, New York. \$3.00.

THIS book deals with the customs of an important Uganda tribe, and recounts the attempts of the white man to impose a "Western civilization" upon these enlightened, happy, well-ruled, and honorable people.

Ten years before the birth of Chief Ati's son, on the night of the Feast of the New Moon the drums proclaim the advent of a white man—Stanley in search of Livingstone. Ati, intrigued by Stanley's knowledge, asks him to send him men who can read Stanley's book (the Bible) as well as make guns. After the coming of Catholic, Protestant and Moslem missionaries and an attendant religious war involving all the natives of the region, Chief Ati concludes that his old tribal religion is good enough.

Ati's son by the finest of his 375 wives, and whom his father wishes to name for Stanley, is refused Christian baptism by the Reverend Mr. Hubert because Ati "is living in Sin." Later it is difficult for the Chief to reconcile this attitude with the Story of Solomon read to him from the Bible. The boy, at the age of two, known by the native name Mujungu, begins his education under the best native tutors. When Mujungu is twelve, Reverend Mr. Hubert asks the chief to send him to the mission to pursue an elementary training. This school, unfortunately, strives to eliminate everything of native origin, to punish the lad for his freedom of thought and to leave his inquiring mind unsatisfied.

After Mujungu's graduation from a private school—he has been expelled from the Mission for writing a letter to the young woman he expects to marry—smallpox breaks out and Ati falls sick. Mujungu heroically takes charge, summoning a German doctor from Tanganyika and being vaccinated and inducing all his people to do likewise. Again the drums telegraph for medical assistance from Mombasa and Zanzibar. The ready response of these medical men is in pleasing contrast to the refusal of near-by missionaries to aid the stricken tribe. Ati succumbs to the plague and Mujungu is invested by the King as Chief. He now devotes himself utterly to his people.

The Story of an African Chief is more than an interesting tale. Due to its fictional form it is a highly appealing narrative. It is illuminated by adage and fable. Reading between the lines, Prince Nyabongo and Mujungu are obviously one. In the modest recounting of his deeds of intelligence and bravery, in his struggle to learn the truth, there is a sincere plea for the preservation of the best in the ancient Buganda civilization and against the inculcation of Western ideas unless adaptable to an enlightened people whose origins of culture are in a remote past.

Prince Nyabongo, student and friend of Pro-

fessor William Lyon Phelps at Yale, is now at Oxford. His book is one in which all lovers of Africa, as well as readers in general, will find delight.—MARY L. JOBE AKELEY

Recent American Museum Publications

NOVITATES

- No. 796. Distributional and Phylogenetic Studies on Indian Fossil Mammals.—I. American Museum Collecting Localities in Northern India. By Edwin H. Colbert.
- No. 797. Distributional and Phylogenetic Studies on Indian Fossil Mammals.—II. The Correlation of the Siwaliks of India as inferred by the Migrations of *Hipparion* and *Equus*. By Edwin H. Colbert.
- No. 798. Distributional and Phylogenetic Studies on Indian Fossil Mammals.—III. A Classification of the Chalicotherioidea. By Edwin H. Colbert.
- No. 799. Distributional and Phylogenetic Studies on Indian Fossil Mammals.—IV. The Phylogeny of the Indian Suidae and the Origin of the Hippopotamidae. By Edwin H. Colbert.
- No. 800. Distributional and Phylogenetic Studies on Indian Fossil Mammals.—V. The Classification and the Phylogeny of the Giraffidae. By Edwin H. Colbert.
- No. 801. Results of the Archbold Expeditions. No. 1. A New Genus and Species of Squirrel from Celebes. By R. Archbold and G. H. H. Tate.
- No. 802. Results of the Archbold Expeditions. No. 2. Twelve Apparently New Forms of *Rattus* from the Indo-Australian Region. By G. H. H. Tate and Richard Archbold.
- No. 803. Results of the Archbold Expeditions. No. 3. Twelve apparently New Forms of Muridae (other than *Rattus*) from the Indo-Australian Region. By G. H. H. Tate and Richard Archbold.
- No. 804. Results of the Archbold Expeditions. No. 4. An Apparently New Race of Wallabies from Southern New Guinea. By G. H. H. Tate and Richard Archbold.
- No. 805. New American Spiders with Notes on other Species. By W. J. Gertsch.
- No. 806. New American Asilidae (Diptera).—IV. By C. H. Curran.
- No. 807. The Tahitian Black Marlin; or Silver Marlin Swordfish. By J. T. Nichols and F. R. Lamonte.
- No. 808. Parasitic Bees of the Genus *Coelioxys* from the Belgian Congo. By T. D. A. Cockerell.
- No. 809. Bees from Eritrea, Northwest Africa. By T. D. A. Cockerell.
- No. 810. Results of the Archbold Expeditions. No. 5. Seven Apparently New Forms of Phalangeridae from the New Guinea Region. By G. H. H. Tate and Richard Archbold.
- No. 811. An almost totally Ambicolorate Halibut, *Hippoglossus hippoglossus*, with partially Rotated Eye and Hooked Dorsal Fin—the only Recorded Specimen. By E. W. Gudger and Frank E. Firth.
- No. 812. New American Diptera. By C. H. Curran.
- No. 813. New Asilidae from the Southwestern United States (Diptera). By A. Earl Pritchard.
- No. 814. Results of the Archbold Expeditions. No. 6. Twenty-Four Apparently Undescribed Birds from New Guinea and the D'Entrecasteaux Archipelago. By Ernst Mayr and A. L. Rand.

BULLETIN

Volume LXVIII, Art. 5. The Taxonomy of the Genera of Neotropical Hystricoid Rodents. By G. H. H. Tate.

Recently Elected Members

A REPORT from the membership department lists the following persons who have been elected members of the American Museum:

Patron

Mr. Robert W. Johnson

Fellow

Mr. Orlando F. Weber, Jr.

Honorary Life Members

Messrs. Harry F. Beers, F. D. Duke, Henry J. Langham, George N. Pindar.

Sustaining Members

Mrs. Anna E. Kresge

Messrs. William W. Fleming, Joseph Glass.

Annual Members

Mesdames G. S. Achilles, Matthew Andrews, V. Blanchard, Samuel J. Carpenter, Emily Fearhake, H. D. Haight, S. Peters Holmes, John Quincy Hunsicker, Malcolm S. Mackay, Endicott Peabody, Herbert N. Straus, Sheldon Whitehouse.

Sister Lapierre.

Misses Mary T. Cockcroft, Minnie A. Daly, Mary Findlay, Mary E. Hart, Martha Hird, Elvine L. Neeser, Lou Rogers.

Doctors Alex. A. Allen, August F. Bauer, George Evans, Maurice Finkelman, Jacob Kaufmann.

Messrs. Albert Farwell Bemis, Hugh Brooks, Randolph Bullock, Don Burdick, Harry E. Byram, John E. Chibas, Charles L. Couard, James Crosby, Eugene Eisenmann, Robert D. Elder, J. W. Farley, William B. Goodwin, Bernard Halfond, Preston J. Jennings, Felix W. Knauth, Halstead Lindsley, Frederick William Ockert, John Olyphant, John G. Rolph, Theodore I. Schneider, Joseph Simola, Jr., Frederick H. Stoye, Sheldon Whitehouse, Charles T. Wilson.

Associate Members

Mesdames J. Walter Allen, L. S. Allison.

Daniel Bacon, Bagster-Collins, Geoffrey Bare, Willette Spragg Barker, Charles T. Bartlett, Laura Dolbear Beach, Thomas H. Beck, Herman Benkema, Hattie Voss Beringer, Alfred K. Biggs, James E. Blythe, J. Mora Boyle, Horace R. Boynton, Rose Swain Brown. Stanley P. Chase, E. Whittredge Clark, A. S. Cobb, T. A. Curtis.

Elizabeth G. Dadisman, J. de Chadenedes, D. W. Dennis. Hedwig H. Ernst.

Jessie Benedict Faye, E. J. Feisel, Jr., Richard T. Fisher, John Taintor Foote, Madeline Clarke Foreman, George D. Forrest.

Annie E. Gardner, W. D. Gregory.

Meredith Hare, I. B. Harris, E. F. Helling, Robert B. Henderson, Alice Herriott, George R. Hill, Alice M. Hooks, George S. Huntington.

B. A. Jackson.

Beatrice S. Kitchen, Sadie B. Knox.

Ambrose Lansing, Rosamond N. Lefebvre, Raymond Lewis, Liane Limpus, George G. Lockwood.

J. W. Magruder, Reyburn McClellan, Howard I. Michaels, C. P. Moss.

Martha J. Neubauer, Isabel M. Newell.

Rena M. O'Connor.

J. G. Pearsall, E. S. Pennell.

Marian Robinson.

Frances P. St. Clair, Phoebe D. Schwarz, T. L. Sharp, Mary W. Sheffert, Robert T. Shellenberger, Mary Hunter Sicha, W. W. Silk, Harry R. Sinclair, Anthony Sini, D. P. Sullivan.

C. A. Taylor.

N. S. V. Underhill.

James N. Van Devanter.

Carolyne Hyde Woodin.

Misses Margaret W. Alexander, Louise Allen, Dorothy Allers-Ferre, Marie Annenberg, Julia A. Arnold, Joan Avery, Fannie B. Ayers.

Della L. Baker, M. Alberta Banks, Agnes C. Barrett, Mary Beckett, Isabelle K. Beinert, Margaret Bishop, D. A. Boardman, Sophie N. Boatwright, Alice K. Bowen, Grace Carmen Braem, Bernice L. Bursley, Mary P. Burtzell.

Emma M. Cain, Nora Carmody, Carrie L. Chapin, Frances H. Clark, Victoria Clyne, Susan de L. F. Cooper, Elsie M. Cox, R. Margaret Crabb, Marie B. Cremer, Caroline C. Cresson.

Kate Daum, Mary E. S. Davidson, Alice C. Dean, Jessie E. Dow, Della C. Downing, Stephanie Dukoff, Ethel C. Dunlap, Amy C. Duryee.

Sylvia H. Evans, Jr., Edna E. Ewald.

Erma E. Foster, Norma Foster, Joanna Aitken Fowler.

Gail Gartz, Dorothy Gaton, Susan Gregg Gibson, Agnes Gifford, Alice J. Griffin, Eugenie V. Griffin, Helen M. Grimmell.

Josephine V. Hall, Kate N. Haney, Elisabeth Harris, Marian Huckins, Melba F. Hurd, Nancy Isabel Hutton, Evangeline Hymer.

Mabel M. Johns.

Elsie M. Kliber, Elsbeth Kroeber.

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Josephine T. Mainster, Edith C. Mason, Lila McNutt, Mildred Meeker, Rachel Mirsky, Edith Mortensen, Gladys A. Munro.

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Elizabeth Paine, Anita M. Peterson, Callie Pitts, Maggie Purnell.

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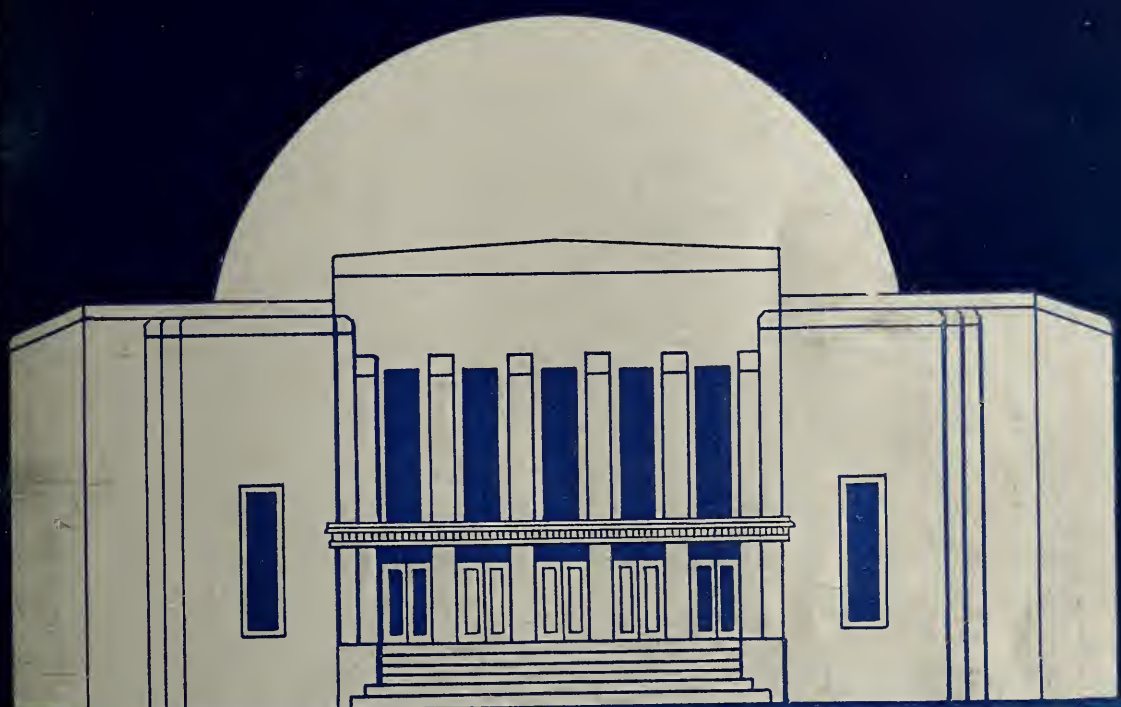
Minnie Schwartz, Bertha C. Schwenger, Romaine Sessions, Minnie M. Shannon, Edna Corning Smith, Emma Estelle Pulley Smith, Susie B. Smyth, Josephine Sullivan.

Virginia Tear, Martha R. Thompson, Katharine Tobin, Jean C. Tompkins.

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Reverends Arthur F. McKenny, Henry K. Pasma.



NATURAL HISTORY

JOURNAL OF THE AMERICAN MUSEUM OF NATURAL HISTORY

FIFTY CENTS

OCTOBER 1935



Museum Animal Theatres

ANIMAL THEATRES reproduced from the lifelike exhibits in the Museum—four of these fascinating theatres to be set up which will prove a delight to every boy and girl possessing them. It will be an absorbing work to cut out and arrange these theatres—hours of anticipation. What a supreme delight would these have been to the young people in *Little Women*! The animals may be moved about and no paste is necessary. It is a natural history exhibit that can be staged in any home. The backgrounds are taken from the exhibits in the Museum and the animals modeled on those seen in the groups.

Sold only in sets of four for \$1.00

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No. 1 represents the African Lion [*Felis leo*]. It is a scene on the edge of the mysterious veldt near Nairobi, British East Africa. The king of beasts is waiting, with his family, under a tree for the dusk to descend prior to their sally for their evening meal.

No. 2 represents the Bengal Tiger [*Felis tigris*] in the Kheri forest in India. The tigress leads her cubs to the stream to drink and through the reeds and trees appears the lordly male. This represents one of the groups collected for the American Museum by the Vernay-Faunthorpe Expedition.

No. 3 is the Gorilla [*Gorilla savages*]. Here we see the Lake Kivu region of the Belgian Congo with the slope of Mt. Mikena showing in the purple sunset. This great animal was carefully studied by Carl E. Ackley on his many trips to Africa and from this theatre one will glean many interesting facts about a creature that has long been too little known.

No. 4 is the African Elephant [*Elephas africanus*]. The world's largest game animal is seen in a beautiful setting near Lake Paradise, British East Africa. The group is dispersing to cover after having been startled and the great bull wheels about to charge the enemy.

Each theatre when set up measures 18" wide, 10" high and 8" deep. Maps and descriptive material accompany each set. Because of their artistic colors, these animal groups make unusual decorations in the home as well as being splendidly adapted for class room use and above all for the playroom of every child. Parcel post charges additional. The weight packed for transportation is 3 lbs.

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NATURAL HISTORY

The Journal of the American Museum of Natural History

VOLUME XXXVI ☆ ☆ ☆ ☆ OCTOBER 1935

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Champlain, N. Y.

CHARLES HAYDEN

*Donor of the Planetarium instruments, and
in whose honor the Planetarium is named*



There is, in my opinion, no finer way of expressing the splendid influence the Hayden Planetarium will have on the spiritual and educational life of the community in the years to come than Mr. Hayden's own words when he announced his magnificent gift:

"I believe that the Planetarium is not only an interesting and instructive thing but that it should give a more lively and sincere appreciation of the magnitude of the universe and of the belief that a much greater Power than man must be responsible for the wonderful things which are daily occurring in the universe.

"I hope that the Planetarium when completed will give many people that view of life."

F. Lu Lee Dawson



The Hayden Planetarium

The story of an actual trip through an astronomical wonderland, where the stars are brought indoors, and the heavens themselves come closer

THE Hayden Planetarium is one of the most recent additions to the American Museum of Natural History. This unusual project was made possible by a loan from the Reconstruction Finance Corporation, while the planetarium instruments were the gift of Mr. Charles Hayden, for whom the planetarium is named. The red brick edifice with its copper dome stands on the northeast section of the Museum grounds, facing Eighty-first Street near Central Park West.

The modest-looking building is more than it appears to be on the outside, for here we have not a building only, but a veritable treasure-house of the stars, a theatre of sky magic where the heavens hang low and clear, and rainy nights are things unknown. Here, on any day of the week, and any month of the year, afternoon or evening, come the multitudes of those who are eager to see clear skies above them, that they may be able to trace, away from the fog and smoke of the city, the patterns of the stars against the blue of night. Here, too, come those who wish to learn more about the stars, those great suns—and the planets—near neighbors of the earth—and the numerous other interesting things that are to be found in the sky.

A super "magic lantern"

Let us visit first the very heart of the planetarium building—the great domed hall on the second floor where the stars "perform." As we enter this room, we are immediately conscious of its size—a size greatly augmented by the stretch of the dome some forty-eight feet above our heads. One of the first things we notice is the peculiarly shaped instrument which

stands in the center of the room—a mechanism resembling a giant dumb-bell, about twelve feet long. This bizarre-appearing "creature" is the projection instrument which throws upon the white background of the dome—as upon an artificial sky—the images of the stars and other heavenly bodies. It is in reality a collection of more than 120 stereopticon lanterns—a super "magic lantern." The lantern slides are irregular in shape but the images they throw fit closely together, with no gaps between, and the projection instrument throws upon the artificial sky the spots of light representing the stars. The large globes at either end of the "dumb-bell" are connected by a rod, upon which the whole instrument pivots, so that any particular set of stereopticons—those presenting the stars of the northern hemisphere, say, or the Milky Way—can be turned upon the sky.

The stars come out

Now that we have had an opportunity to look around a bit in the light, let us sit down and wait for night to come. There are many others under this great dome (the room holds 742 people) who are as eager as we for the stars to come out. Suddenly music begins to play; a sense of expectancy hushes the room. A lecturer steps unobtrusively into the speaker's desk at the north end of the room, he waits for a moment, and then gradually, as he stands there waiting, night falls. The walls and ceiling of what was a moment ago a great room disappear, and we find ourselves outdoors—in Central Park, surrounded by the New York City skyline—with the darkening heavens above us. It is night, and suddenly, taking our breath with their beauty, the stars come out.

There they are above us, shining in their accustomed places, arranged in the constellations which to many of us are old and familiar, and to many others new and unfamiliar—a brand-new world which many are just entering. An involuntary gasp of amazement rises from the audience—for this surely is no planetarium, no “show”—this is the sky above us, with the real stars shining down.

A journey through the heavens

Soft music still plays on. The lecturer begins to speak. The music dies away. “Now that evening has come,” he says, “and such a clear and cloudless evening—perhaps you would like to hear for a while about the stars.” Then, with his electric pointer as our guide, we enter into that other world of the sky—we refresh our memories of the star names and groupings, we see the moon rise and the planets pass across the pattern of the stars; we see the heavens wheel above us. But more than this—we come to understand, perhaps for the first time clearly, why the moon appears sometimes as a crescent, and sometimes as a great disk of light; we understand what makes the planets “wander”; why the stars pass nightly over our heads; we see for the first time a comet journeying away from the sun with its tail before its head.

Our forty minutes under the stars have been filled with interest and beauty, and after all too short a time the voice from the speaker’s desk warns us that the night is over and it is almost dawn. In the east gradually appears the flush of light which precedes the sun, and then, quickly, precipitately, from beyond the horizon comes the sun “driving night before him.” It is day.

As we pass the speaker’s desk, we hear him explaining that with this wonderful instrument, standing so grotesquely and clearly revealed now in the daylight, one can move time backward or forward. By this he means that it is possible to show the heavens as they appeared thousands of years ago or as they will appear 12,000 years from now, for instance, when Vega will have become our pole star instead of Polaris. Many are the potentialities of this great instrument, but it is impossible to put it through all its paces in one brief period of forty minutes. We shall come again to see a shower of meteors, that marvelous and awe-inspiring sight which so few of us will ever see outside

this building. We shall come to gaze, wide-eyed, at the northern lights which we so seldom see in these latitudes. We shall come again, and then again, for here we shall find the ever-changing and dramatic panorama of the heavens.

The Copernican Planetarium

And now let us descend to the first floor where we shall find that other instrument which so splendidly and adequately complements the Zeiss projection planetarium—the great Copernican planetarium placed on the ceiling of the first floor chamber. This is in reality a glorified orrery, forty feet in diameter, with a lighted bulb in the center to represent the sun, and with globes representing the six planets nearest the sun revolving around that body at their relative speeds. Not all of the satellites are included, as the orbits of some of those of Jupiter and Saturn are, because of unavoidable discrepancies in the scale of the model, so distant from their primaries that some of the satellites would have become entangled with each other. While the Zeiss Planetarium on the second floor shows the heavens as they appear from the earth, the Copernican Planetarium on the first floor shows the other half of the picture, the solar system to which our earth belongs, more or less as it would appear if we could observe it from out in space.

After we have watched for a few moments the planets and their moons as they revolve about the sun, we happen to glance at the floor of the room. There we notice a beautiful design inlaid in colored terrazzo, and circular in shape. This is an exact replica of the famous Aztec Calendar Stone, the calendar device of those early Mexican astronomical pioneers. Labels on the pillars of the hall explain the ancient and beautiful symbolism of the Stone.

The blue walls of this circular room are decorated with figures of the zodiacal constellations taken from an early work on astronomy, Bayer’s historic *Uranometria*, published in 1603. The stars of the constellations are of luminous silver paint, standing out realistically against the blue background.

Interesting exhibits

Now let us examine the ambulatories or halls of the building which we shall find filled with interesting objects. We shall find that to

those who were well acquainted with the American Museum before the days of the Hayden Planetarium, many of these astronomical objects are old friends. We notice the great meteorites, Ahnighito and Willamette, with the many smaller irons which were formerly in the Museum foyer. This collection of meteorites is probably not excelled by any other in the world.

We rediscover with pleasure the three beautiful paintings of solar eclipses by the late Howard Russell Butler. These are placed over one of the main entrances to the projection planetarium chamber—the entrance opposite the door leading from the Roosevelt Memorial Building. We find on the walls of the ambulatories, also, Mr. Butler's other astronomical paintings—which were formerly in the Pro-Astronomic Hall in the Museum. We note especially the two paintings of Mars as seen respectively from its two moons, the exquisite painting of the Aurora Borealis, and the striking colored panels of the solar prominences.

We notice also the Museum loan collections of sundials, astrolabes, compasses, and hour-glasses. One case before which we stop contains two accurate replicas of Galileo's telescopes, the first telescopes to be used astronomically.

Notable among the new furnishings of the building are the large transparencies—fifty in all—which decorate the walls of both ambulatories. These photographs on ground glass are placed in cases in the walls and lighted from behind, giving a luminous appearance especially

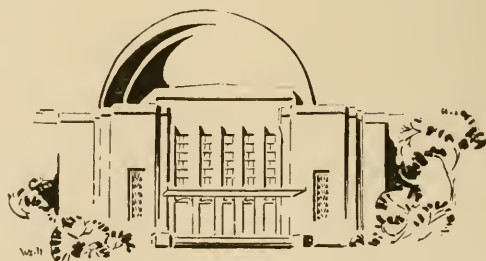
appropriate to astronomical phenomena. Here we find represented the finest astronomical photographs in the world—planets, comets, sun, moon, nebulae, star clouds, star clusters, etc.

Opposite the main entrance to the building, on the first floor, is an interesting group of paintings, a triptych showing outstanding features of American Indian astronomical mythology. In these murals by Mr. Charles R. Knight we discover the typical Indian Thunder Bird; the great Arch of the Aurora, upon which dance the White Indians of the North; the Old Man creating the earth from the mud under the sea; and many other figures from American Indian mythology.

The old and the new

As we leave this wonderful building, we carry with us a last impression of the twelve photo-murals on the walls of the foyer opening on Eighty-first Street. These murals, like those in the Copernican Chamber, are reproductions of the constellation figures in Bayer's *Uranometria*. Quaint and beautiful in design, the Rabbit, the Big Bear, the Little Bear, the Swan, and the other mythological figures from the sixteenth century gaze out at our twentieth-century crowds coming to view one of the most modern of all modern devices. And they, as well as the Planetarium itself, attest the eternal wonder which man has found in the starry skies.

—MARIAN LOCKWOOD





Wurts Bros.

THE EAST STAIRWAY

As one stands on the landing of the east stairway one sees, below, the first-floor ambulatory and the entrance to the Copernican Chamber which contains the model of the solar system in motion. Just

outside the entrance to this room stands the Willamette Meteorite, the largest meteorite so far found in the United States. The stairway above leads to the entrance to the Projection Chamber



(Left) This photograph shows, in their Planetarium setting, the famous triptych of eclipse paintings by Mr. Howard Russell Butler

Wurts Bros.

(Below) The Calendar Stone, famous monument of the Aztecs, was doubtless connected with the worship of the sun. It records many Aztec creation myths as well as divisions of the year, day signs, and points of the compass





Wurts Bros.

Rising against the skyline-silhouette of New York City, this modern "Aladdin's Lamp" brings the stars indoors. Comprising in its grotesque form more than 120 stereopticon machines, the giant apparatus turns and twists, throwing aloft on the dome the images of thousands of celestial bodies



The switchboard controlling the projection instrument—a complicated affair. On the level "desk-top" are the switches which turn the stars on and off. On the vertical part of the board are the rheostats controlling the brightness of the stars and other celestial objects



Wurts Bros.

Night has come to the Planetarium Chamber, darkening the sky as the sun sinks below the horizon. The stars come out, shining with a clear and beautiful light above the towers of New York.

Suddenly, against the sky, are projected the celestial circles—always so difficult to visualize—the celestial equator, the ecliptic, the meridian—as well as their relations to each other



An audience enthralled. A group of youngsters whose faces show plainly what they think of the Planetarium "show." No boredom here!

Exploring in Space

In the following series of pictures the reader is invited to take an imaginary 10,000,000,000,000,000-mile trip which will include in its ports of call the Sun, Moon, and Mars in the Solar System; Star Clusters and Nebulæ in the

Galaxy, and a side trip to an Island Universe, returning on a Meteor Trail. Traveling at the speed of light (186,000 miles per second), the entire trip, not including stop-overs, could be completed in sixteen hundred millennia

Legends

by

Dorothy A. Bennett

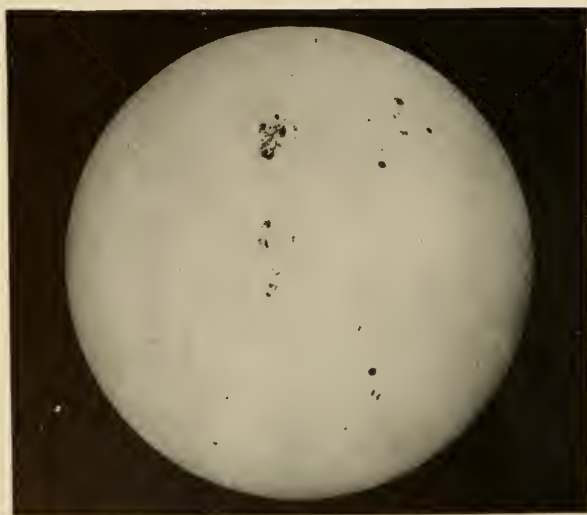
Aurora Borealis. These swaying streamers of the Northern Lights, painted as the artist saw them on the coast of Maine in August, 1919, are evidence of electric activity in the earth's upper atmosphere. A beautiful phenomenon correlated with the sun spots, the aurora follows the eleven-year cycle of the solar disturbances

*From a Painting by
Howard Russell Butler*





Yerkes Observatory



(Above) Solar prominences. From the seething surface of the sun escape hydrogen, helium, and calcium in rose-red prominences that rise thousands of miles. Until lately only observed at the infrequent times of eclipse, they can now be studied on any clear day with the spectrohelioscope

(Left) The sun's disc. The black spots on the sun's surface are giant whirlpools of magnetic activity. Small in comparison with the greater sun, they are larger than the earth. Cool in contrast to their hotter background, they appear black even though white-hot

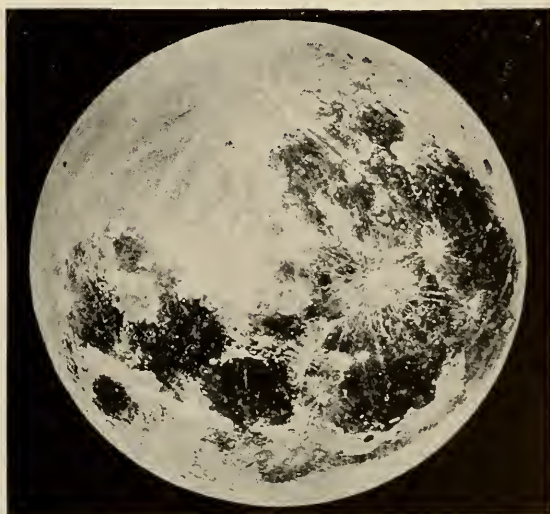


Mt. Wilson Observatory

Sun and Moon

Full moon. Although only $1/400$ as wide as the sun, the moon can cut it completely from earthly view because it is 400 times nearer. The spots on the moon's hard surface are great open plains, mountains, and craters—hot in sunlight, frigid in darkness

Yerkes Observatory





A LUNAR LANDSCAPE

No atmosphere protects the moon's rugged surface, no twilight softens its shadows, no erosion rounds its jagged features, no life clothes its barren wastes. In the airless black sky, stars and planets are visible in the daytime. On the distant

earth, which may be seen in the sky above, clouds and oceans proclaim it a more fortunate world. The Lunar Landscape, painted by Howard Russell Butler, is the joint conception of Mr. Butler and Dr. Henry Norris Russell

A planet like the earth, Mars is possessed of an atmosphere, a 24-hour day, seasons, and—perhaps some kind of life. The dark wedge of Syrtis Major, a polar cap, and drifting clouds are seen here as from one of the two tiny Martian moons

From a painting by Howard Russell Butler



THE GREAT NEBULA IN ORION

Beyond the realm of the planets, the stars are scattered in space. Seen from the earth in groups, they form the star pictures or constellations. In one of these, Orion, the naked eye sees but a faint star in the

sword where the camera records this immense gaseous cloud. Shining by its own light and by that of the four bright stars immersed in its center, it illuminates a vast sky area

Yerkes Observatory





Mt. Wilson Observatory

"NORTH AMERICA" NEBULA IN CYGNUS

Uncounted thousands of stars ceaselessly radiate light and heat to illuminate this vast gaseous continent in space, and yet it has never been seen by human eyes! Only the camera can see it, although it is

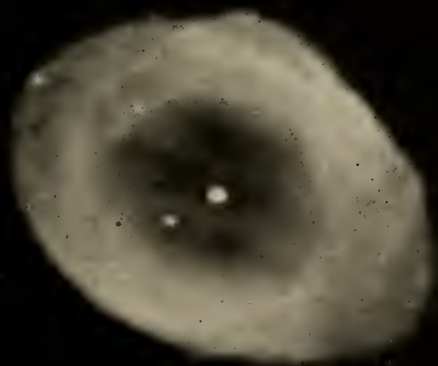
millions of times larger than its counterpart upon the earth. In fact, if the whole of the known world were placed in its midst, the world would be but as a speck of dust upon a plain



(Left) Globular star cluster in Hercules. Light from the fifty thousand stars which make up this famous star cluster takes more than thirty-five thousand years for its trip to the earth. Strange that it should be but barely visible to the naked eye! Any one of these stars might be our own sun—possessed of light, heat, magnetic storms, prominences—and even a system of circling planets

(Below) Ring Nebula in Lyra. The ring nebulae are of unusual beauty and of rare occurrence in the Milky Way galaxy. Their hollow spheres of gaseous material are lighted by the central stars which are among the bluest and hottest known. Distance removes them so far from view that the faintest stars visible to the naked eye are 9000 times brighter than these brilliant luminaries

Photographs from Mt. Wilson Observatory

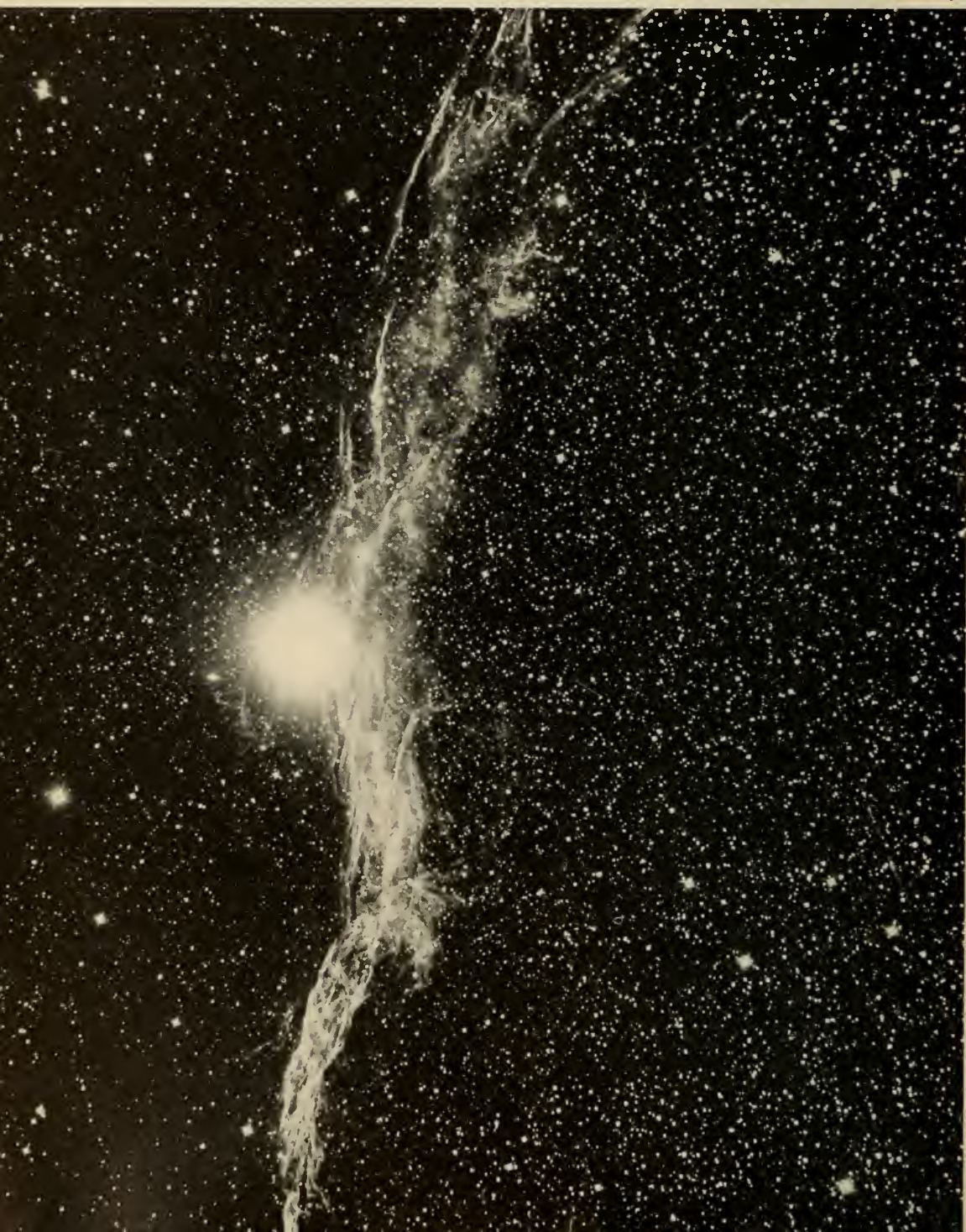


NETWORK NEBULA IN CYGNUS

This exquisite lacy film extends for millions of miles among the stars. As it moves slowly but steadily through space, its gauze-like wings hide myriad suns from

view. It is invisible to the naked eye and a seventeen-hour exposure was necessary to catch its misty filaments upon the photographic plate

Mt. Wilson Observatory





Mt. Wilson Observatory

DARK NEBULA IN OPHIUCHUS

Once thought to be holes in the sky giving view to empty space, the dark nebulae are now known to be masses of opaque matter obscuring the light of the stars behind. The S-shaped obscuration winds in the midst of a star-studded region



Klepesta in Czechoslovakia

METEOR TRAIL

This photograph of the nearest of the remote island universes was almost complete when a near-by meteor flashed on to the plate, streaking across at the left.

The pair are a paradox—the one, a giant star system far beyond our Milky Way galaxy; the other, a tiny bit of matter only a few miles from the earth's surface

Problems of Construction

Some of the interesting architectural and engineering difficulties which were overcome in building the Hayden Planetarium

By WAYNE M. FAUNCE

*Vice-Director and Executive Secretary,
American Museum*

THE new Hayden Planetarium marks the culmination of ten years' effort to secure for the American Museum of Natural History in New York a Projection Planetarium—that marvelous piece of precision equipment for visual instruction and entertainment developed by the German firm of Carl Zeiss to demonstrate the fascinating drama of the night skies.

Plans for an astronomic section of the Museum were first developed in 1925 by the late Howard Russell Butler, in collaboration with the Museum staff and the architects, Trowbridge and Livingston. These early plans called for a five story building, to be erected on the site of the present Museum auditorium and to contain four large exhibition halls devoted to astronomical subjects. The uppermost hall was to be surmounted by a hemispherical dome, on the inner surface of which it was proposed to project images of the heavenly bodies. For this purpose, the Zeiss Projection Planetarium was considered, and Dr. Clyde Fisher, now curator of the Hayden Planetarium, went to Germany with the chief object of studying two installations which had then been made of this extraordinary instrument, the invention of Dr. W. Bauersfeld of the engineering staff of Carl Zeiss, Jena. Doctor Fisher returned with great enthusiasm for the possibilities of the Projection Planetarium and it became a definite feature of the plans for the Museum's proposed astronomical building. Not until 1933, however, were sufficient means found to finance such a project.

In the spring of 1933, the Trustees of the

American Museum formed a separate corporation, known as The American Museum of Natural History Planetarium Authority, thereby becoming eligible to apply to the Reconstruction Finance Corporation for a loan on a self-liquidating basis to construct and equip a Planetarium. Mr. Charles Hayden of New York became interested in the project and made the generous, public-spirited offer to donate both the Zeiss Projection Planetarium instrument and a large Copernican Planetarium which was desired for installation on the first floor.

Breaking ground

Satisfied that the Museum's proposition was financially sound and that the anticipated revenue from admission fees would be sufficient to pay all operating expenses and amortize the investment in not more than twenty years, the Reconstruction Finance Corporation granted a loan of \$650,000 to construct the Planetarium building. At the ground-breaking ceremony on May 28, 1934, Mr. Hayden turned the first shovelful of earth, and it was announced that, in appreciation of his magnificent gift of the two instruments, the building would be officially designated by the Trustees as The Hayden Planetarium.

In the preparation of the plans and specifications, the experience of existing planetariums in America and abroad was drawn on to the fullest extent. Dr. Philip Fox of the Adler Planetarium in Chicago, Mr. James Stokley of the Fels Planetarium in Philadelphia, with their respective staffs, and Mr. John C. Austin, architect of the Griffith Observatory and Planetarium in Los Angeles, coöperated in supplying general and technical information required to bring the plans as near to perfection

as possible. Dr. K. A. Bauer, representing the firm of Carl Zeiss, Inc., and Mr. J. W. Fecker, the expert telescope builder of Pittsburgh, who designed and built the Copernican Planetarium, gave invaluable advice concerning the arrangement of the Planetarium instruments.

Working in close coöperation, the architects, Trowbridge and Livingston, the Museum's administrative and technical staff, and the Trustees' Advisory Committee, of which Mr. A. Cressy Morrison is chairman, developed the final plans for the two story and basement building, 146 feet long by 122 feet wide.

A dramatic effect

The great surmounting dome, with an outside diameter of eighty-one feet, is finished in copper, which has been given an effect of age by an artificial treatment rendering it a dark bronze in appearance. To enhance the attractiveness of the Planetarium at night, provision has been made for illuminating the dome and the front of the building by floodlights, concealed above the marquee and on near-by Museum buildings.

The Planetarium building as a whole has been built as a self-contained unit, although its operation will be an integral function of the American Museum. Every attention has been given to insure the comfort and enjoyment of visitors. Clean, conditioned air is provided throughout. During the warm months of the year, cooling equipment in the ventilating system will keep the temperature comfortably below that of the outside air, but not so low as to cause a disagreeable physiological reaction when one leaves the building.

Facilities for checking wraps are provided in the basement mezzanine, adjacent to the public lounge rooms. The broad stairways are provided with handrails down the center and along the side walls. For those whose strength might be overtaxed by the stairs, a small elevator is available. Ornamental settees have been distributed in the ambulatories at convenient points.

A brief discussion of some of the unusual problems encountered in the construction of the Planetarium building may be of interest.

Before excavation for the foundation was begun, it was known that the site of the Planetarium had once been a small pond, the remnant of a larger one which formerly extended

from Eighty-first Street to Seventy-seventh Street. Long time residents in the neighborhood of the Museum distinctly recall this pond and according to their recollection it afforded fairly good cat-fishing in days before the growth of the Museum encroached on the area. This pond was probably fed by a small creek which until very recently was running underground in the Museum's square.

As the excavation for the foundations progressed, it became evident that the old fill had been dumped in rather carelessly, and more than forty years of settlement had not sufficiently consolidated the subsurface material to support the Planetarium building as originally planned, without extending the foundation down to bed-rock or to more substantial earth. In large areas, loose heaps of irregular bowlders from two to four feet thick, with sizable voids around them, were uncovered. At other points infirm material, such as ashes, was disclosed, and the shore line of the old lake was clearly discernible in places. To meet this adverse condition, the architects recommended that a system of foundation piles be adopted to provide proper foundation support.

A firm foundation

A combination of bearing piles and friction piles was driven. The bearing piles were forced down to solid rock and the friction piles were driven to such a depth that the resistance of the earth to further deformation, together with the friction on the sides of the piles, was sufficient to bear the required weight. A total of 326 piles was necessary. They were all of the concrete type. In placing them, a hollow, water-tight tapered steel shell was driven down by means of a 6,500-pound steam hammer, impinging on a steel core. At the proper depth, the core was removed and the shell filled with concrete.

The solution of the foundation problem was not quite so simple as the foregoing would indicate, because it was impossible to drive piles through the masses of loose rock. Consequently, forty-two pits for as many clusters of piles had to be laboriously excavated down to a level of ten feet below the basement so as to remove the loose rock, and conditions were such that it was necessary to do most of this excavating by hand. Then because it would have been unsafe to operate the fifteen-ton pile driver,

towering sixty feet, on ground checkered with pit holes, extensive cradles and runways of twelve-inch by twelve-inch timbers supporting steel rails had to be erected over the pit holes to permit of moving the driver over the area of operations. Once it commenced, the pile driving was carried out with despatch, but not without considerable irritation to the nerves of residents in the neighboring apartment houses.

The Planetarium dome

In the design and erection of the Planetarium superstructure, there was no extraordinary departure from general building practice, except in connection with the dome. The pattern of the steel framework, as shown in the accompanying illustration, is perhaps unusual and certainly very interesting, but its design presented no unique problems. The structural dome, however, is quite different from those of other American planetariums. It is hemispherical in shape, eighty-one feet in external diameter, and its thickness is incredibly small, varying from three inches at the top to three and a half inches at the base or spring line, where it rests on a twelve-inch thick concrete ring bearing on the steel frame of the building proper. It is a shell type of structure entirely self-supporting, without the aid of trusses, hangers or other external features, and furthermore carries the weight of the inner or projection dome suspended from it and weighing approximately fifteen tons, including steel hangers. Of reinforced concrete, it derives its strength from its shape and the arrangement of one-quarter inch round iron rods, imbedded in the concrete. In Europe this method of constructing domed and arched surfaces has been used quite extensively but it is just beginning to be introduced in America.

The Hayden Planetarium dome was cast in place, but not by the usual method of pouring semi-liquid concrete into a form composed of two false-work surfaces, held apart a distance equal to the thickness of the finished concrete. A single faced wood form was employed, upon which was nailed a layer of "rock cork" one and one-half inches thick, which corresponded to the inside surface of the finished dome. Then the cement was blown into place by means of a cement gun. This remarkable device, known as the Akeley Cement Gun, was invented by the late Carl Akeley—that many-

sided genius who was a member of the American Museum staff from 1909 until his death in 1926, and to whose memory the Trustees have dedicated the Akeley Memorial African Hall.

The inner dome, suspended from small T-shaped bar anchors imbedded in the reinforced concrete dome, is exactly seventy-five feet in diameter. It, too, is hemispherical and is carried down to an irregular horizontal line representing the sky line of New York City, nine feet from the floor of the Zeiss Planetarium chamber. Its main purpose is to serve as the projection screen of the Planetarium, but to achieve satisfactory acoustics, which means the prevention of disturbing echoes of the lecturer's voice and other undesirable reverberations, this inside dome has been made somewhat porous in character. This is so that sound will not be reflected from its surface to an excessive degree, but pass through and be absorbed by the rock cork lining of the structural dome.

The individual curved plates which make up the projection dome were lapped three-eighths of an inch and electrically "spot" welded along the laps at one inch intervals. One long edge of each plate is turned up at ninety degrees in a stiffening rib one inch wide, which also serves as a means of attaching the vertical hangers, on which the projection dome is suspended from the structural dome above.

A gigantic sieve

By a long series of experiments before the Fels Planetarium was built, it was found that a steel alloy of the stainless type lent itself best to the sort of fabrication called for in such a large spherical surface. Also, by conducting acoustical experiments with metal sheets of different thicknesses and different degrees of perforations, plates one-sixteenth of an inch thick, with a regular pattern of one-sixteenth-inch round holes, three-sixteenths of an inch apart, over the entire surface, proved to be best suited for the Planetarium purpose.

One might think that such a sieve would not provide a satisfactory projection screen, that as their images pass over the surface of the dome some of the small stars might disappear in the holes and that the dome would be too porous to represent the sky with any degree of realism. Fortunately, the smallest of the stars projected (none which can be seen by the unaided human eye are omitted) are larger

than the holes, and under demonstration conditions there is no serious loss of light in this way. A final finish of flat white paint renders the dome an excellent reflecting surface without filling up the holes and during the dark demonstration periods or even when the room is moderately lighted to facilitate seating, there is very little visible evidence of the perforations. They do not detract in the slightest from the illusion of the night sky, and without such perforated treatment of the dome and the vertical circular side walls of the Planetarium chamber, as well, the room would be impossible acoustically. The echoes of the speaker's voice and the distortion of the incidental music would be intolerable.

Comfortable seating arrangements

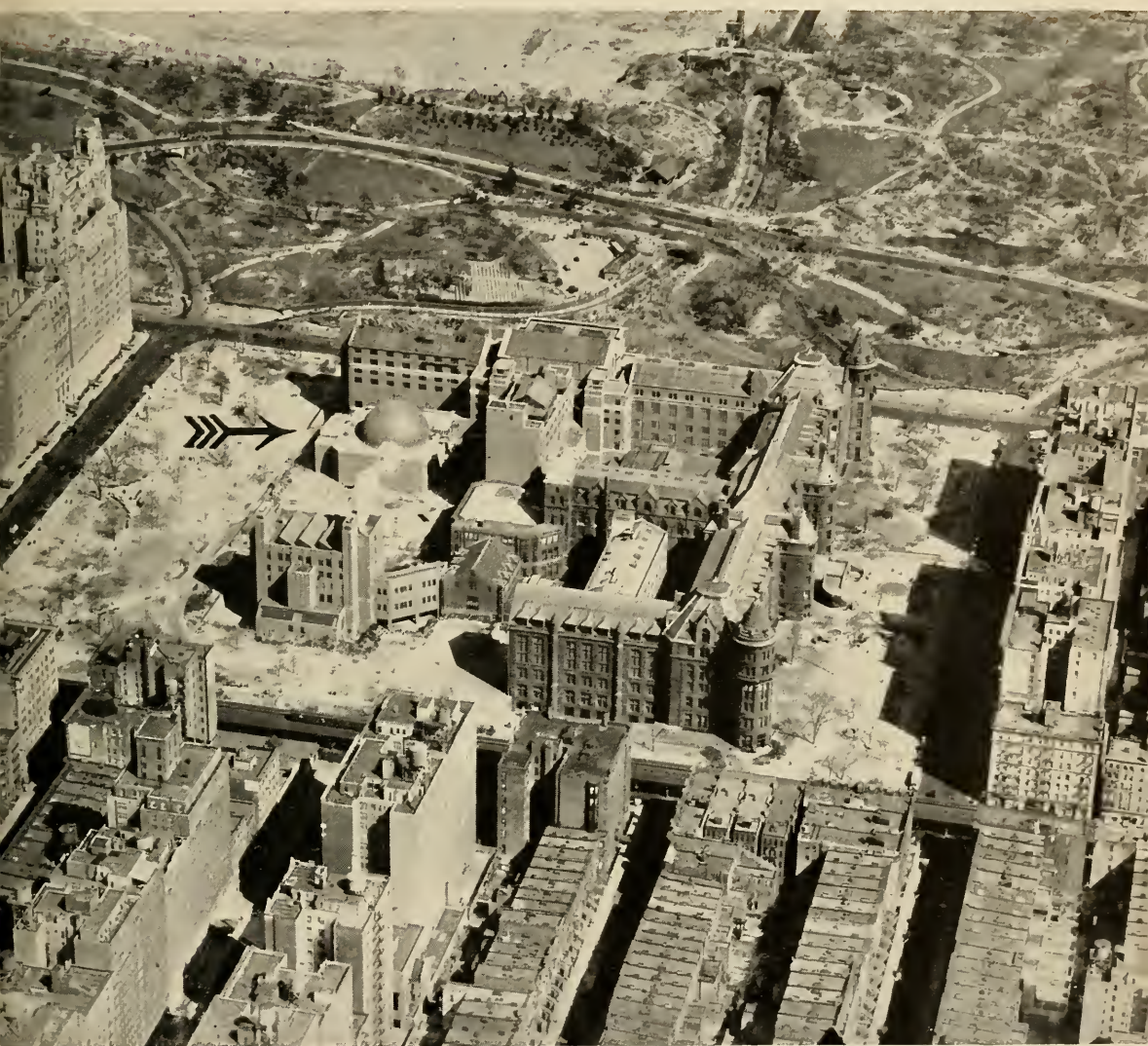
No other detail of the Planetarium equipment has been given as much thought and study as that devoted to the design of a special chair, of which there are 742 in the Projection Planetarium chamber. Several samples, embodying original ideas, were developed. These were experimented with, modified and, through the courtesy of the Franklin Institute, tested under actual demonstration conditions in the Fels Planetarium. All suggestions—and they ranged from the *chaise longue* through plain backless benches to hydraulically operated barber chairs, with head rests—were carefully considered. Apparently everybody who has attended a lecture in a planetarium has a different idea of the type of chair which should be used. In order to see all sections of the “sky,” the observer must do a certain amount of craning and the Hayden Planetarium chair is designed to minimize strain on the neck and shoulder muscles. The back of the chair is shaped to allow free twisting of the shoulders and yet it supports the observer's back comfortably in a relaxed position. A ten degree tilt backward adds to the comfort and the brackets supporting the short curved arms are set back far enough to permit easy turning. The body of these chairs is wood, with a black finish. They are rigidly fixed in concentric circular rows on iron pedestals bolted to the floor.

In connection with the lighting (there are no windows in any of the exhibition or demonstration spaces), many unique problems had to be solved. The general overhead illumination in the exhibition corridors is quite subdued in order not to interfere with the transparencies; nevertheless, exhibits in the center of these passageways, such as the large meteorites on the first floor, have to be properly lighted. Inconspicuous ceiling fixtures, which direct the light downward through concentric circular vertical vanes, have been installed to control this illumination. They provide adequate lighting for the floor exhibits but restrict the distribution of light, so that very little from these sources diffuses to the side walls. The transparencies required special lighting and careful experiments were necessary to develop a diffusing arrangement which would flood them with a uniform light, sufficiently intense to bring out all the details of these spectacular photographs.

The fruit of experience

The Museum is confident that the Hayden Planetarium will reflect favorably the thorough planning of all parts of the building. It is the composite result of study and experiment by many technical experts and lay advisers, who deserve a large measure of credit for any success which may have been achieved. The experience of other planetariums has been the chief guide, and the staffs of these institutions have coöperated in every way in pointing out possible errors in design to be avoided. It is the belief of those who have been associated with the development of this project that in a happy combination it presents the advantages of both the Zeiss Projection Planetarium and the large Copernican Planetarium, brought together under one roof in a well-rounded educational plant. It is their firm conviction that it embraces the essential exhibits and demonstration equipment to instill in Museum visitors a deeper appreciation of the marvels of the universe and a clearer understanding of the many mysteries that we see in the heavens.

The Planetarium in the Making



McLaughlin Aërial Survey

AËRIAL VIEW OF THE GROUP OF AMERICAN MUSEUM BUILDINGS

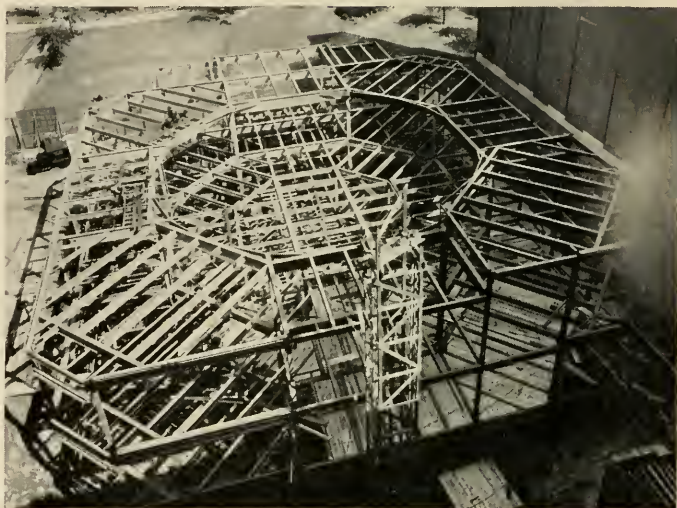
Taken from a southwesterly direction. The Hayden Planetarium, indicated by the black arrow, is located in the north-east court of the Museum's ultimate ground plan. Until the erection of future building sections planned for the north side and corresponding to the completed south façade, the Planetarium will be directly accessible from Eighty-first

Street (to left of arrow) by an attractive approach landscaped by the Department of Parks of the city of New York. The hemispherical dome (appearing prominently in the picture) is a striking feature of the exterior. It, as well as the north façade of the building itself, can be illuminated by floodlights concealed above the marquee and on near-by buildings



(Left) The site of the Planetarium had evidently been a dumping ground for loose rock excavated during the construction of earlier Museum buildings. Before the foundation piles could be driven, forty-two pits for as many pile clusters had to be laboriously excavated. Photographs on this page by R. L. Bertin, White Construction Company

(Right) The steel framework for the Planetarium Building was of unusual design, providing for a two-story rectangular building with central circular rooms on both floors and for the support of a heavy concrete domed roof over the upper room



(Left) Circular platforms for the convenience of the mechanics who installed the horizontal pipe rings and the upright wooden ribs of the temporary form for casing the dome. This form was ultimately self-supporting, entirely free from the scaffolding seen in the picture

The temporary wooden form for the dome nearing completion. Near the top of the picture appears one of the horizontal pipe rings. Lower down, the upright ribs are in position between the rings, and on the lower part of the form, the diagonal bracing strips have been nailed on



White Construction Company Photo



Eric J. Baker Photo

Not haphazard work, but carefully designed in advance of construction, so that the finished form did not vary from a true hemispherical surface more than a quarter of an inch at any point

Workmen laying the slabs of insulation, the first permanent material of the dome, on the temporary form. Small-headed nails were used, so that they pulled through from the under side when the form was removed, without damaging the insulation

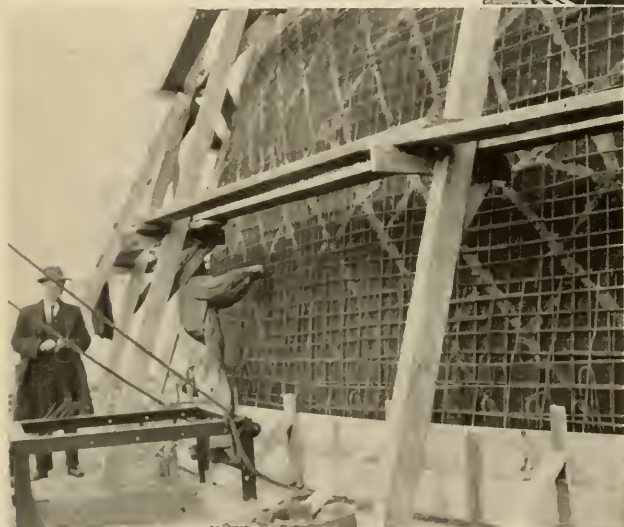


Eric J. Baker Photo



The concrete structural dome was cast over a falsework form unique in design. It constituted a self-supporting skeleton dome and was entirely removed after the concrete dome was finished. Photographs on this page by Eric J. Baker

(Right) The completed $1\frac{1}{2}$ -inch layer of insulating material, known as "rock cork." This lining for the structural dome reduces the transfer of heat through the dome and also absorbs sound which passes through the perforations of the steel projection dome, thus preventing echoes of the lecturer's voice



After the joints of the "rock cork" covering of the temporary form had been calked, a carefully designed pattern of iron reinforcing rods was woven over the entire surface of the dome preparatory to "shooting" on the concrete. The combination of steel rods, embedded in concrete, made a shell exceedingly strong for its thinness, which varied from $3\frac{1}{2}$ to 3 inches

Dr. Clyde Fisher, curator of the Planetarium, watching the cement gun in operation during the casting of the concrete dome. This ingenious device was invented by the late Carl Akeley. Without the cement gun the concrete dome would have been impracticable to build, and other types of suitable domes would have been much more expensive



Eric J. Baker Photo

The cement gun was entirely satisfactory when "shooting" the steep slope of the dome, since the operator could control the consistency of the mixture by the water valve at the nozzle of the gun. Sand, gravel, and Portland cement were pumped dry through the larger hose to the nozzle by compressed air

A view of the Planetarium during construction taken from the west, with the Whitney Wing of the Museum in the background. As the exterior brick walls were laid, work on the dome progressed steadily, and before severe cold weather set in, the building was fully enclosed



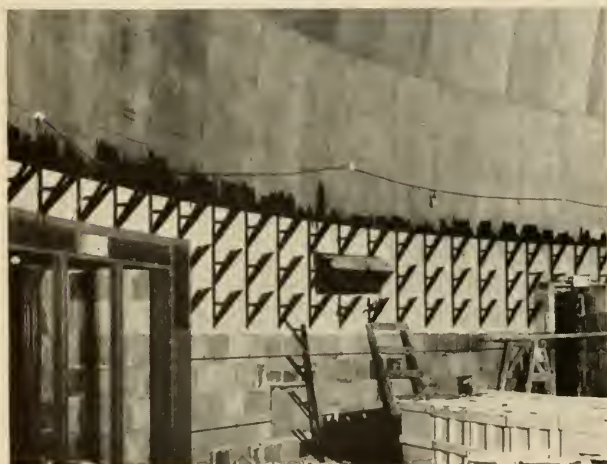
Eric J. Baker Photo



The Planetarium Building fully enclosed. While the concrete dome was being cast, midwinter conditions necessitated special protection against freezing temperature. Huge tarpaulins were employed to form a canopy over the fresh concrete. Photographs on this page by R. L. Bertin, White Construction Company



The dome, entirely weatherproof, with an outer finish of copper plates. This copper finish was finally washed with a solution of salt to age it artificially and render it a rich old bronze in tone



The assembly of the curved stainless steel plates of the inside hemispherical projection dome. The lower edge of the bottom row of plates at the level of the "horizon" of the artificial sky is cut out in a silhouette representing the skyline of New York City. The three rows of brackets appearing below were installed for the purpose of carrying overlapping metal plates set at an angle of 45 degrees to the vertical side wall. These plates are finished with a glossy, black surface so that any light hitting the side walls below the horizon is reflected to the floor and not seen by the audience

Astronomical Fiction

Amusing errors in astronomy to be found in literature, both ancient and modern

By FRANK C. JORDAN

*Director of the Alleghany Observatory,
Pittsburgh, Pennsylvania*

MORE than fifty years ago, the Astronomer Royal of England, Sir George Airy, made the statement that not one person in five thousand knows that the stars rise and set. I have repeated this statement before groups of intelligent persons and found, to be sure, a deplorable ignorance on the subject.

Persons living in a city, surrounded by its lights, do not perceive the heavens. They know that the sun makes its apparent daily journey across the sky, but their knowledge of the moon, its motion and phases, is decidedly hazy. It is only when they get out into the country, away from lights, that they get a clear conception of the starry heavens, the grouping of stars, their motion across the sky, and their difference in color and brightness.

This lack of knowledge of the heavenly bodies and their motions has led to many amusing mistakes in literature, both ancient and modern. The classical example is found in Coleridge's "Rime of the Ancient Mariner":

Till clomb above the eastern bar
The hornèd moon, with one bright star
Within its nether tip.

It is of course impossible for a star ever to appear within the crescent of the moon, for the stars are all far more distant than the moon and consequently never pass in front of its darkened face.

Dr. Clyde Fisher has called my attention to practically this same error in a modern book, *The Bridal Wreath*, where the sentence

appears: "At the end of the street in the blue-green sky rode the new moon's sickle, with a bright star within its horn." The author possibly was influenced by Coleridge without recognizing the error.

There are two more possible errors in the passage from Coleridge. Though the context is not quite clear, it appears that the first half of the night is indicated, at which time the "horned moon" could not be rising in the east. However, it may have been the waning moon rising before the dawn. Be this as it may, other circumstances referred to in the poem, especially the very short twilight, imply that the ship was sailing in the tropics. The crescent moon then would be lying flat on its back, and there could be no "nether tip." A line through the tips would be parallel to the horizon.

Strange ways of the moon

Edgar Allan Poe, in *The Descent into the Maelstrom*, commits a very glaring error. A ship whirling about in the funnel of the Maelstrom (an error also, for the Maelstrom forms no funnel) is lighted by the full moon, which shines directly overhead. This happens on the first of July when the full moon is far south of the equator and would barely rise above the southern horizon for an observer in Norway. To add to the error, the moon six hours later is setting in the west, whereas in reality a celestial object in the zenith in Norway would not set at all, but would be in the circle of perpetual apparition. Furthermore, on July 1 Norway would not have any night, and moonlight would be superfluous.

H. Rider Haggard, in *King Solomon's*

Mines has a party of whites about to be overtaken and slain by a band of savages. They providentially escape because of the occurrence of a total eclipse of the sun during which they stumble along in total darkness for more than an hour. This is truly a remarkable eclipse, for the longest that can possibly happen is a little more than seven minutes, and even then it is not very dark. The evening of the same day they were helped along by the light of the full moon. This of itself is a startling occurrence, for a solar eclipse happens only at new moon, and full moon occurs only after a lapse of two weeks. But in fiction anything may happen. Astronomers so took Haggard to task, however, that this was changed in later editions.

A young and sentimental writer started a story in this way: "It was midnight, and the new moon was just rising in the east." This moon must have got its trolley off the wire, for in the experience of most of us the new moon is always setting in the west, and does not remain visible until midnight.

Mrs. Gene Stratton Porter in her very delightful nature novels plays fast and loose with the moon. She can have it shining whenever and wherever she pleases, and it can do strange things. At one place in *The Harvester*, the half moon is just at the tree tops on the western horizon, which is quite proper. But later in the night it has risen clear of the trees and is flooding the country with light. This is of course impossible, for the moon never rises in the west. In another place it is stated that the moon every night made a bridge of light across a small lake. This could happen for a few nights, but not indefinitely.

Planting "in the moon"

Many gardeners and farmers plant things "in the moon," root crops in the dark, aerial crops in the light of the moon—or perhaps just the reverse. This belief that the moon exerts a strong influence upon vegetation seems to rest partly on the argument that if the moon produces the tides, it should likewise have some effect on the water in the soil. No account is taken of the fact that the moon has the same effect on the tides whether it is in the dark or the light phase. Tides, moreover, are purely a physical phenomenon, while plant growth depends upon chemical reactions. If one argues

that moonlight favors plant growth in a manner similar to sunlight, the reasoning is likewise slipshod. We sometimes hear it said at the time of full moon that it is as light as day. Actually the light of the full moon is visually only about one six-hundred-thousandth as strong as full sunlight. A simple photographic experiment demonstrates this difference. Whereas in full sunlight an exposure of one hundredth of a second will produce a strong negative, in moonlight an exposure of two hours, or 720,000 times as long, will be necessary. So it is an exaggeration to claim that moonlight can exert any appreciable photosynthetic effect on vegetation.

• The moon and the weather

I once knew a man who always planted his potatoes "in the moon." One year when the moon was right other conditions were all wrong. To wait another month for the moon would be too late, so in desperation he planted in the wrong time of the moon. His crop that year was the best he ever had. That converted him. Just a little reasoning or experimentation would cure many people of queer ideas.

It always worries an astronomer to see a painting in which the horns of the moon are directed toward the horizon, yet this is a common error. Actually they should point away from the horizon, because they always point away from the sun, which is below the horizon at night. Artists may see more in a scene than the average person, but they do not always see the heavens correctly.

Some persons profess to be able to predict a dry or wet month from the orientation of the crescent moon, depending upon whether it lies on its back or is at a considerable angle with the horizon. These positions have nothing whatever to do with mundane affairs, but are the result of the relative positions of the sun, moon and earth, which can be predicted years in advance. In latitude of the northern United States the crescent in the winter is on its back, while in summer it is more nearly vertical. The weather, on the other hand, is decidedly capricious. Many persons swear by the prediction in patent medicine almanacs, not realizing that these predictions may have been made by the office boy, or some one equally ignorant of the weather. They are necessarily sometimes correct, but one correct prediction near

at hand hides several false ones farther away. The experts of the weather bureau seldom venture to predict farther than a week in advance, and even then are extremely tentative in their statements.

Dr. E. E. Barnard, the famous astronomer, did not like the book *Ben Hur*, because Sheik Ilderim's racing horses were named after stars which have Arabic names given them about 1000 A. D., while the events of the book took place at the beginning of the Christian Era. Such anachronisms are rather common in literature as well as in art. It is like putting a spyglass in the hands of Columbus, or placing an American flag at the head of Braddock's army. General Lew Wallace also made another error in the *Prince of India*. An astrologer was on the house-top at midnight viewing the planets, among them Venus. Now a terrestrial Venus may keep late hours, but in India the celestial Venus is always tucked away below the western horizon before midnight, and does not appear above the eastern horizon till near the morning dawn.

Multitudes believe implicitly in the pseudo-science, astrology. That the stars and planets can have any influence whatever on the lives of human beings is utterly indefensible. Astrology has served only one fortunate purpose, namely in early years when the study of it led to the real science of astronomy.

Seeing stars by daylight

There is a pleasant fiction that from the bottom of a deep well or a lofty chimney in the daytime a bit of dark sky may be seen, spangled with stars. A very bright star might be seen, but certainly no others. The writer of a story had the hero fall into a deep pit, apparently without any serious injury to life or limb, but he remained there through the light hours of the day without rescue. His one ray of hope was one bright star which remained directly overhead all day. A very accommodating star. The writer was one of the 4999 out of every 5000 persons who do not know that the stars move across the sky.

A certain hazy condition of the sky makes it act like a mirror. In Pittsburgh we have often seen what the Alleghany Observatory staff calls "furnace comets." They are faint yellowish vertical beams of light about 5° or

6° in length, which are the reflection of the flame of a Bessemer steel converter, and do look like comets. Most of the people of the city have never seen one, but when a person is so fortunate as to see one, he calls up the Observatory to find out about his discovery. During the apparition of Halley's Comet in 1910 there were one or two nights in which several of these were visible at once. Then the Observatory telephone was kept busy. One message came:

"I see three comets; which is Halley's?"

One evening a woman called and asked "Am I looking at Halley's comet?"

She was answered "Yes."

"Oh, thank you," was her reply.

Of course we did not know where she was looking, but if she saw a comet, it was certainly Halley's, for no furnace comets were visible at the time.

Persons call and tell of some strange light in the sky, and ask for an explanation. When they are asked where it appeared, the answer is likely to be: "Just over the top of a certain hill, or above such-and-such large building." This of course conveys no information, and when asked the direction in which it appeared, the replies are apt to be very hazy as to the points of the compass.

About two years ago, when Venus was so bright in the northwest sky, the impression got abroad in Pittsburgh that it was a beacon light sent up by balloon from Akron airport. We finally exploded that idea by the argument that, since Akron is 100 miles from Pittsburgh, and Venus appeared at least 30° above the horizon, that light would have to be 50 miles above the earth's surface. This is a good example of how little thinking is done by the average person when some startling idea is advanced.

Read any work of fiction or poetry, and there is a chance of finding astronomical errors. Not in all, however. One striking exception is that of Lord Tennyson, who, it is said, never made such a mistake. The secret is, that before writing any astronomical statement, he always consulted the Astronomer Royal. I would commend such a course to any writer not up on his astronomy.

"Read a little astronomy once a month or oftener, and see your astronomer at least twice a year."

The Birth of the Solar System

Facts, theories, and hypotheses that explain, or attempt to explain how the earth and other astronomical bodies were formed

By CLYDE FISHER

Curator of Astronomy, American Museum

OUR earth has not always been as it is now. It is difficult to understand how the early natural philosophers, though doubtless influenced by religious teachings of the day, could have believed that things were created essentially as they are—the beds of coal, ranging in series from the peat bog, through brown coal, bituminous, anthracite, to graphite; the deposits of limestone and its metamorphic marble; even the fossils in the rocks.

But those days are past. We now realize that there is “nothing unchangeable except eternal changeableness.”

One can observe profound changes taking place in the short space of a human lifetime. And if we read the record in the rocks, we see evidence of far greater changes which took place before man came upon the scene, even before the beginning of either plant or animal life on our planet. Further, if we turn a telescope on Mars and use with it the spectroscope and the photographic plate, we note evidence suggesting that similar changes may have taken place on that planet.

Naturally we have come to wonder about the origin of the earth and its companion planets, and of the sun around which these bodies move.

The age of our solar system—that is, the time that has passed since the great catastrophe which started its development—is estimated to be from two to ten billions of years.

One's earliest astronomical observation is probably that the sun rises in the east, passes across the sky, and sets in the west. Our forebears of not many centuries ago supposed from similar observations of the moon and the stars,

as well as of the sun, that the earth was the center of the universe. Although in everyday life this explanation seems adequate for all practical purposes, we now know that it is incorrect.

It was not until the astronomers had made the important distinction between real and apparent motions, not until they understood that the sun was the center of our solar system, that any intelligent theory for the origin of these bodies could be framed.

The nebular hypothesis

The first scientific theory of the origin of our solar system (and it was a magnificent conception) goes back to the philosophers Kant and Swedenborg. Since it was developed and put into scientific form by La Place, it has been known as La Place's Nebular Hypothesis or Theory, depending upon the credence given. (A hypothesis is more than a guess. It must have some evidence in its favor, and must not be contrary to proven facts. A theory must have more evidence in its favor; while a law is a theory proven beyond doubt. So, hypothesis, theory, and law are relative terms, there being few hard and fast lines in nature.)

According to this Nebular Theory, the sun and all of the planets and their satellites and the asteroids were once a huge, rotating, gaseous nebula, which extended out beyond the present orbit of Neptune. As this nebulous mass cooled it contracted and, since we recognize no resisting medium in space, the speed of rotation increased. As the whole mass contracted, the circumference grew correspondingly smaller, so that the part at the surface went round more times in a given period. This increase in the speed of rotation was accom-

panied by increase in centrifugal force, or the force by which a revolving body tends to fly from the center.

So it was with the mass of the outer part of our theoretical nebula. And when this force had increased until it balanced the pull *toward* the center (centripetal force or gravity), the inner part of the great nebulous mass contracted away from the outer rim or shell of the nebula. It was not conceived that this rim or outer shell was thrown off like drops of water from a grindstone or mud from a carriage wheel, but that it was left balanced between centrifugal force and gravity, and still rotating. This rim or shell, which may not have been complete, or even uniform in thickness, was supposed then to have drawn together into a more or less globular mass, under the influence of gravitation, by which every particle of matter attracts every other particle.

Thus the outermost planet and the rest of them in succession were supposed to have been formed, the one nearest to the sun being produced last of all. In the case of the asteroids, or tiny planets which occur between the orbits of Jupiter and Mars, it is supposed that this shell, instead of forming a single mass, took shape in more than a thousand small masses.

The moons or satellites of the planets were supposed to have been formed in the same way, after each individual planet-mass had been left balanced between gravity and centrifugal force, still revolving around the central portion of the original nebulous mass.

As the nebulous matter condensed and cooled, it changed from gaseous to liquid form and then to solid in the case of the four terrestrial planets, as Humboldt called the four inner ones, Mercury, Venus, Earth and Mars. The four outer or major planets, Jupiter, Saturn, Uranus, and Neptune, although they present only an outer surface of cloud, may be solid underneath the cloud. Very little is yet known about Pluto.

Two kinds of evidence

When the nebular theory was first conceived, it was thought that there were two kinds of evidence in its favor: First, there were certain features in our solar system whose existence the theory would account for; and second, there were systems outside our own in phases suggesting the early phases of our own system.

Evidence of the first kind was most impressive, for it was thought the theory would explain the following conditions:

(1) The orbits of all the planets and nearly all of the asteroids are practically in the same plane, which determines that these bodies occupy a narrow belt in the heavens only a few degrees wide. No planet is ever found near the North Star or even near the Big Dipper, and none is ever found near the Southern Cross, but all are always found in the narrow belt called the Zodiac.

(2) The orbits of all the planets and almost all of the asteroids are nearly circular.

(3) All of the planets and asteroids revolve around the sun in the same direction.

(4) The sun rotates on its axis in the direction in which the planets revolve, and its equator is but little inclined to their orbits.

(5) The planets of greater density are nearer the sun.

(6) The moons or satellites revolve about the planets in the direction in which the planets themselves rotate (except the eighth and ninth satellites of Jupiter and the ninth satellite of Saturn).

(7) The orbits of the satellites are nearly circular and nearly in the plane of the planet's equator (except for the eighth and ninth satellites of Jupiter and the outermost satellite of Saturn).

It is not reasonable to suppose that such conditions as these are due to chance and therefore insignificant. If the situation were the result of chance, we would expect to find the planets and asteroids scattered over the sky and revolving around the sun or around each other in many and diverse ways. As it is, the conditions point to a common origin and to an orderly development.¹

The second kind of evidence—namely, phases in systems outside of our solar system which suggest stages in the development of our own—consisted chiefly in nebulae.

The first nebulae to be discovered, the Great Nebula in Andromeda and the nebula in the

¹ A generation ago Simon Newcomb and other leading astronomers believed that the nebular theory was "almost a necessary consequence of the only theory by which we can account for the origin and conservation of the sun's heat." The British astronomer, Sir Robert S. Ball, explained this phenomenon thus: "As the sun loses heat, it contracts, and every pair of particles in the sun are nearer to each other after the contraction than they were before. The energy due to their separation is thus less in the contracted state than in the original state, and as that energy cannot be lost it must reappear in heat. . . In this way we can reconcile the fact that the sun is certainly losing heat with the fact that the change in temperature has not been large enough to be perceived within historic times."

sword of Orion, can be seen with the naked eye, and many more have been discovered with the telescope. Sir William Herschel observed faint diffused nebulae, others in which a nucleus can just be discerned, and others in which the nucleus is a brilliant starlike point. No telescope has been made that is powerful enough to reveal planetary systems around any of the stars other than our sun, if they exist. But the spiral nebulae certainly do appear to be solar systems in the process of development. A striking example is the well-known Whirlpool Nebula in the constellation The Hunting Dogs.

Larger telescopes to be sure, resolved some of the so-called nebulae into stars. At first this was thought to be fatal to the nebular theory, because of the natural conclusion that still larger telescopes might resolve the rest of the nebulae into stars. But the invention of the spectroscope proved that some nebulae were irresolvable. Thus spectrum analysis reestablished the nebular theory on a firmer basis than ever.

Downfall of the nebular theory

As investigation has gone forward in recent years, however, the nebular theory has lost the weight of the evidence thought to be furnished by the spiral nebulae, for these are now believed to be immense island-universes or galaxies—great assemblages of stars—far outside of our own galactic system known as the Milky Way Galaxy.

The abandonment by present-day astronomers of this splendid speculation, the nebular theory, seems to be due to two objections.

First, it is now believed by many astronomers that an extended tenuous ring or shell would not condense into a single body, but into many bodies, like the asteroids or the rings of Saturn.

The second objection centers in the distribution of angular momentum in the solar system. The angular momentum of a planet is computed from its mass and the angular distance it traverses in a given time. Almost all the angular momentum of the bodies comprising the solar system—98 per cent of the total—is at present associated with the major planets (Jupiter, Saturn, Uranus, and Neptune), which embrace only 1/700 of the total mass. The sun's rotation provides almost all of the remaining 2 per cent, so that the four terrestrial planets (Mercury, Venus, Earth, and Mars)

contribute less than one-tenth of 1 per cent of the whole. No acceptable theory has yet been advanced to explain through forces entirely within the solar system, how 98 per cent of the angular momentum could have been segregated in less than 1/700 of the total mass.

The nebular theory attempted to explain the origin of the solar system under the action of forces entirely within the system, but this is now believed by many astronomers to be impossible. The present distribution of angular momentum is believed to be due to forces from outside of the system.

The planetesimal theory

About twenty years ago Chamberlin and Moulton of the University of Chicago proposed an alternative theory, which would not be subject to the difficulties mentioned above. At first their theory was usually referred to as the planetesimal *hypothesis*, but now it certainly should be dignified by the term "theory."

According to this conception, our sun in the remote past was a star without planets, and another sun or star (for all stars are suns, and our sun is a star) in its journeying through space came so close to our sun that it caused a tremendous disturbance, pulling out great masses of the sun and starting them on their revolution around the sun. By a kind of explosion, due to the disturbance of gravity, myriads of these masses were projected into space, probably varying greatly in size, and these were the so-called planetesimals.

Not only was this new theory free from the fatal difficulties of the nebular theory, but it was found to explain the many features of the solar system pointing to a common origin by an orderly process—to explain them indeed in some cases better than the older theory.

The myriads of planetesimals which were left revolving around the sun, were slowly gathered together by the action of gravity into the planets, asteroids, and satellites. Perhaps the meteors are stray planetesimals, and perhaps the comets, which in some cases seem to be related to meteors, may also be accounted for by this theory. However, the comets have never been very definitely included in either the nebular theory or the planetesimal theory.

In his *The Two Solar Families* Professor Chamberlin considers the comets and the meteors to be children of the sun, yet "not a

brood—in the full sense that this is true of the planetary family—but an unrelated succession of independent births.”

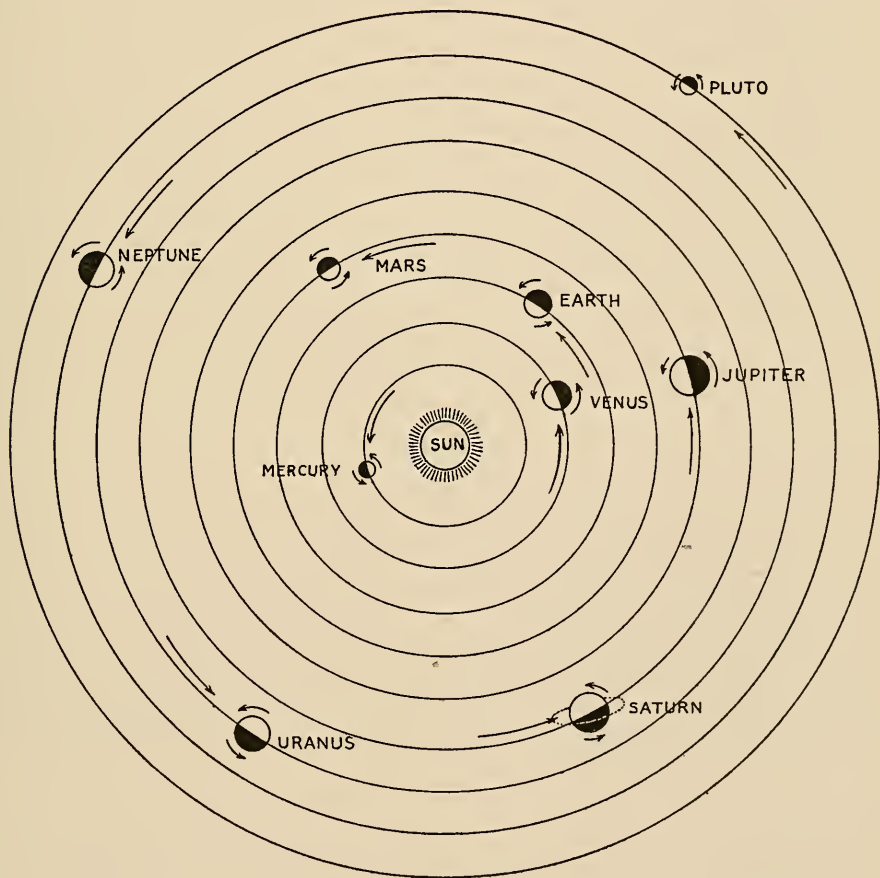
The craters on the moon were formerly believed (and still are by many astronomers) to be of volcanic origin. But there is much in favor of the theory that they were caused by the impact of planetesimals or meteorites.

The tidal theory

There have been modifications of the nebular theory, and there have been modifications or substitutions suggested for the planetesimal theory. Among the latter should be mentioned the tidal theory of Jeans and Jeffreys. These

men agreed with Chamberlin and Moulton in the occurrence of a near-encounter between our sun and some other star and in most of the essential results of that event.

According to the tidal theory, however, Jeans conceives that instead of myriads of masses (planetesimals) having been pulled out of the sun, all of the planets, asteroids, and other bodies were pulled out in one tremendous cigar-shaped mass of gas, which later broke up into these bodies. The largest planets, Jupiter and Saturn, according to this theory came from the middle of this huge, spindle-shaped cigar, while the terrestrial planets came from one tapering end and the outer smaller planets



THE SOLAR SYSTEM

Diagrammatic drawing of the solar system showing that all the planets revolve around the sun in the same direction, and rotate in the same direction that they revolve

from the other end. In accordance with this view, the planets must have possessed nearly their present masses from the time of the "dynamic encounter."

Since the tidal theory, or the tidal form of the dynamic encounter theory was advanced, Jeffreys has come to the conclusion that there was a *real* collision, although a grazing collision, between our sun and this other star, instead of a near-collision.

From the standpoint of probability a real collision is many, many times less likely to occur than a near-collision. This is evident when one thinks how much less probable it is that another star should actually strike our sun, than that it should pass within say one hundred million miles of it, which in the present sense might be called a near-collision.

The principle of Roche's Limit

Then there is another difficulty with the theory of real collision, and that is the principle of Roche's Limit, as pointed out by Professor Chamberlin. In the establishment of this principle it was calculated that a satellite could not approach its primary closer than 2.44 times the radius of the primary without being pulled apart into small fragments by the strong differential attractions of the two bodies. The planets, to be sure, are believed to have come from the sun, but any theory of their origin which depends upon the annihilation of the sun is obviously impossible. The sun was gaseous and already predisposed to eruption, and if a larger star were to pass it at less than the Roche limit of the star, the sun would be dispersed and the star would be likely to carry off most of the wreckage. Thus it seems impossible that there could have been a real collision between the sun and a star of a larger size.

The star which caused the disturbance resulting in the birth of the planets, whether larger or smaller than the sun, must have passed close enough to the sun to pull out one seven-hundredth of its mass, for that is the total mass of all the planets in comparison with the mass of the sun.

There seems to be no doubt that at the present time the prevailing theory for the origin of the solar system is the dynamic encounter theory, that is, the planetesimal hypothesis of Chamberlin and Moulton, or some modification of it such as the tidal theory of Jeans.

It is only fair to say, however, that to the minds of many astronomers this explanation is doubtful. Whether it will be supplanted by some such theory as that presented by Professor Dinsmore Alter, in which he calls for no outside forces, remains to be seen.

According to Professor Alter's theory the planetesimals were formed from the solar atmosphere without the necessity of an encounter with another star. He suggests that the increase of angular momentum necessary to cause the planets to separate from the sun might have been secured through *radiation pressure*.

An example of *radiation pressure*, readily observable, is seen in a comet with a tail. While the comet approaches the sun, its tail is behind it; when it swings around the sun at its closest distance from the sun (perihelion), its tail is at right angles to the path; and while the comet is moving away from the sun, its tail is ahead of it. In other words, the tail of a comet always points away from the sun—and this is due to the radiation pressure of the sun.

After the planetesimals were formed, the evolution of the planets according to Professor Alter's theory proceeds in exactly the same manner as that outlined by Chamberlin and Moulton in the Planetesimal Hypothesis.

The recent behavior of Nova Herculis in increasing and decreasing and increasing again in magnitude evidently does not lend itself to dynamic encounter explanation.¹ Perhaps here is a hint that our solar system was not formed by a dynamic encounter at all.

When we comprehend the relation of the earth to the solar system, and wonder about its origin, and when we get a glimpse of the relation of the sun to our galactic universe, the Milky Way system, and realize that there are millions of galaxies far beyond the limits of ours, we naturally wonder whether they are in any way related to one another. The natural tendency of all knowledge to "unity and simplicity" makes us feel that they are.

That very law which moulds a tear,
And bids it trickle from its source,
That law preserves the earth a sphere,
And guides the planets in their course.

—SAMUEL ROGERS

¹ This phenomenon has been noted in the following issues of NATURAL HISTORY Magazine: February, 1935, page 170; April, 1935, page 353; and May, 1935, page 440.



Courtesy of Mt. Wilson Observatory

THE WHIRLPOOL NEBULA

This great spiral nebula in The Hunting Dogs (Canes Venatici) was photographed on May 15, 1926, by an exposure of three hours with the world's largest telescope, the 100-inch Hooker reflector. Original-

ly it was thought to be a solar system in the process of formation, according to the Nebular Theory. Now it is known to be a great assemblage of stars, an island-universe, similar to our Milky Way Galaxy



(Left) Mars, the ruddy wanderer of the sky. This drawing of Mars by Prof. E. M. Antoniadi is based upon studies made through the 33-inch telescope at Meudon, the largest refractor in use in Europe. The increase and decrease in size of the polar caps (the south polar cap being shown) are evidence that Mars has seasons similar to those on the earth

Courtesy of Observatory at Paris-Meudon

(Below) This photograph of the total eclipse of the sun, of May 28, 1900, shows the corona—both the polar and lateral streamers—in fine detail. The shape of the corona is correlated with the periodicity of sunspots

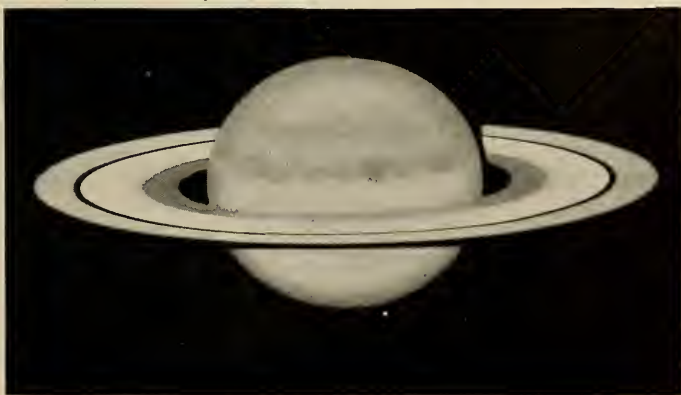
Courtesy of the Yerkes Observatory





Courtesy of Mt. Wilson Observatory

Courtesy of Observatory at Paris-Meudon



(Above) The northern portion of the moon showing Crater Copernicus in the upper right-hand corner; the lunar Apennines in upper left with Crater Eratosthenes at the right tip of the range; and other features

(Left) Saturn and his "fiery" rings, now known to be cold and composed of millions of small solid bodies or "moonlets." From a drawing by E. M. Antoniadi



Courtesy of Yerkes Observatory

MOOREHOUSE'S COMET

The above picture shows one of the most beautiful comets of the present century, as photographed November 16, 1908. The stars have made short streaks on the plate, because the telescope was made to

follow the comet during the long time exposure. The exquisite tail was so tenuous, as the tails of comets always are, that one could see the stars through it almost as distinctly as in other parts of the sky

Ancient Man and His Universe

Interesting and ingenious conceptions held by many ancient peoples concerning the universe and the part their own earth played in the scheme of things

By MARIAN LOCKWOOD

Assistant Curator of Astronomy and the Hayden Planetarium, American Museum

ASTRONOMY, or the study of the heavenly bodies, is undoubtedly one of the most ancient of the sciences.

When the first man stood on his first hilltop, and looked out across wide stretches of primeval country, watching the beautiful colors of the sunrise as the light of day came out of the east—at that moment man became a lover of the skies, and astronomy as a science was coming to birth. As he rose night after night from his bed of leaves or skins, he watched the heavens for the first sign of day, confident that the dawn would bring to him again the mysterious warmth and light of the great round disk which passed so slowly and majestically over his sky day after day.

As time went on, he began to wonder where the sun came from and where it went when it sank so quickly into the west. At night, as he watched the stars appear one by one, he wondered about those lights that shone so brightly in the sky. And the moon—where did it come from—was it the other side of the sun's face?

In time he even questioned the part that he himself and his familiar world had to play in this great parade of sun and moon and stars across the heavens. Gradually he began to tell himself interesting stories about the earth and the sun and the moon. He had, of course, in primitive times very little knowledge of what was actually happening.

Since the very beginning, however, he has wanted to *know*, and before the days of scientific method, when he could not understand

actual causes, he found it a simple enough expedient to invent explanations. Our interest in these explanatory stories, however, should be no less because today we know how ridiculous they are scientifically in view of our greater understanding. Such universe or world stories afford us fascinating glimpses into the mind of early man, while as myths or legends many of them are very beautiful indeed.

Some early theories

Up to the present time man in his great ignorance has been inclined, naturally enough, to conceive of himself as the center of the universe. His world, the earth, seemed to him to have been created for his particular benefit, and he simply took it for granted that the rest of the universe was so planned. To his unsophisticated reasoning it seemed that because he was the most important thing in the universe to *himself*, therefore he must of course *be* the most important thing—that for which the universe had been created, that about which the sun and moon and stars, even the heavens themselves, circled daily.

There are numberless legends and tales and folk-beliefs concerning the nature of the earth and the universe. The Egyptians, the Babylonians, the Scandinavians, the Chinese, the Mexicans, the American Indians—all peoples have evolved their own stories of the creation and nature of the earth and the universe.

One of the most ingenious theories probably originated with some race of people who lived on an island, or at least near the water. They saw the earth, or the portion of it that they knew, surrounded by water on all sides, and they came to believe that the earth floated in

these waters. They also came to believe that water was the universal source or essence of all things.

Since the sun and the moon appeared to them as flat disks in the sky, their conception of the earth likewise was that of a flat disk which floated on the waters much as a leaf would float on the water of a pond. Furthermore, since they saw the leaves that floated on the surface of the pond send forth roots which stretched down and into the earth below the water, so they believed that the earth itself put forth roots which stretched down into the depths of the water below the earth. Through these "universe-roots" it was supposed that the earth drew up into itself the sustaining power from the universal waters.

These primitive people also observed that in the morning the sun rose right up out of the sea, and at night sank back into those same waters and disappeared until the following morning. What could be more natural, then, than to believe that during the night the sun was busily swimming through the water under the earth to get back to the other side so that it could rise again at the proper time and place?

The Vedic priests of India taught a variation of this idea. They thought that the earth was supported on twelve massive pillars and that it was flat, lying on these pillars as it would on a table. Of course, in this way only its upper side was habitable. The sun passed over the face of the disk-like earth during the day, and during the night it passed back again to the other side between the great pillars underneath.

An interesting conception held by the Hindus is that the earth has four foundations, one on top of the other. At the very base is a great, coiled world-serpent, which floats on the universal waters; on top of the serpent stands the great tortoise upon whose immense back rest four elephants which directly support the earth itself. These figures were supposed to be its actual physical foundation.

The earth supported by a whirlwind

The question of what supported the earth in space was always of great interest to ancient astronomers and philosophers. Many of the early thinkers agreed that the eternal waters supported the earth. Empedocles, a Greek poet and physicist who is credited with the discovery of the four elements, believed that the earth

remained poised in space because it rested upon a whirlwind. And this whirlwind, as it rushed constantly around the earth, kept the heavenly bodies from falling down and destroying the earth. It was also the cause of the motion of the heavenly bodies—it blew them around the sky.

Anaxagoras, a contemporary of Empedocles, believed that the whirlwind had originally torn bits of matter from the earth and whirled them into the sky, thus forming the stars. Moreover, the stars, he believed, shone only by the friction caused by this great wind rushing past them. The sun, according to Anaxagoras, was an ignited stone or rock.

Anaximander, a Greek who lived in the sixth century B. C., was one of the first to realize that the pole star was the point about which the stars and the heavens themselves seemed to revolve. He believed also that the earth was at the center of the hemispherical dome of the sky—a flattened cylinder which had originally been surrounded by three envelopes—water, air, and fire. It still retained the envelopes of water and air, but the fiery envelope had been shattered and scattered to form the sun and stars. These were fastened to celestial circles in the sky and revolved with the heavens around the earth, which was believed to be the center of all things.

The Music of the Spheres

Pythagoras, another Greek philosopher, was the first thinker to understand the abstract nature of number. In experimenting with the science of numbers, Pythagoras and his followers evolved a fascinating theory of the universe. They believed that the intervals between musical notes corresponded to the distances between the planets, and that the five planets with the sun and moon formed a perfect musical scale, and these, with the celestial sphere—the perfect cosmic octave. Each heavenly body had a musical note of its own, and as the heavenly bodies moved in their orbits, all of these notes combined to produce that beautiful and unearthly music often referred to in literature as the Music of the Spheres.

One of the most fantastic theories was a modification of this original Pythagorean idea. Philolaus, another Greek, removed the earth from the center of the universe, where Pythagoras had placed it, and gave to it an orbit of its own. This left the most sacred place, the center

of the universe, empty. Philolaus solved this difficulty by placing fire in the center—fire, the purest of the elements. But by giving the earth a movement of its own, Philolaus had upset the cosmic octave by adding to it another moving body. So long as the earth was motionless it was silent, but when it began to move it added its own note to the others. And now Philolaus was in a predicament. He had nine moving bodies, including the celestial sphere. This would never do, for seven (the original number of musical notes) was a sacred number, and so was ten, but nine was not so considered. So Philolaus, ingeniously, invented another planet, Counter-Earth or Antichthon. This made ten, and maintained the proprieties of the sacred numbers. No one had ever seen Counter-Earth, of course, but even this dilemma was not too much for Philolaus. He gave to Antichthon an orbit between the central fire and the earth, but since the earth always kept its habitable face from the central fire, no one ever could see this Counter-Earth.

Democritus, still another of the Greeks, believed in the early idea of the earth as a disk, but a disk resting in air rather than in water. He believed that the sun and moon were smaller than the earth, and that they had originally been like it but in colliding with our planet they had become partly absorbed and had lost their cores. Democritus also maintained that comets were formed when two planets approached each other closely, and that the Milky Way had once been the path of the sun before that body left it for a new course through the sky.

Astronomy and religion in Ancient Egypt

The ancient Egyptians worked out a comprehensive picture of the universe, albeit one which would not fit in with our scientific knowledge today. One of the greatest and most important of the Egyptian gods was Ra, the Sun-god. Many of the Egyptian deities were associated in some way with astronomical bodies—the Egyptians even considered the earth and the sky as gods. Because of this, it was an important part of their religious ritual that the movements of the heavenly bodies be noted most carefully—that the sun be observed at the exact moment of his appearance in the morning and his disappearance at evening, and likewise the movements of the moon and stars.

And so, at a very early period, the priests of Egypt became her astronomers. Wherever there was a temple, to whatever god, there would be at least one priest, many of whose duties were astronomical in character. It is a rather compelling picture—these numberless temples scattered over Egypt and along the Nile, silent in the depths of the night, with the figures of their white-robed priests standing motionless upon the observation platforms or on the great pillars, their long garments blowing in the night wind as they observed the heavenly bodies which were portents for good or evil in their cosmology.

The Egyptian universe

The Egyptians believed that the universe was four-sided, with Egypt itself in the center. Egypt lay in the middle of a flat plain surrounded by enormously high mountains, with four higher mountain peaks at the four corners to indicate the cardinal points, and also to hold up the dome of the heavens. The sky was, to their minds, an iron ceiling over the universe, containing holes through which at night obliging gods let down the lamps of the sky—the stars—on cables, for the sole purpose of furnishing beauty and illumination for Egypt. In the morning these same gods pulled up the lamps, economically enough, and then the great God Ra, the Sun, started on his daily journey around the ramparts of the world, riding in his Nile chariot on the celestial river which flowed along the base of the mountain range and in which the Nile was believed to have its source.

The Egyptians believed sometimes that this boat in which the Sun-god sailed was a magic bark which navigated without hands or brain to steer it. At other times it was like one of the regular Nile boats, fully manned and equipped with a pilot in the prow and one in the stern, with a quarter-master, and half a dozen sailors.

At most times the boat of the Sun sailed along peacefully, but occasionally the great serpent, Apopi, who lived in the depths of the celestial river, would arise from the waters and attack the Sun-god. At such times the crew of his boat rushed to arms and sought in every way possible to overcome the dread monster—not only by arms but by the din of terrific noise. They beat and struck upon every conceivable instrument until at last Apopi, wearied and

tired out, overcome by the magic of the gods, sank back again into the depths of the river, and the sun once more emerged. This, of course, was the Egyptian explanation of a solar eclipse.

The Babylonians had a similar idea of the universe as a box or chamber whose floor was the earth. In the center of this floor there was a high mountain peak, covered with snow, which they believed to be the source of the Euphrates River.

Other Egyptian beliefs

Another belief of the Egyptians was that the sun hatched daily from the Sun Egg, laid by a gigantic goose whose mate, the gander, daily announced this event by his loud cries at dawn. From this circumstance the Celestial Gander, sometimes known as Sibū or the Earth-god, was called the Great Cackler. Out of the Sun Egg came the bird which was the sun. According to some it was a heron, according to others a lapwing, or perhaps a sparrow hawk.

An ancient Egyptian tradition said that the earth and the sky were originally wedded gods, the Earth-god Sibū and the Sky-goddess, Nuit. From this marriage the Egyptians believed that everything came that ever has been or is or shall be. And then suddenly there came a new god, the god of air or sunshine, Shu, who came between Sibū and Nuit, the earth and the sky, and forced them apart. The goddess Nuit was forcibly pushed up into the region

above the Earth-god and became the sky, and the God Shu remained forever between the Earth-god and his love, the sky.

Another belief of the greatest antiquity, and one which also came out of Egypt, is known as Orphism. It was believed that there existed first great silent darkness everywhere, and that in time out of this primordial night there was born a World Egg which eventually divided into the skies and the earth. There are many variations of this belief, found among all races in their traditions and myths. One which is most commonly illustrated is that of the great World Serpent twined about the Earth Egg, warming and hatching it.

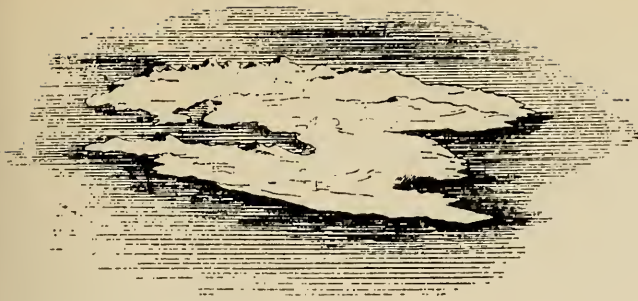
There are numberless interesting legends and early philosophies about the creation of the earth and the universe and the relation of one heavenly body to another. It seems to us that we have come a long distance from the time when man believed that the sun was swallowed by a dragon at times of eclipse, and that the world was originally an egg hatched by a serpent. But the most important thing is that we have come to understand that, as we acquire knowledge, our concepts change and we must adjust ourselves to new theories and new methods. Knowledge and understanding are what we seek. The real student of science is he who remembers that while we seem to have far outrun primitive and ancient man in our understanding of the universe, we must still maintain a real humility in the presence of the countless questions yet unsolved.



THE CELESTIAL BARQUE OF THE SUN-GOD

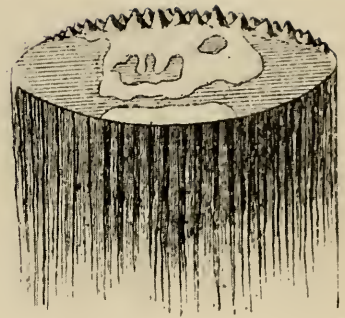
The Sun-god, with his attendant deities, is shown enthroned in his celestial barque. The

Egyptians conceived of the Sun-god with the trappings and prerogatives of an earthly king

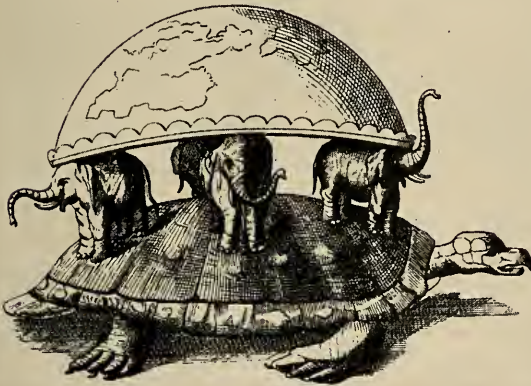


*(Above) The flat disk of the earth
lying in the eternal waters*

*(Right) The earth with roots
stretching down into the waters
below*



*(Left) One Hindu conception of
the foundations of the universe.
Here the elephants and the tortoise
alone support a hemispherical earth*



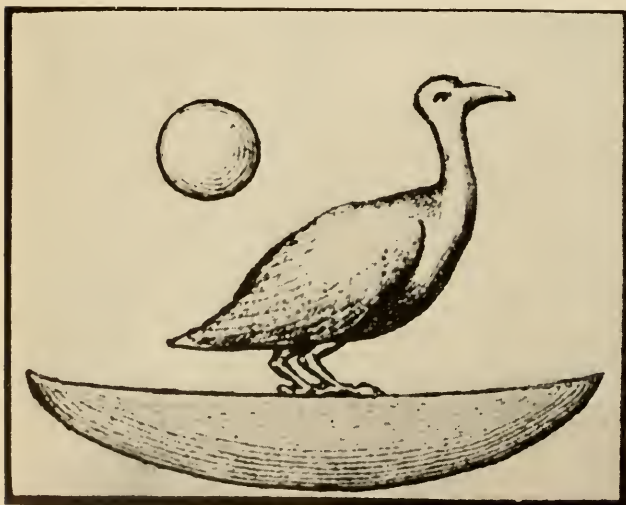
*(Below) The Egyptian Earth-
god Sibu separated from his
mate, the Sky goddess Nuit, by
Shu, the god of sunshine or air*



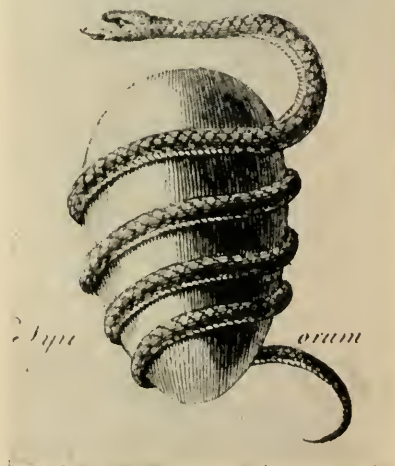


(Above) As early Egypt conceived of the universe. The Sun-god can be seen traveling along the celestial river in his river-chariot. Through holes in the sky "ceiling" hang the stars which the gods light and extinguish like lamps

(Below) The celestial goose which, so the Egyptians believed, laid daily the egg which hatched into the sun



OPHIS et OVUM
MUNDANUM



(Above) The World Egg encircled by the great Earth Serpent whose warmth causes it to hatch

Glimpses into Relativity

A non-mathematical consideration of certain more or less obvious relations of the Einstein Theory of Relativity, with suggestions as to their importance in understanding the universe

By CLYDE FISHER

*Curator of Astronomy and The Hayden Planetarium,
American Museum*

*And from my pillow, looking forth by light
Of moon or favoring stars, I could behold
The antechapel where the statue stood
Of Newton with his prism and silent face,
The marble index of a mind forever
Voyaging through strange seas of thought,
alone.*

Wordsworth, THE PRELUDE,
Book third (Residence at Cambridge).

EARLY in the present century a new theory of space, time, mass, velocity, and gravitation was presented to the scientific world by a professor of physics in the University of Berlin, whose name has since become a household word. Einstein's Theory of Relativity, although admittedly difficult to understand, has intrigued the layman as well as the mathematical physicist and astronomer.

Soon after Einstein's Theory of Relativity had swept the scientific world, an address on the subject was presented before the American Association for the Advancement of Science, the largest and most important society of scientists in America. This lecture was given by Prof. Joseph Ames, head of the department of physics in Johns Hopkins University, and later president of that institution of learning. In the course of his discussion Professor Ames said: "It has been stated that only a dozen men in the whole world understand the theory of relativity, and I am not one of the twelve." Needless to say I, myself, am not able to increase that select number to a "baker's dozen."

At a dinner given in honor of Sir James Jeans on his recent visit to America, Sir James said that the only conception of the universe that can now be framed is a mathematical conception, and that after you have framed it, only a mathematician can understand it.

Prof. Edwin E. Slosson, in his *Easy Lessons in Einstein*, written soon after the theory of relativity had been announced, has given some encouragement for such an attitude. In a prefatorial dialogue between the author and a fellow commuter, who has just read in his morning paper something about relativity, the following conversation occurs:

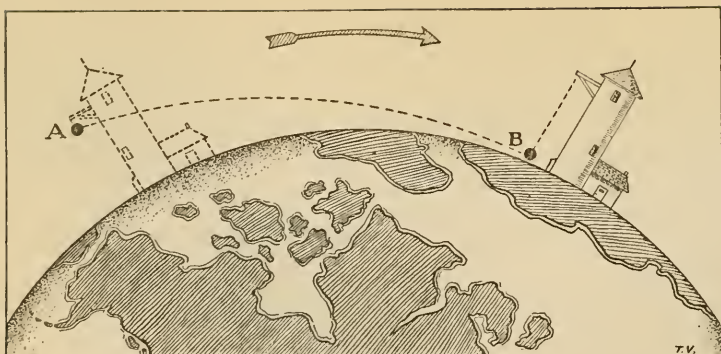
THE READER: "Can you tell me in plain language what it is all about?"

THE AUTHOR: "Yes. Just that. I can tell you what it is *about*, though I can't tell you what it *is*."

It is of great interest to observe that the theory of relativity, though radically new, has been accepted by practically all physicists and astronomers of the world. The acceptance of relativity, perhaps not in its present form, but as a principle, is well-nigh universal. There are so few well-known physicists and astronomers who oppose it that one is reminded of the old saying that the exception proves the rule.

Newton considered space and time and mass and force as *absolute*. He looked upon gravitation as a force, but according to the theory of relativity this notion must be abandoned. As Bertrand Russell remarked, "Just as the sea does not cause the water to run toward it, so the sun does not cause the planets to move round it."

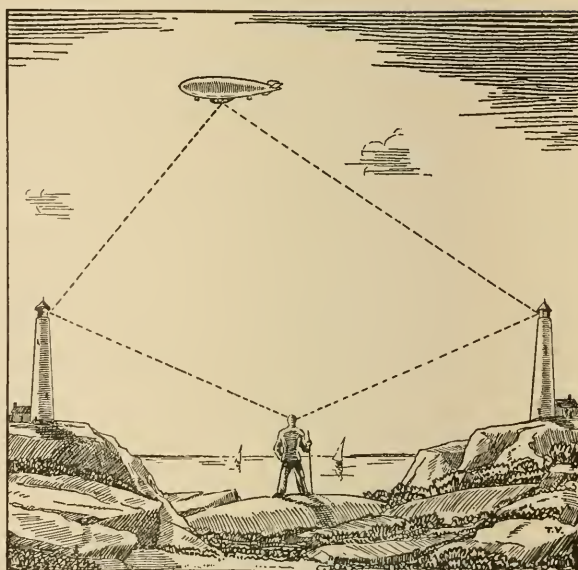
We have given up the notion of force, since it does not represent anything that is genuinely



DIRECTION IS RELATIVE

From the point of view of an observer in the tower, an object dropped from the top of it appears to fall in a straight line. We know, however, that the earth itself is constantly turning, and that if observed from a fixed position in space, the object would be seen to travel not in a straight line but in a curve. It might be said to drop straight toward the point on the earth directly under it, but that point is moving. Therefore, the actual path of the object is a curve, illustrated diagrammatically in this figure by the dotted line between A and B.

This illustration takes into account only one motion of the earth, namely its rotation on its axis



TIME IS RELATIVE

If lights are flashed from both towers at the same instant, the observer midway between sees the flashes simultaneously. But an observer in the airship overhead, being closer to the left-hand tower, would receive the flash from that tower sooner than from the other.

The speed of light is so rapid that the lag could not be detected by the eye; but that there

is such a difference is obvious. We are all familiar with the lag between a flash of lightning and the bolt of thunder. The thunder seems to occur several seconds after the lightning, but this is only because the apparent time of their occurrence is relative to the speed of light and sound respectively. Actually they occur in the same instant

to be found in the physical world. Although "force" is no longer to be regarded as one of the fundamental concepts of dynamics, but only as a convenient way of speaking, as Bertrand Russell points out, it can still be employed, like "sunrise" and "sunset," provided we realize what we mean. Often it would require very roundabout expressions to avoid the term "force."

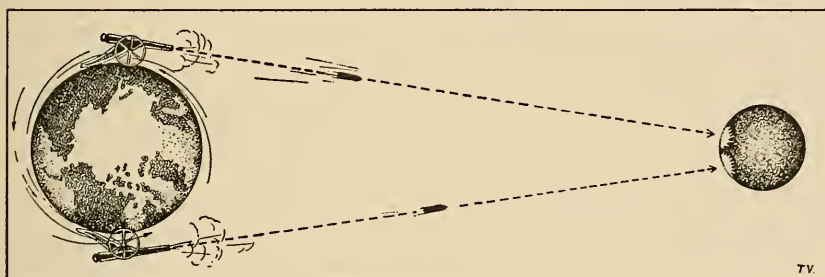
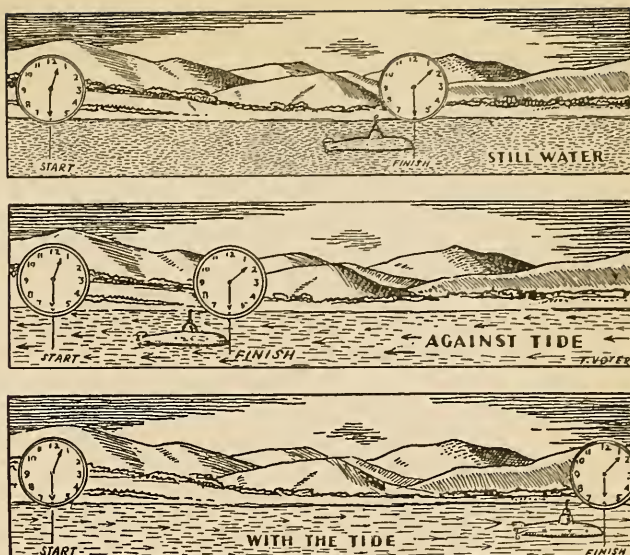
The so-called "law of the conservation of matter" and the so-called "law of conservation of energy" of a former generation cannot now be held as true in a strict sense. Matter and energy are interconvertible. Mass increases with speed. Time shrinks or stretches depending upon the velocity.

The name "relativity" therefore is applied to Einstein's theory simply because the primary

SPEED IS RELATIVE

Suppose that in each of these three drawings the submarine is being driven forward at the maximum speed of its engines. Its velocity with relation to the water is consequently the same throughout. But because the water itself may be moving, the speed of the submarine relative to the land is variable.

All three drawings show the distance traveled by the submarine in one hour. An observer not knowing about the tide would suppose that the motors were being run slower and faster. The speed of the craft relative to the land is not always the same



SPEED OF LIGHT, A STANDARD IN RELATIVITY

Because the speed of light is not altered by any movement of the medium through which it passes or by motion at the source, it serves as a standard of measurement.

In this diagram two shells are fired at the same instant from a pair of cannons on opposite sides of the earth. Because the earth is spinning, the lower shell travels faster than the upper, and reaches the moon approximately 166 hours sooner. The speed of rotation of the earth is in

one case added to the speed of the shell, and in the other subtracted.

But this does not apply to light. Beams of light sent out from each of the cannons at the same instant arrive at the moon simultaneously, regardless of the movement of the earth. It is because the speed of light is not influenced by motion at its source or by motion of the medium through which it passes, that it figures prominently in the theory of relativity

factors in astronomy such as direction, speed, size, and time are relative. Any one of these factors cannot be reckoned by itself, but only in relation to the others. The reader is referred to the simple examples of the relativity of direction, time, and speed illustrated herein.

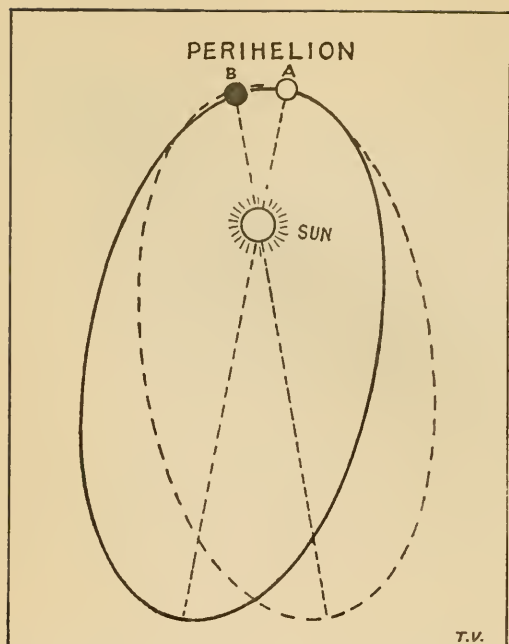
For Einstein the old luminiferous ether does not function, and in the sketch that he draws of natural phenomena there is no mention of this hypothetical, imponderable, all-pervasive, and intermediate substance.

In his special theory of relativity (1905)

Einstein did not include gravitation (accelerated motion) in his formulæ, but after ten years of study (1915), he incorporated this phenomenon in his general theory.

Prof. Henry Norris Russell of Princeton has summed up the matter as follows:

The central fact which has been proved—and which is of great interest and importance—is that the natural phenomena involving gravitation and inertia (such as the motions of the planets) and the phenomena involving electricity and magnetism (including the motion of light) are not independent of one



MOVEMENT OF PERIHELION
POINT OF MERCURY

On successive revolutions around the sun the axis of Mercury's orbit turns. Represented diagrammatically, the end of the major axis moves in one year from A to B, in reality a distance of 43 seconds

another, but are intimately related, so that both sets of phenomena should be regarded as parts of one vast system, embracing all nature.

Eddington in *Space, Time and Gravitation* describes an imaginary experiment in which he supposes an aviator traveling at a speed of 161,000 miles a second relative to the earth. After making allowance for the time of transmission of light, there would still be a retardation in time. His cigar lasts twice as long as one of ours. But here reciprocity comes in because, in the aviator's opinion, it is we who are traveling at 161,000 miles a second past him; and when he has made all allowances, he finds that it is we who are sluggish. Our cigar lasts twice as long as his. Bertrand Russell, who accepts the validity of this supposed experiment, mischievously remarks: "What a situation for envy! Each man thinks that the other's cigar lasts twice as long as his own. It may, however, be some consolation to reflect that the other man's visits to the dentist would also last twice as long."

After correcting Newton, as has been remarked, it remained to correct Euclid, and it was in terms of non-Euclidean geometry that Einstein stated his new theory. According to the theory of relativity, it is believed that no complete description of an occurrence in nature can be made with the three coördinates of Euclidean geometry—length, breadth, and thickness—but that a four-dimensional space-time system must be conceived. Minkowski stated the essence of this conception in the following prophetic words: "Henceforth space by itself and time by itself shall sink to mere shadows, and only a union of the two shall preserve reality."

The question of infinity

Another question connected with the theory of relativity is whether the entire universe is infinite or finite. Twenty-five years ago perhaps most astronomers were inclined toward the idea that the universe is infinite. It was said that one could not imagine an end or an edge. And as yet there is no experimental evidence to prove that it is not infinite. Nevertheless, this theory has given the theoretical physicist some difficulty in his dealing with gravitation, and since the advent of relativity, there has been a swing toward the notion that the universe is finite.

The surface of a sphere has no boundary, yet it is not infinite. The universe may be shaped like a huge globe or sphere, and if so, there would be no end or edge. It is conceived as so huge that it would require time of the order of a thousand million years for light to travel around this possibly finite universe. And here is introduced the idea of curved space. There may be no straight lines about which we were taught in our Euclidean geometry. These supposedly straight lines may be arcs of great circles on this huge, though possibly finite, universe. As we know, things are not always as they seem. It may help in some of these apparently contradictory conceptions to recall the principles of perspective. When we look down a railroad track, the rails seem to converge, yet we know they do not.

As shown by Einstein, a finite universe is a necessary condition under the conception of a static universe. Under the modern conception of a non-static or expanding universe, however, he has shown that the universe may, or it may not be finite.

Einstein suggested *three* experimental tests which the astronomer could apply to the theory of relativity:

FIRST—The movement of the perihelion point of the planet Mercury (See figure on p. 238). After all the disturbances caused by the attraction of other planets had been taken into account, there still remained an unexplained perihelion movement of the orbit of Mercury. In other words, astronomers had found that the theory of Newton does not suffice to calculate the observed motion of Mercury with an exactness corresponding to that of the delicacy of observation attainable even three quarters of a century ago. In 1859 Leverrier found this unexplained perihelion movement to be 43 seconds in a century. This observation was corroborated in 1895 by Newcomb. The phenomenon had puzzled astronomers until Einstein explained it in 1915 by the general theory of relativity. He found that, according to his formulæ, this movement must really amount to just that much. At the time when he published his theory, this was its only experimental verification.

Einstein's explanation accepted

Immediately de Sitter, the great Dutch astronomer, accepted Einstein's explanation and confirmed the correctness of this astronomical test. Einstein stated that Professor de Sitter also contributed to the theory of relativity by showing that observations of the spectroscopic double stars prove that the speed of light is not dependent upon the dynamic condition of the source of light. Einstein stated further that Doctor de Sitter made great con-

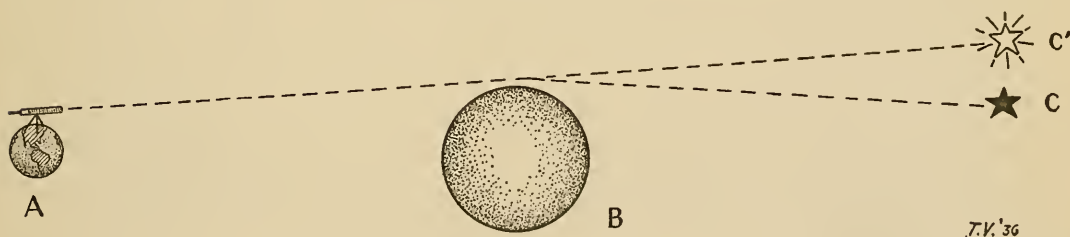
tributions in the relativity theory of the structure of space in the great cosmological problem.

SECOND—The bending of the rays of light from a star in passing the sun due to the gravitational pull of the sun (See pp. 239 and 241). This can be tested only at a total solar eclipse, when the moon comes between us and the sun and shuts off the overwhelming light of the sun, thus making it possible to photograph the stars in that portion of the sky in which the sun is located.

This effect was first observed under the direction of Prof. Arthur S. Eddington and others at the total eclipse of 1919, and has been observed at succeeding total eclipses of the sun.

A few months ago, H. Spencer Jones, Astronomer Royal, made the following interesting statement: "The British eclipse expeditions of 1919, which provided the first evidence in support of Einstein's conclusions as to the amount of deviation of rays of light in passing near the sun, would probably not have been sent out had de Sitter's papers not appeared." The papers here referred to were three in number, communicated by Doctor de Sitter in 1916-17 to the Royal Astronomical Society, shortly after the appearance of Einstein's paper on the generalized theory of relativity. Surely Doctor de Sitter had much to do with securing the general acceptance of the theory of relativity.

THIRD—The shifting of the spectrum lines of the sun toward the red owing to its own gravitational pull. This is entirely apart from the shifting due to the motion of a heavenly body either toward or from us. In accordance with this latter principle, it has long been known



LIGHT RAYS ARE BENT BY GRAVITY

According to one of Einstein's principles, rays of light are bent by the gravitational pull of any large heavenly body close to which they pass. Light rays coming from the star C are bent

toward the sun (B) when passing near it, so that an observer on the earth (A) sees the star in the direction of C' instead of in its true direction

that, when a star is approaching us, there is a shift of the spectrum lines toward the violet, and when the star is receding, there is a shift toward the red. By applying this principle it has been possible to go further and calculate the velocity of approach or recession of a heavenly body. Also, by observing and comparing the shift on one side with that on the other, it has been possible to prove that certain heavenly bodies and systems rotate. This shifting due to the approach or recession of a heavenly body is known as the Doppler effect, and it may be better understood by comparison with a familiar, analogous phenomenon in sound.

The Doppler effect

If one stands by a railroad track when a locomotive is passing with the bell ringing or the whistle blowing, he will note an abrupt change in the pitch of the bell or the whistle as the locomotive passes him. When the locomotive is approaching the observer, the pitch will be higher than when it is just passing him, and after the locomotive has passed by the pitch will be lower than when it was passing him. The slur in pitch as the locomotive passes is very noticeable. Since pitch varies with the number of vibrations that strike the ear per unit time, it is evident that this marked change is due to the piling up of vibrations while the locomotive approaches, thus causing more vibrations to strike the ear per unit time—producing a higher pitch—and the stringing out of the vibrations when the locomotive is receding, thus producing a lower pitch after the locomotive has passed.

In the case of light, when a heavenly body approaches, there is an increased frequency of the waves of light, or, in other words, the wave-length is shortened, which causes a shift of the spectrum lines toward the violet; when the body is receding, there is a decreased frequency of the light, or an increase in the wave-length.

Aside from the Doppler effect there is, according to Professor Einstein, a slight shift of the spectrum lines of the sun toward the red. And this has been proved experimentally by the late Dr. Charles E. St. John at the Mt. Wilson Observatory.

And there has been a further confirmation of this effect in the case of the dense companion of Sirius. This star is believed to be so dense

that one cubic inch of it brought to the earth would weigh nearly a ton, i.e. two thousand times the weight of platinum, our planet's heaviest known substance. On account of the greater gravitational potential of this exceedingly dense star, it was calculated that the shift here would be twenty-seven times as great as on the sun, and this was confirmed by actual test by Dr. Walter S. Adams, director of the Mt. Wilson Observatory.

The latest confirmation of this test was reported last April before the annual meeting of the National Academy of Sciences in Washington. Dr. Robert J. Trumpler described his six years' work at the Lick Observatory, consisting of observations of Class O stars, the hottest, most luminous, and at the same time the most massive stars in the universe. They reach a mass 180 times that of our sun, and their surface temperatures are 40,000 degrees Centigrade as compared with 6000 degrees for the surface temperature of our sun.

Radial velocity

Fortunately for the astronomers, many stars of Class O occur in clusters in the Milky Way, Doctor Trumpler stated, and in this investigation he studied nine such Class O stars in six different star clusters. The stars of such a galactic cluster form one physical system and thus all the star members of the cluster must have nearly the same motion. Yet, while all the stars in a cluster have the same true motion, those which have higher luminosity, and higher temperature and mass, show a radial velocity greater than the smaller, fainter, and colder stars in the cluster system.

The excess in radial velocity of the more massive and luminous stars, namely, the O type stars, cannot be due to the Doppler effect, Doctor Trumpler reasoned, since the actual motion of the O stars cannot be greater than the motion of the fainter stars in the same cluster. The excess, therefore, in the observed velocity of the O stars, an excess which reveals itself by a shift toward the red in the spectra, must be due entirely to the red shift predicted by relativity.

In the opinion of one of our leading American astronomers, Dr. W. W. Campbell, formerly director of the Lick Observatory and more lately president of the University of California, all three astronomical tests of the Ein-

stein Theory of Relativity have been satisfactorily met.

In a recent address Dr. Robert A. Millikan, of Cosmic Ray fame, who was awarded the Nobel Prize in Physics in 1923, stated:

I wish to dispel a very common misconception, since the average man, who only knows science from afar, labors, I suspect, under the misunderstanding that we honor Einstein only because he was the author of the theory of relativity.

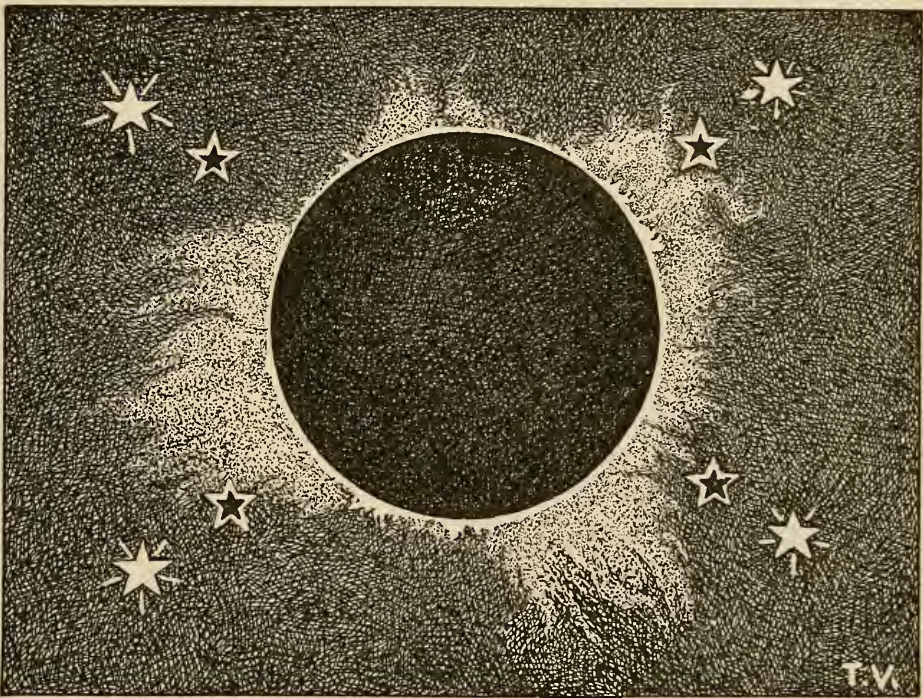
Now, every physicist knows that the Nobel prize committee, which awarded him that honor in 1921, did not have to consider the theory of relativity at all in making that award. They might have given it on any one of at least four grounds, and the scientific world would have been unanimous in applauding the award on any one of them. I myself have the best of reasons for knowing which one of these four they actually chose. The late Professor Gullstrand, the chairman of the Nobel committee in making the 1923 award, stated that it was the experimental verification of the Einstein photo-electric equation that removed all doubt as to its validity in the minds of the committee, so that they chose the first theoretical statement of that equation in 1905 by Professor Einstein as the basis of the

award to him in 1921, and the experimental verification thereof as the half basis of the 1923 award. Now, this equation has nothing whatever to do with relativity, but I think that all students of modern physics will agree that it is of quite as far-reaching significance as is relativity, or, indeed, as is anything that has appeared in modern physics, for it necessitated, as soon as it was firmly established, our return to at least a semi-corpuscular theory of the nature of radiant energy.

The extraordinary penetration and boldness which Einstein showed in 1905 in accepting a new group of experimental facts and following them to what seemed to him to be their inevitable consequences, whether they were reasonable or not as gauged by the conceptions prevalent at the time, has never been more strikingly demonstrated.

Any small contributions that I myself have made to the progress of physics have been largely in the nature of experimental verification of predictions contained in three theoretical equations first set up by Einstein, and but one of these has had anything to do with relativity.

The first of these was the Brownian movement equation (1905) whose verification by a number of observers removed the last doubts as to the atomic theory of matter; the second was the aforementioned photo-electric equation (1905) which changed rad-



ECLIPSE VERIFIES EINSTEIN

The outer symbols represent the false positions in which four stars appear when total eclipse makes it possible to photograph them. The real positions of these

stars, determined by photographing that section of the sky when the sun was not there, are indicated by the inner symbols having dark centers

ically our conception as to the nature of radiation; the third was the equation expressing the interconvertibility of mass and energy. This grew out of special relativity (also 1905) and it has recently predicted for me verifiable relations in the radioactive field, and it also constitutes the most important basis for the cosmic ray conclusions that I am now wishing to draw. All these three are of equal significance, I think, with the predictions from general theory of relativity

You can throw general relativity into the wastebasket if you will, and *Professor Einstein's position as the leading mind in the development of our modern physics would still remain unchallenged.*

On the same occasion an address was delivered by the late Prof. A. A. Michelson, inventor of the interferometer, the only instrument with which we can measure the diameter of the stars, the instrument that made possible the Michelson-Morley experiment on ether-drift. Professor Michelson, the first American to receive the Nobel Prize in Physics (1907), expressed himself as follows:

I consider it particularly fortunate for myself to be able to express to Doctor Einstein my appreciation of the honor and distinction he has conferred upon me for the result which he so generously attributes to the experiments made half a century ago in connection with Professor Morley, and which he is so generous as to acknowledge as being a contribution on the experimental side which led to his famous theory of relativity. I may recall the fact that in making this experiment there was no conception of the tremendous consequences brought about *by the great revolution which Doctor Einstein's theory of relativity has caused—a revolution in scientific thought unprecedented in the history of science.*

To refer again to Professor Millikan's mention of our return to at least a semi-corpuscular theory of the nature of radiant energy, the following conclusions on this subject, made by Prof. Arthur H. Compton, third American winner of the Nobel Prize in Physics, are illuminating:

Perhaps the best picture that one can give of the relation between waves and particles is the analogy of sheets of rain which one sometimes sees in a thunderstorm. We may liken the waves to the sheets of rain that one sees sweeping down the street or across the fields. The radiation particles would correspond to the rain drops of which the sheet is composed.

How then does the matter stand? The tangible objects with which we are familiar we find constituted of molecules. These, in turn, are composed of atoms and these of positively charged and massive protons and the negatively charged and mobile

electrons. The light which makes plants grow and which gives us warmth has the double characteristics of waves and particles, and is found to consist ultimately of photons.

A few years ago Dr. Frederick C. Leonard, professor of astronomy in the University of California, was asked to prepare a list of the ten greatest astronomers of all time, arranged in the order of their greatness, with reasons for his choice. The article was published in *Popular Astronomy* for November, 1930. Newton's name heads the list, and there is only one living person included in the ten and that is Einstein. Here is Professor Leonard's list in the order in which he gave it: Newton, Copernicus, Galileo, Kepler, Einstein, Hipparchus, Herschel, Kirchhof, Ptolemy, and Tycho.

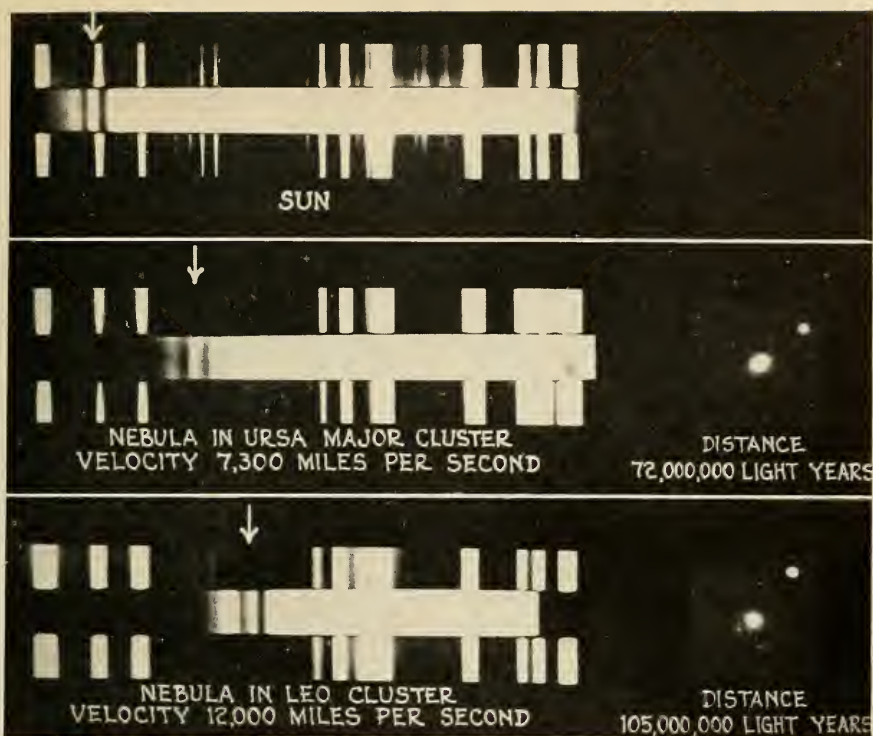
Professor Eddington stated the matter thus:

When Einstein overthrew Newton's theory, he took Newton's plant, which had outgrown its pot, and transplanted it into a more open field. All this new growth of science had its roots in the past. If we see farther than our predecessors, it is because we stand on their shoulders.

It is manifestly unfair to say, as we sometimes hear it, that Einstein has destroyed Newton, for every great creative scientist builds on the work of those who have gone before. Kepler built on the work of Tycho Brahe. Without Galileo and Kepler there would have been no Newton. And Einstein has extended the work of Newton and the other titans who preceded him. When Lord Haldane introduced Einstein's lectures in Kings College, he said to the audience, "You see here before you the Newton of the twentieth century, a man who has called forth a greater revolution in thought than even Copernicus, Galileo, or Newton himself."

In his work, Einstein has always given full credit to his predecessors, and he has been equally generous with his contemporaries, among whom he especially mentions Lorentz, Minkowski, Michelson, and de Sitter.

There is still much misunderstanding in lay circles concerning the theory. The word *relativity* is still confused with the word *relativism*. All who have dipped into relativity at all, however, know that it cannot be understood without the mathematics for it is essentially a mathematical theory. It may, however, be possible without mathematics to arrive at some notion of what it is all about.



Courtesy of Mt. Wilson Observatory

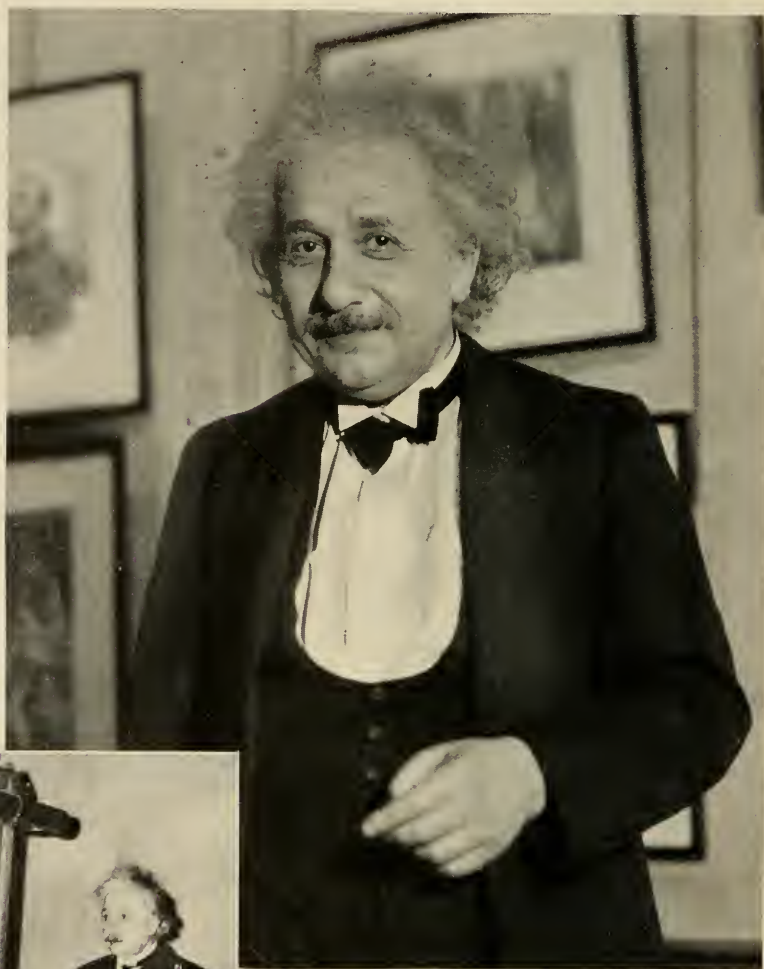
Shift of spectrum lines toward the red. The shift of the spectrum lines of these nebula toward the red is interpreted as due to their motion away from us, and is known as the Doppler effect. As described on pp. 240-241, there is, according to the theory of relativity, an additional shift toward the red in light from the sun and other massive bodies, exactly like this in character, due to the gravitational potential of the body

The Einstein Tower. This Solar Tower, like those at Mt. Wilson and at Arcetri, Italy, was constructed for the purpose of studying the sun. At Potsdam an important object was the study of the Einstein shift in the spectrum of the sun

Photo by Courtesy Astrophysical Observatory at Potsdam



Informal Glimpses of Exponents of Relativity



Photograph by Clyde Fisher

Professor Albert Einstein, author of the Theory of Relativity, and member of the staff of the Institute for Advanced Study at Princeton



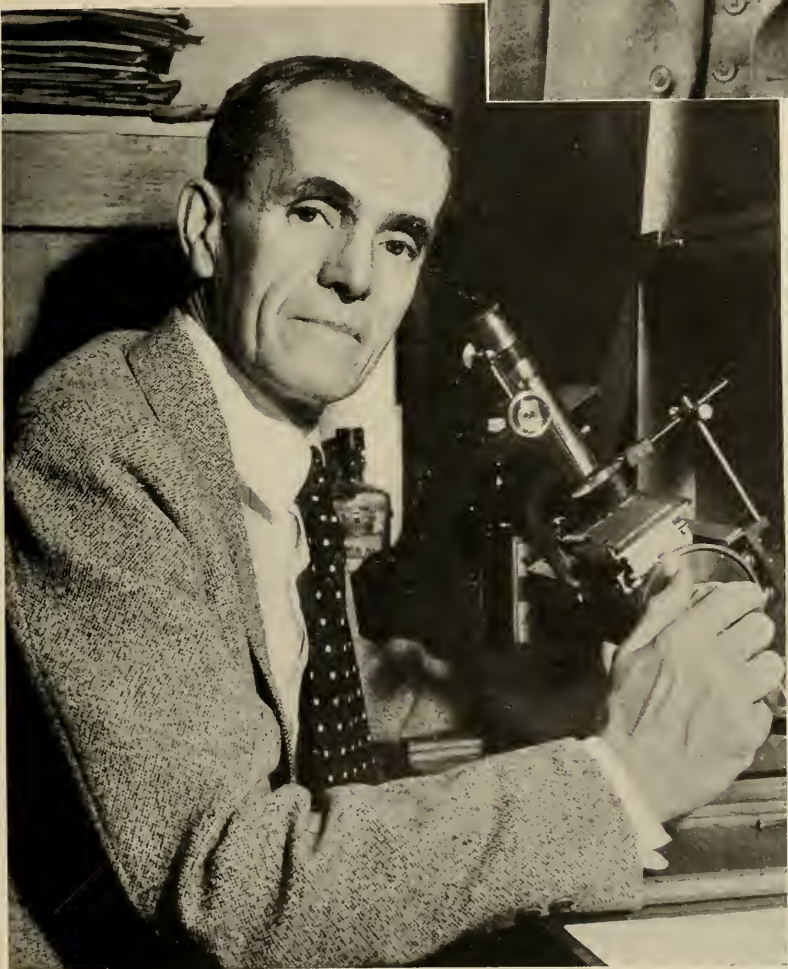
Professor Einstein proving the Principle of Equivalence in a lecture before the American Association for the Advancement of Science, December 28, 1934, in Pittsburgh. Matter and energy are interconvertible

Photograph by Keystone View Company

(Right) Sir Arthur S. Eddington, Plumian Professor of Astronomy and Director of the Observatory at Cambridge University, who directed the first investigation of the second astronomical test of relativity at the 1919 total eclipse of the sun. (See p. 239)



(Below) Dr. Walter S. Adams, Director of the Mt. Wilson Observatory, who by observation confirmed the Einstein shift toward the red in the spectrum of the dense companion of Sirius. (See p. 240)



Photograph by Clyde Fisher

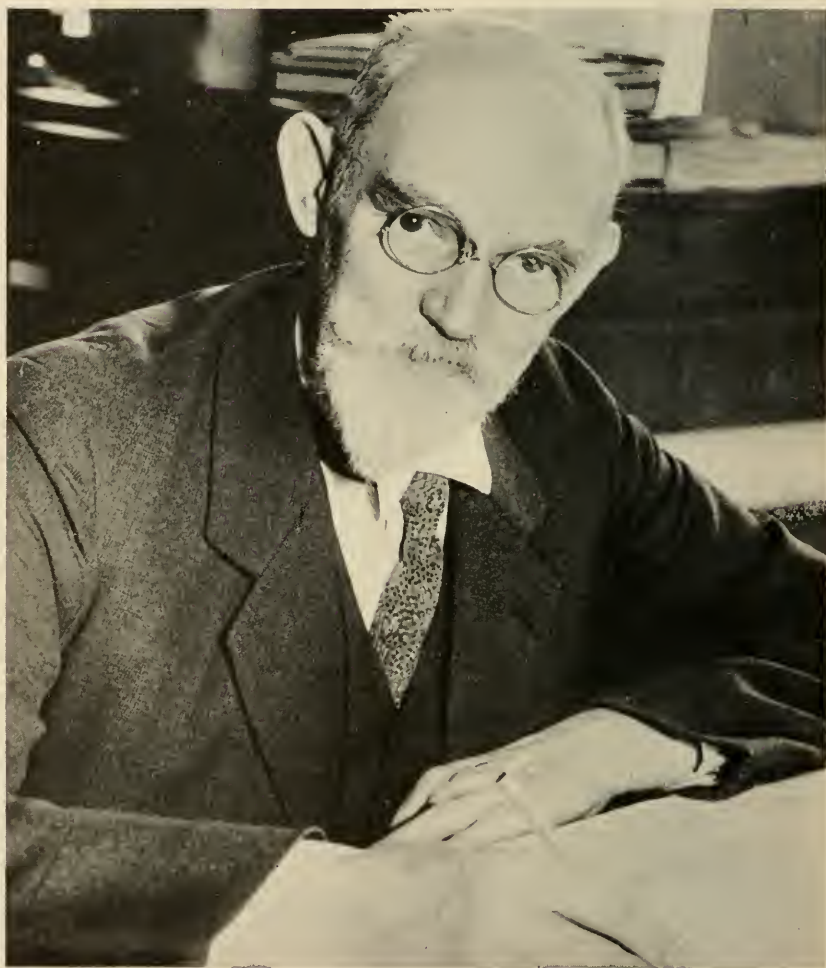
Courtesy of
Wide World Photos



(Left) Dr. Henry Norris Russell, Research Professor of Astronomy and Director of the Observatory at Princeton University, who has promoted the general acceptance of the Theory of Relativity by his lucid discussions

Photograph by Clyde Fisher

(Below) The late Professor Willem de Sitter, former director of the Leyden Observatory. This brilliant Dutch astronomer has probably done more than any one, except Professor Einstein himself, to establish the Theory of Relativity



*Courtesy of
Wide World Photos*

The Calendar Through the Ages

Complications in the measurement of time that have beset man from ancient times to the present day

By FREDERICK SLOCUM

Wesleyan University,
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IN a cemetery in Middletown, Connecticut, is this epitaph:

"In memory of Mr. Nath'l. Goodwin who was born in Boston, Feb. ye 24th 1672/3, departed this life March ye 7th, N.S. 1753, upon his birthday, being just 80 years old."

That reads like a paradox—born February 24, died March 7, upon his birthday—but it simply means that there had been a change in the calendar during his lifetime. The "N.S." in the epitaph stands for New Style of reckoning dates.

This is only one of many changes that have been made in the calendar, and still further revision is now being actively discussed.

Genesis i. 14, reads:

"And God said, Let there be lights in the firmament of the heaven to divide the day from the night; and let them be for signs, and for seasons, and for days and for years."

The writer should, of course, have put "for days, for months, and for years." These three are the units of time upon which most calendars have been based. These are natural units, being measures of the rotation of the earth on its axis, the revolution of the moon around the earth, and the revolution of the earth around the sun. In addition the calendar contains artificial units, such as weeks, hours, minutes, and seconds.

The use of the year as a measure of time is referred to in the very earliest writings, but its universal adoption in a calendar began in the first century B. C. Prior to this time many

different types of calendar were used by the various nations. They were developed chiefly in connection with religious festivals and were, in general, under the control of the priests. As many of these rites were associated with the moon, some of the calendars were based upon the month, but since the dominating factor in all primitive life was the changing seasons, the year, too, played a prominent part as a calendar unit.

Babylon, Assyria, Egypt, and China had calendars as early as from three to five thousand years before Christ. In Central America the ancient Maya civilization produced its own complicated but accurate calendar at a not much later date.

Regulating the seasons

The chief difficulty with most of the early calendars is the incommensurability of the month and the year. In most countries the month was reckoned from the first appearance of the crescent moon, an event greeted by the priests with prolonged blasts of trumpets. From one crescent moon to the next is about 29.6 days and twelve of these intervals would amount to 355 days, whereas the year, as measured by the apparent motion of the sun, is 365 days. In such a calendar, in order to keep the seasons always in the same months of the year, it would be necessary to add a few days from time to time, or, to use the technical phrase, to make an intercalation.

According to Cicero, the Greeks were in the habit of adjusting their calendar when it appeared to be in error, by lengthening or shortening a month. In Aristophanes' play,

"The Clouds," the moon is represented as scolding the Athenians on account of the confusion in their calendar, and the consequent errors in the dates of the festivals. When the gods were mourning, the Athenians were making merry; and when the Athenians ought to be sacrificing to the gods, their courts were in session and their men were transacting routine business.

Sometimes, apparently, the calendar fell into disorder from ignorance, or from the unskillful way in which the intercalations were made, but, at times, it was undoubtedly deliberately juggled for some special purpose such as to increase or shorten a term of office or to add to the number of revenue payments.

When Julius Cæsar came into power, he found the Roman calendar in great confusion, and proceeded, with the aid of the Egyptian astronomer Sosigenes, to rectify this inconvenient state of affairs.

January 1 becomes New Year's Day

First of all, he decided to ignore the phases of the moon and to base the calendar upon the year as determined by the revolution of the earth around the sun, or, what amounts to the same thing, by the apparent motion of the sun around the earth. This was assumed to be $365\frac{1}{4}$ days. He retained the idea of dividing the calendar into months, but increased the number of days in them to produce the right total. The first month of the year at that time was March, and December, as the name implies, was the tenth. Cæsar changed the beginning of the year to January 1st, and made that date fall shortly after the winter solstice, probably, in that particular year, at the time of the new moon next following.

Most of the old names of the months were retained, but Quintilis, the fifth month counting from March, was changed to July, for Julius, to commemorate the revision. Later, Sextilis was changed to August by Augustus Cæsar.

Since the calendar must contain an integral number of days, it was decreed that, in order to take account of the fraction $\frac{1}{4}$, there should be three consecutive years of 365 days followed by one of 366 days, the extra day being added at the end of February.

The seven-day week was also retained in the calendar of Cæsar. The origin of the week

is not known with certainty, but it probably was connected with religious festivals. This seven-day period was used by the early Chaldeans, Egyptians, and others, and the days of the week were, in nearly all cases named for what were known as the seven wandering stars, viz., sun, moon, and the planets Jupiter, Saturn, Mars, Venus and Mercury. The names that we now use have come down to us through the Anglo-Saxons. Their name for Jupiter was Thor, whence our Thursday. Mercury was Woden; Mars, Tues; Venus, Friga; etc.

The effect of religious festivals

The Julian Calendar was put into effect in the year 709 of the Roman Era, which corresponds to 45 B. C. in our present method of reckoning. Most of its details were soon adopted by nearly all the civilized world. In a few countries, notably in England, the date of the Vernal Equinox was retained as the beginning of the year. It was not until the sixteenth century that any change was deemed necessary. The revision then undertaken was due to the fact that some of the religious festivals were gradually changing with respect to the seasons. For example, at the Council of Nicæa, held in 325 A. D., Easter was defined as the Sunday following next after the date of the full moon which occurs on or next after the date of the Vernal Equinox. In that year, 325 A. D., the date of the Vernal Equinox was March 21, but by the time of Pope Gregory XIII, 1582, it had worked forward to March 11. The reason for this is that the tropical year, that is, the year of the seasons, reckoned from equinox to equinox, is not exactly $365\frac{1}{4}$ days, or 365 days and 6 hours, but is 365 days, 5 hours, 48 minutes, and 46 seconds. This difference of $11^m 14^s$ between the year of the Julian calendar and the correct tropical year amounts to one whole day in 128 years.

Pope Gregory ordered that ten days be dropped from the calendar to bring the date of the Vernal Equinox back to March 21, and in order to keep it there, instead of decreeing that one leap year should be omitted every 128 years, he decided that three should be omitted every 400 years, which amounts to nearly the same thing. Thus he amended the Julian rule so that February would have 29 days on every year that is divisible by 4, *except* those century

years that are *not* divisible by 400. Thus the years 1700, 1800, 1900 were not leap years.

This Gregorian calendar was adopted in Roman Catholic countries in 1582, but it met with great opposition in all parts of Europe that were not under the Papal supremacy. It was not until 1752 that the British Parliament finally voted to make the change. They decreed that eleven days should be omitted between September 2 and 14. This caused rioting on the part of the general populace, who assumed that they were being robbed of that much time, and many churchmen were scandalized at the idea of deliberately changing the dates of the holy days.

The decree of Parliament also provided for moving the beginning of the year from March 25 to January 1, and for the adoption of the "New Style" of reckoning in all the colonies. For many years previous to this it had been the custom in Great Britain to recognize the Gregorian calendar by writing two numbers for the year between January 1 and March 25. For example, in the quoted epitaph, February 24, 1672/3, means that it was still 1672 in England, but according to Rome, 1673 had begun on the previous January 1.

Making use of leap years

Under the Gregorian rule for leap year, the date of the equinox will change only one day in 3000 years. Russia, Greece, and other countries in which the Eastern Orthodox Church held sway, adhered to the Julian calendar until 1923, when they adopted a scheme which is even more accurate than the Gregorian, namely, that century years shall be leap years only in case their numbers, when divided by 9, give a remainder of 2 or 6. This is equivalent to omitting seven leap years every nine hundred years.

Either of these rules is satisfactory for maintaining the seasons in a fixed place, but there are other factors in the calendar which make it far from ideal. For example: the months range in length from 28 to 31 days; the number of business days in any month varies; there may be either 4 or 5 Sundays in a month; the year, as well as the month, may begin with any day of the week; holidays of fixed date, like December 25, February 22, and July 4, may fall on any day of the week; Easter may fall on any date between March 22 and April 25.

To remedy these difficulties various schemes have been proposed, many of which have recently been under discussion by a committee appointed by the League of Nations to consider revision of the calendar. The two plans that met with the most favor are for fixed calendars, the same for every year, except for the leap day.

Two new plans

One arrangement retains the twelve months but makes every third month 31 days long; the other nine, 30 days each. This adds up to 364 days, or 52 weeks. Each quarter would consist of three months, or 91 days or 13 weeks, beginning on a Sunday and ending on a Saturday, exactly the same for every year. The 365th day would be called New Year's Day, and would not be counted in any week or in any month. In the case of a leap year, an extra day would be inserted before July 1. It is proposed also to define Easter as a fixed date, possibly April 8.

The other plan is to divide the year into thirteen months of 28 days or four weeks each. This also would necessitate considering New Year's Day and Leap Day as extra days. Thus every month would be exactly like every other month, but the year could not so easily be divided into halves and quarters.

In all the calendars mentioned above, the days are counted, but neither the day itself nor its subdivisions are specifically defined. Among the early Greeks and Romans the daytime was divided into twelve hours, and the night into a like number of hours. The length of such hours would vary from summer to winter. We still follow the custom of using twice twelve hours, but now they are fixed in length. The earliest timepieces were some form of sundial for the daytime, and a sand clock, a clepsydra (water clock), or a candle or a lamp for marking the hours during the night.

Cæsar, in his *Commentaries* on the winter campaign to Great Britain, states that the water clocks froze, throwing the night watches into great confusion.

During the seventeenth century accurate clocks and watches were made and these were adjusted to keep *mean solar time*, by which is meant a uniform fictitious time which may be explained thus: The apparent solar day, as reckoned from noon to noon, varies in length throughout the year. This interval is due not only to the rotation of the earth on its axis, but

also to the motion of the earth in its orbit around the sun. Since the orbit is an ellipse, the earth's distance from the sun varies, with a corresponding variation in the gravitational pull of the sun on the earth, and, as the speed of the earth in its orbit depends upon this pull, the apparent solar days must vary in length. A still further irregularity is due to the fact that the plane of the earth's orbit is inclined about $23\frac{1}{2}^{\circ}$ to the plane of the equator as determined by its rotation.

A universal time measure

To obviate the irregularities of apparent solar time, a fictitious sun is imagined to move along the celestial equator at a uniform rate, equal to the average rate of the true sun. Time kept by this fictitious sun, called mean solar time, is now universally used.

All kinds of time are intimately connected with the longitude of the place from which the time is reckoned, so the longitude is frequently expressed in time units as well as in angular units. Thus 360° would correspond to 24 hours, or 15° to one hour. The sun in its apparent daily motion is, of course, always moving westward, so when it is noon at Greenwich, for example, it is 1 P. M. at a place 15° east of Greenwich and 11 A. M. at a place 15° west of Greenwich.

Prior to 1883, each town kept time reckoned from its own local meridian. New York time was less than Boston time by $11^m 31^s$ and greater than Washington time by $12^m 22^s$. No two places kept the same time unless they happened to be on the same meridian. This

caused no great inconvenience until the coming of the railroads, telegraph and telephone. With a wider spread of commercial interest, it was found necessary to adopt a standard time for relatively large areas. In general, all places within $7\frac{1}{2}^{\circ}$ of a meridian which is a multiple of 15° reckoned from Greenwich, keep the time of that meridian. Thus the United States has four time belts. The first extends from the Atlantic Coast to a line running from eastern Michigan to western Florida. This area normally keeps the time of the 75th meridian, or Eastern Standard Time. The next belt extending westward to a line from North Dakota to Texas keeps 90th meridian time; the Rocky Mountain region, the time of the 105° meridian; and the Pacific coast states, the time of the 120° meridian. In some parts of the country during the summer, where the so-called Daylight Saving Time is used, the clocks are set ahead one hour, which is equivalent to using the standard time of a meridian 15° farther east. Thus in winter New York keeps the time of the 75th meridian and in summer the time of the 60th meridian.

The determination and distribution of accurate time is a job for the professional astronomer. On every clear night some member of the staff of the U. S. Naval Observatory observes with a transit instrument a number of stars as they cross the meridian of Washington. From his observations he deduces the time that the fictitious mean sun would indicate at the various standard meridians. This is the time that is broadcast by means of the radio at intervals during each day.

Ceremony of the New Month. The Jews announced with a blare of trumpets the coming of the new month, which began

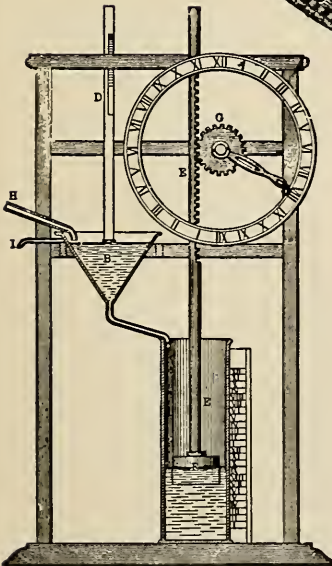


when the thin crescent of the new moon was first visible. (From "Astronomy of the Bible" by E. W. Maunder)

Man's Timekeeping —

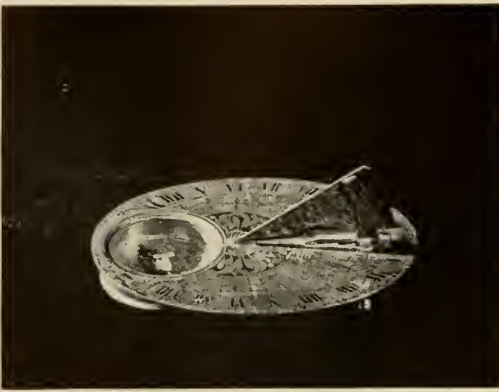
Past and Present

Harking back to the days of Cæsar: A Roman calendar in which the months, with their zodiacal signs, were conveniently arranged on the four sides of a tablet

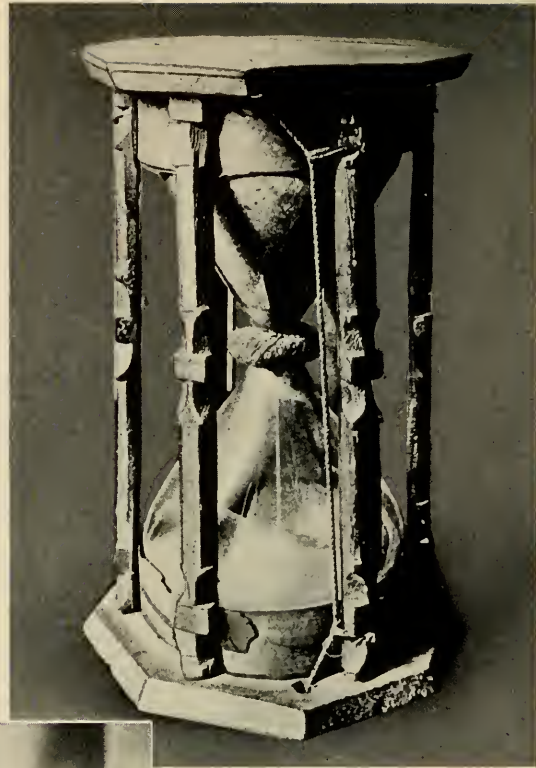


The Calendar Stone, the most famous of Aztec monuments, not only represents the sun's face, with the divisions of the year, the days of the month, the points of the compass, but also the creation myths of the Aztecs

A common form of clepsydra or water clock (about 140 B. C.). The water from the conical vessel flows into the compartment below it at a known and even rate. The time elapsing during any given part of this process can be read by means of the scale at the side, or by the hand on the geared wheel



The essential element in any sundial is the gnomon. This casts a shadow which, moving with the sun, points out the hour in the dial face



A reminder of time gone by: an interesting hourglass. The flowing of the sand from one chamber to the other marks a given interval of time. Designed for use in the pulpit, this glass doubtless brought to an end many an old-fashioned sermon



The Terry Clock, a famous old timepiece which dates back to the year 1792 and is now in the Arthur collection at the Museum of New York University. The photograph shows the clock-works from the back

Ewing Gallotway

*A water clock in the Pin-
cian Gardens, outside
Rome. This is a more
elaborate development of
the older form of clepsy-
dra, which not only marks
intervals of time but indi-
cates the exact time*

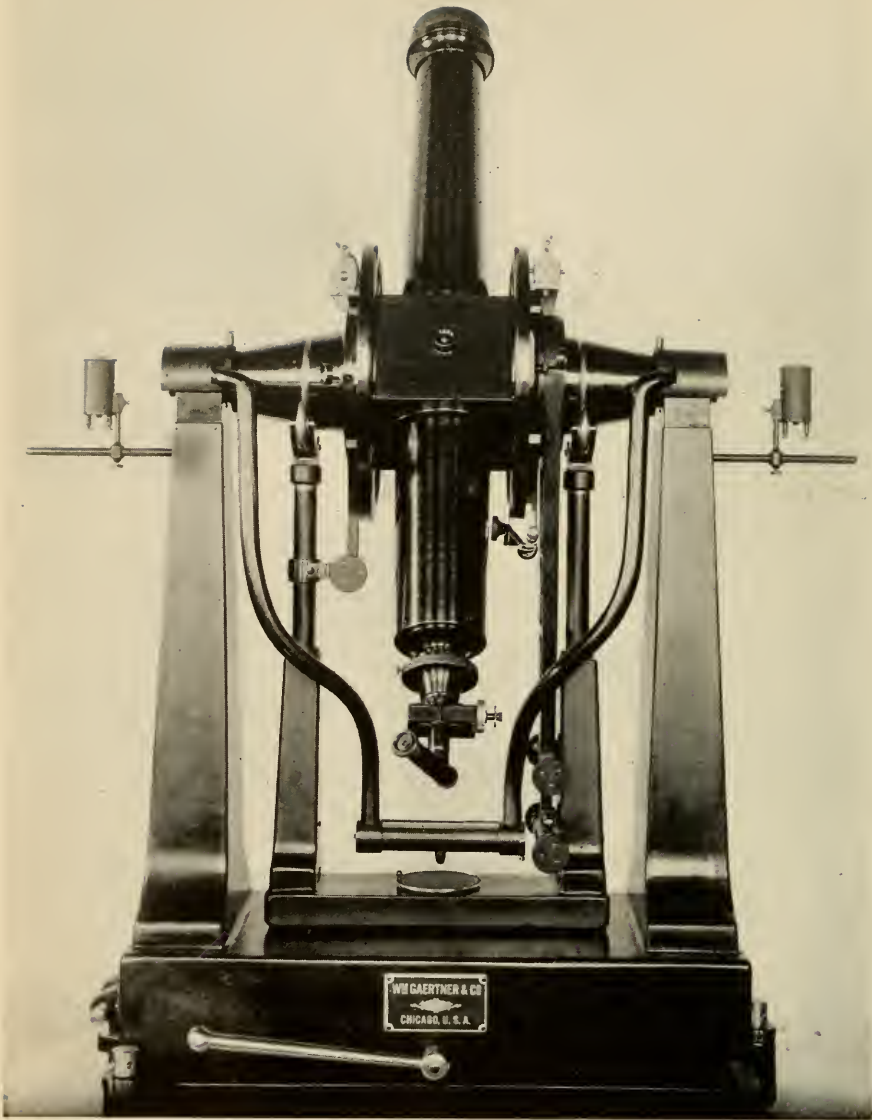


Ewing Galloway



*A modern sundial. Beautiful and accurate as many
dials are, all have the
serious limitation of being
useless when the sun is not
shining. As the familiar
dial motto puts it, "I mark
only the sunny hours"*

Ewing Galloway



Ewing Galloway

An astronomical transit. A modern instrument for the determination of accurate time



The oldest watch in existence, dating back to 1520-25. It is of the type known as the "Nuremberg egg," made by the inventor of the watch, Peter Henlein

Cosmic Rays

A discussion of the various theories concerning the origin and behavior of the cosmic rays

By W. F. G. SWANN

*Director, Bartol Research Foundation
of the Franklin Institute, Swarthmore, Pa.*

IN each second of our lives, each one of us is riddled by about ten bullets shot through us from some unknown cosmic machine guns. These bullets, the cosmic rays, have enormous energy in comparison with normal bullets of their kind. For the last twenty-five years we have wondered what they are, and where they come from.

When the physicist encounters some new phenomenon, he frequently has to gain understanding of it through circumstantial evidence, and so it is through circumstantial evidence that we have had to learn much of what we now know about cosmic rays. Our procedure must be analogous to the following.

A physicist might observe a large, jagged breach in a wall, and hear somebody exclaim, "A rifle bullet has been fired at the wall!"

"No," the physicist would argue, "a rifle bullet could not have caused a hole such as that. It must have been caused by a large, slow-moving body such as an elephant."

Or, standing by a window-pane with a clean-cut hole in it, the physicist might hear his friend remark, "Some fellow poked his walking stick through that window."

"No," he would reply, "a walking stick would have shattered the glass completely. Such a clean-cut hole must have been made by a small thing traveling at high speed—a thing like a rifle bullet!"

Our first knowledge of what are now called cosmic rays came through the discovery of the fact that the air of our atmosphere can conduct electricity. It conducts electricity through the

agency of carriers in the form of positively and negatively charged atoms or molecules of air, called ions.

When left to themselves, positive and negative ions, owing to their mutual attraction, recombine to form neutral atoms or molecules. It follows therefore, that in order to maintain a constant density of ions, they must be continually reformed.

Sources of ionization

Over the land, the most potent sources of ionization are the radiations from radioactive materials in the soil and in the atmosphere. Thus, for example, although the atmosphere of the whole earth contains only about ten ounces of radon, the radiations from this radon are sufficient to contribute quite perceptibly to the ionization observed. These radiations ionize the gas by tearing electrons from the atoms as they pass by or through them.

However, there is practically no radioactive material in or over the great oceans, yet the conductivity of the atmosphere there is comparable with the conductivity over land; and is such that, even there, ions must be produced at a rate of twenty or thirty per cubic inch per second in order to maintain the necessary ion density in opposition to recombination.

Either over land or ocean, if we take a hermetically sealed vessel containing air freed, as far as possible, from radioactive contamination, and shielded from external radioactive radiations, we find that ions are actually produced in it at the rate of about twenty or thirty ions per cubic inch per second. As a matter of fact, such a rate of production of ions represents an exceedingly rare phenomenon from the point

of view of the molecules themselves. If we draw an analogy between the molecules and the population of the earth, and compare the ejection of an electron from a molecule with a murder, the production of twenty or thirty ions per cubic inch per second means that the catastrophe of ionization would appear as rare an event to the molecules in general, as would the crime of murder to mankind if only one were committed every three hundred years.

About twenty years ago the Austrian physicist Hess, and later Kolhörster, measured the ionization in a closed vessel during balloon ascents and found that it increased with altitude until, at an altitude of six miles, it attained a value of about 1300 ions per cubic inch per second. This suggested the existence of a radiation which comes from outside the atmosphere, and is gradually absorbed as it penetrates into it. They concluded that the radiation possessed ten times the penetrating power of any other known radiation, and they called it the "penetrating radiation."

Cosmic radiation

Later, their results were confirmed in general outline and extended by others, through measurements on mountains, in airplanes, in manned balloons, and in apparatus carried aloft in small pilot balloons. As a result of all these experiments, we have been led to belief in the existence of a cosmic radiation, possibly composite in character and coming from above, of such penetrating power that appreciable amounts of it can pass through seventy-five feet of lead.

What can be the nature of such a radiation?

When the physicist encounters some new phenomenon such as the cosmic radiation, he likes to see it as a representative of the activities of something with which he is already familiar. He likes to think that the cosmic ray is an electron of high energy; but since the highest energy electrons obtained in ordinary laboratory phenomena can pass through no more than a tenth of an inch or less of lead, and the cosmic radiation can pass through seventy-five feet of lead, he must extend his mental picture by supposing that the electrons have exceptionally high energies. Or he likes to think of the cosmic ray as an X-ray; but, since X-rays produced in the laboratory cannot penetrate more than a fraction of an inch of lead, he must suppose that the cosmic rays—if X-rays—must be of

a peculiar type to provide for this high penetrating power. His knowledge of the way in which penetrating powers of X-rays depend upon the nature of the X-rays then suggests to him that X-ray cosmic rays must be X-rays of exceptionally short wave length. In other words, the physicist does not like to invent ghosts or evil spirits to explain new phenomena. He prefers to see the phenomena as the activities of some of his old friends in new garb.

Candidates

Now among the candidates which present themselves for the position of cosmic rays are—first, electrically charged particles. Then we have X-rays of a particularly hard, or penetrating type. Ordinary X-rays are a kind of invisible light of wave length 1000 times smaller than that of ordinary light. Gamma rays, which are emitted by radioactive substances, are X-rays of still shorter wave length, and the cosmic rays would have to have still shorter wave lengths. The concept of light rays, X-rays, and gamma rays as waves is not without its difficulties. From some points of view, these radiations behave like spreading waves, while from others they behave more like streams of bullets. One characteristic feature is that their energy goes out in perfectly definite units, or quanta, as they are called, the energy in any quantum being greater the smaller the wave length. Quanta of energy of this type are frequently called "photons."

Then, within the last few years we have come to recognize the existence of another entity known as a neutron, and regarded as a composite of a particle of negative electricity and one of positive electricity traveling along in close proximity as a single entity, with a velocity comparable with that of light.

Agencies of all these types stand as candidates for the position of cosmic rays.

Then, finally, we have the dramatic suggestion of the Abbé Lemaitre, to the effect that the cosmic rays are a mixture of electrons, charged atoms, neutral atoms, and every kind of atomic or sub-atomic entity, these entities representing the débris of a gigantic explosion in which all of the matter of the sun and the stars, of the nebulae of space and everything else, once gathered together in a single compact mass, blew up.

Now a characteristic feature of high energy

charged particles is that, as they pass through the atmosphere, they ionize the air continually. They fritter away their energy in small amounts, in amounts insignificant compared with the total energy which they possess. They go on losing energy in this way until finally they have lost all and their journey comes to an end. All rays of the same energy travel the same distance. Shooting electrons into the atmosphere is like shooting bullets into a thick layer of cheese. The bullets will lose more and more energy as they burrow into the cheese, but all bullets of the same energy will travel the same distance in the cheese.

On the other hand, photons, and uncharged particles do not ionize the air continually as they pass through it. They act through assistants. A photon travels along through the medium with its energy undiminished until it strikes some atom with a particularly direct blow. Under such conditions it loses the whole of its energy, or a large portion thereof. It hurls electrons out of the atom which it has struck, and the plebeian work of ionizing the air is left to these electrons. Shooting photons into a gas is thus like shooting a machine gun into a grove of trees. A bullet will go on with undiminished energy until it hits a tree, in which case it loses all of its energy at once. If a beam of bullets be aimed more or less in one direction, all will not travel the same distance. Some will go farther than others, the number to be found at any distance from the machine gun depending upon the laws of chance as applied to the chance of hitting a tree.

Variation of ray intensity with altitude

It is easy for the reader to see, in view of the foregoing considerations, that if we should have a telescope which was capable of measuring the number of cosmic rays passing through it per minute and should point it vertically to the sky and then measure the number of rays which it records per minute for various altitudes above the surface of the earth, the way in which the number would increase with altitude would be characteristically different for charged particles from what it would be for photons. One has only to think of the bullets shot in the cheese and of the bullets shot into the forest to realize this fact. Now, experiments on the variation of cosmic ray intensity with

altitude gave a result which at first sight is much more in harmony with the photon idea than with the charged particle idea.

Another matter which plays a prominent rôle in deciding between charged particles and neutral particles or photons arises from the fact that the earth is a great magnet and so possesses the power to deflect the paths of charged particles which approach it.

More than twenty years ago, Birkeland and Störmer sought to explain the aurora borealis as light emitted from the upper atmosphere by atoms which have been bombarded by electrons from the sun. Electrons of relatively low energy would be caused to spiral around the earth's lines of magnetic force so that they would strike the earth's atmosphere near the poles. Only electrons of exceptionally high energy could strike in low latitudes. In order to account for the extension of the aurora to latitudes as low as that at which it is observed, it was necessary to postulate the existence of electrons with energies 300 times as great as any with which we were actually acquainted in the laboratory. An energy ten times greater than this would be necessary to enable an electron to strike the earth's atmosphere at the equator.

Such considerations as these would lead us to believe that if the cosmic rays are charged particles, there should be a considerable variation of cosmic ray intensity with latitude. Until comparatively recently, no such variation had been found. Within the last few years, however, J. Clay in Europe, and A. H. Compton and his associates have established a definite variation of intensity with latitude; and, with this phenomenon are also associated others concerned with the variation of intensity from different points of the compass, which phenomena would be expected if the cosmic rays were charged particles.

These latitude and directional effects call as insistently for the assumption of charged particles as their absence (as formerly supposed) called for photons or neutral particles. The latitude and directional effects necessitate that we assume that at least 31 per cent of the total primary cosmic radiation must be of the charged particle kind. This 31 per cent is enough to spoil the story of variation of intensity with altitude which was so nicely provided for by the photon hypothesis. It makes it imperative that we revise our views as to the

details of the charged particle hypothesis with the aim toward making it, itself, harmonize with the altitude-intensity measurements. If we succeed in this, there is no greater barrier to the assumption that all of the primary cosmic radiation is of the charged particle type.

The rays as charged particles

The modification of the charged corpuscle hypothesis which serves the end in view, is one in which we postulate that the primary cosmic rays coming from space travel for the most part right through our atmosphere, losing energy on the way. We suppose that on their journey they eject high energy charged particles, called secondary rays, from the atoms in their path. We suppose further that the number of secondaries ejected per unit of path of the primary increases with the energy of the primary, and is in fact proportional to it. These secondary rays are supposed to be the things measured in our experiments. The number of them to be found at high altitudes is greater than the number at low altitudes because the energy of the primary rays is greater at high altitudes; and on submitting the whole matter to calculation we find that the theory fits, satisfactorily, the experimental results concerned with the variation of cosmic ray intensity with altitude.

It thus appears that while the experiments do not exclude the possibility of photons as representative of a part of the primary cosmic ray intensity, they are in harmony with the view that all of the radiation consists of charged particles.

When cosmic rays pass through dense materials such as lead, they cause, occasionally, a kind of atomic explosion in which as many as five thousand high energy charged particles may be ejected. Those who favor the photon hypothesis see in this phenomenon an illustration of the actual creation of matter from radiation. For some years physics has recognized a close connection between mass and energy in the sense that if by any procedure, matter is caused to disappear, energy in the radiant form appears in proportional amount. It is calculated that the annihilation of a single drop of water would produce enough energy in the form of radiation to supply two hundred horse power for a year.

It is believed that the reverse phenomenon

can occur. It is supposed, in fact, that when a photon comes into close proximity with the nucleus of an atom, it may become mathematically irritated in such a way as to cause it to change its state of existence and materialize as a shower of material particles. As a crude analogy, we may liken the phenomenon to a spiritualistic seance, in which the photon is the ghost, the charged particles the materialized ghost, and the atom is the medium.

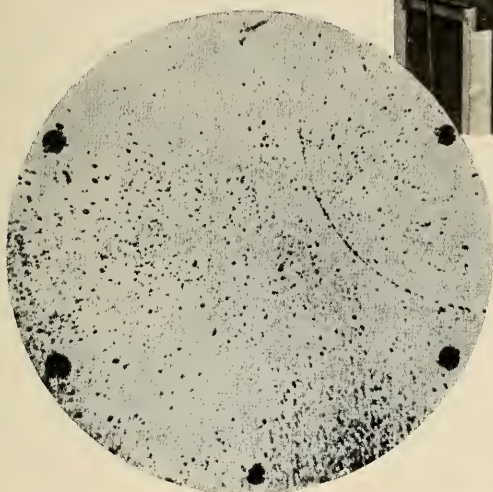
Fascinating as this hypothesis may be, it requires modification, in detail at any rate, when applied to the explanation of the explosive emission of particles to which I have referred. For, it appears that, in these explosions, the ejected particles do not all come from one point. The phenomenon is such as to suggest that one initial center of explosion starts others in the substance, and that these, possibly, start others, so that the conglomerent explosion observed represents the débris of a large number of smaller explosions taking place throughout the substance.

However this may be, we have here a phenomenon initiated by cosmic rays and representing an actual creation of matter; or, if not that, then a transmutation of matter from one form to another—from the form represented by the nuclei of the atoms to the form represented by the free particles which are observed when the phenomenon occurs.

Source of the rays

The origin of the cosmic rays presents an interesting field for speculation. On the view that they are photons, Millikan has suggested that they represent a radiation emitted at the instant of birth of atoms from charged particles in interstellar space. If they are charged particles, we can see how they could acquire their enormous energies under the influence of such electrical forces as might arise in something like thunderstorms on the stars. Again, we know that fluctuating magnetic fields can cause motion of electricity. It is by such means that an ordinary electrical transformer operates. Now we know that varying magnetic fields are to be found upon the sun—in the sunspots in fact; and while it is not likely that the sun could provide the energies observed in cosmic rays—although it could provide energies comparable with them—it is quite within the range of possibility that the different conditions found in other stars may provide the energies required.

(Right) Cosmic rays penetrate a New York City bank vault. Here Doctor Swann is demonstrating his cosmic ray counter to well-known scientists. From left to right they are O. H. Caldwell, Dr. Clyde Fisher, Doctor Swann, Dr. H. F. Stetson, and Dr. Sergius Grace

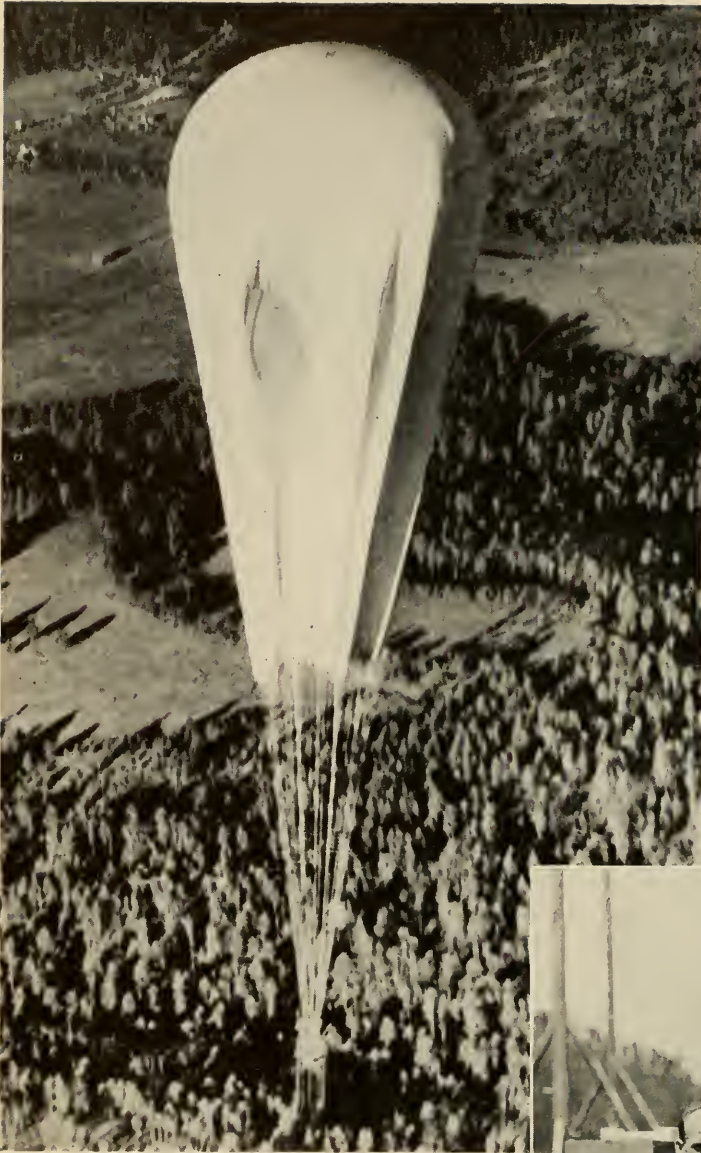


(Left) This picture shows the path of a cosmic ray particle bent in its course into the arc of a circle by a large magnet. The particle has disrupted the atoms of air in its path. Upon these disrupted atoms water vapor has been condensed by a well known device and thus the path of the particle is rendered visible. (Anderson)

(Below) Mr. A. Zuhn, a member of the Byrd Antarctic Expedition, studying the cosmic ray at Antarctica

Photo courtesy Byrd Antarctic Expedition





(Left) The take-off of a recent stratosphere flight at Rapid City, South Dakota. The balloon reached an altitude of 60,000 feet, then crashed to earth near Loomis, Nebraska. All of the delicate instruments were smashed, but fortunately the crew was uninjured. Another stratosphere flight is being planned for the near future

Apparatus for studying cosmic rays. The picture shows Dr. G. L. Locher on the left and Mr. Oscar Steiner (holding cables), chief mechanic, of the Bartol Research Foundation, on the right. The apparatus they are holding comprises three parts. The lower, and largest unit, is a system of dial recorders designed by Doctor Swann and Mr. Steiner, for recording the cosmic ray pulses. The box on which Doctor Locher's hand rests is another recording system working on an optical principle, and designed by Doctor Swann and Mr. Steiner. The remaining piece is the camera which photographs the dials every half minute



Photo courtesy National Geographic Society



Photo courtesy National Geographic Society

(Above) Captain Stevens (left) has his hand on the Geiger counter apparatus. Captain Anderson is using the ear phones. Low down to the right, showing a dial, is a closed chamber

apparatus designed by G. L. Locher for obtaining closed chamber tracks of atomic matter, electrons, and other subatomic entities burst out of atoms by cosmic rays in the stratosphere



(Right) L y m a n Briggs, director of the Bureau of Standards and chairman of the Advisory Committee, and Doctor Swann. The latter is holding a new form of electroscope designed by him for use in an apparatus for measuring atomic bursts produced by cosmic rays in the stratosphere

Photo courtesy National Geographic Society

The Mysterious Moon

Separated from the earth by 240,000 miles, the moon yields its secrets to the astronomer

By DOROTHY A. BENNETT

*Assistant Curator of Astronomy and the
Hayden Planetarium, American Museum*

NEAREST and most studied neighbor of the earth, the moon is still an object of mystery. Despite the fact that thousands of features on its surface have been measured and mapped, there are countless formations that cannot even be explained. Although much of its surface is better known than equal areas on the earth, there is one whole side of it that has never been seen by human eyes. Even though it doubtless sprang from the same parent as did the earth, it has been denied the possibility of life.

This companion of the earth's travels in space not only accompanies the earth in its journey about the sun, but swings around the earth and turns on its own axis as well. In the course of a month it completes a circuit of its orbit and a spin upon its axis. This is the cause of a strange phenomenon—one side of the moon always faces the earth, and the other is forever hidden from earthly view. Slight noddings on its axis bring the margins into view, but even then, all that we know of the moon's now familiar face has been learned from only a little over half of this mysterious world. What lies beyond our sight can be speculated upon, but its true nature can be solved only when flights into outer space are possible.

The known half of the moon itself is hidden monthly from view when it passes between the sun and the earth. Because it is a dark, cold body, the moon must borrow its light from the sun and so moonlight is essentially second-hand sunlight. Our moon, a better mirror than some, reflects less than a tenth of the light received from the sun. Of necessity, its illuminated sur-

face must always be that toward the sun, and in its journey about the earth varying amounts of the lighted half are presented to the earth. This, of course, is the explanation of the familiar phases, one of man's first astronomical observations and one of the most common sky happenings in his experience. Everyone has observed the moon change from crescent to full and then back again to crescent; almost everyone at some time or other has seen the "old moon in the new moon's arms." This strange effect of the bright crescent with the rest of the moon but dimly illuminated within its horns is produced by third-hand sunshine. Light from the sun has traveled to the earth, been reflected to the moon's dark side, and returned to our eyes as "earthshine."

Markings on the moon

An even better known moon marking is the "man" or "lady in the moon." Strangely enough, it is vast, smooth, bare areas on the moon's surface that produce this illusion. Once called seas, they were thought by early observers to be either great expanses of water or the dried-up beds of former oceans. But when observed with modern instruments, their dark surfaces, quite the opposite from glaring sunlit water, proved to be nothing but plains. Unlike earthly plains, these are not grassy fields but naked areas of bare rocks.

Even a small telescope reveals a great variety of markings. Extensive mountain ranges border the plains or maria. Some of their peaks tower thousands of feet above the lunar surface and far exceed the height of the tallest mountains on the earth. As the sunlight advances across the lunar surface, it caps the mountain peaks with brilliant light long before the sur-

rounding regions or valleys below are visible. The peaks look like stars hung against the black background of the lunar surface. Then as the satellite slowly turns on its axis, the sun's rays creep forward, the valleys below come into view, and the jet shadows of the peaks drop beyond in sharp relief. From these shadows the heights of lunar markings may be determined, and from the boldness of a feature's outline its proportions may be calculated by an observer 240,000 miles away.

Lunar craters

Spotting the plains that are rimmed by mountains are many walled depressions. Ranging in size from a few miles to more than a hundred, these walled plains or craters are one of the most conspicuous and fascinating features of the moon. They are visible only in a telescope and are not large enough to appear even as a freckle upon the face of the "man in the moon." One of the most unusual of these is Newton, the deepest of the lunar craters. Located close to the south pole, it never receives the slanting rays of the sun at its base, which is far below the level of the surrounding regions. In contrast to the dark depths of Newton is the glowing floor of Aristarchus, the most brilliant of the craters. Some strange characteristic of its walls makes this crater seem to shine by its own light and it has more than once been mistaken for an active volcano. The most striking of all the surface features of the moon is the ray system about Tycho. From this ringed pit light-colored markings about fifteen miles in width extend over the moon's surface for hundreds of miles. Passing through craters and over mountains, like fingers of lava radiating from a dead volcano, they suggest faults, ridges, or cracks.

A discussion of the origin of the craters can turn the most dignified of astronomical seminars into the hottest of debating camps—one school insisting that millions of years ago when the moon was young, furious volcanic activities upheaved these ringed scars; the other, that passing groups of meteors pitted the surface in merciless bombardment. There is much to be said for either explanation, and perhaps a true solution of this mystery of the moon can be reached only by a visiting geologist pecking on the lunar rocks.

A fortunate circumstance in the study of the moon is that time is of little consequence

upon its surface. Even though many centuries be consumed in the perfection of a space vehicle to take us to our near neighbor, little change would take place in the meantime, for the airless moon will not be cracked by frost or scarred by erosion in the intervening years. The same jagged outlines which were first viewed by Galileo in 1610 are even now observed nightly by moon enthusiasts.

An airless satellite

If the moon were clothed with an atmosphere, the many features visible at the edges would be wrapped in mist and the bold outlines of its mountains, plains, and craters would be clouded from view. The horns of the crescent would be exaggerated in brilliance and the jet black of the shadows would be dissipated by refraction. None of these effects is seen—no erosion smooths the jagged features, no detail is masked by clouds, no twilight borders the brilliant sunlit portions from those dark in the depths of night, no blanket of clouds thins the solar rays, and no armor of air protects the scarred surface.

A swarm of meteors rushing at the moon meets no resistance like that offered by the atmosphere of the earth. Their swift descent is unheralded by the brilliant flash and the occasional loud report which marks their advent on the earth. They strike and leave their mark, while on the earth many are lost in the upper air, and only scattered dust is evidence of their visit. With no medium in which to move, the vibrations of their fall create no sound, and an object weighing tons which penetrates the moon to a depth of many feet is as noiseless as cotton dropping upon grass.

A world without life

Without atmosphere, without water, this barren world must also lack life. The sun shining for fourteen days on end heats the lunar surface to the unbearable temperature of 200 degrees above zero, and this same surface when turned away from the sunlight without insulating air to retain the acquired heat, drops to 200 below zero. On the earth a variation of 50 degrees in temperature within twenty-four hours is considered drastic; in a lunar day, however, the change is eight times as great.

How came this airless world? Its motions, its composition, its origin and its destiny par-

allel the earth's. Why should it be deprived of the essential elements which make the world possible as the home of man? Did it ever have an atmosphere? If so, why has it lost it? To these questions there are two answers, both of which hinge upon the moon's lesser gravitational attraction. The moon is so small, with a diameter of only 2000 miles, that it attracts an object at its surface with only one-sixth the pull exerted by the earth. Thus, a hundred-pound earthly visitor to the moon would tip the scales at only sixteen pounds; a javelin thrower could toss his spear six times as far with the same effort. Therefore it is not difficult to see that the little moon with its feeble pull may never have been able to attract an atmosphere or hold its dancing gases. Which of these is the true chapter in the moon's history is still open to dispute, but there is little room for discussion on the actual presence of atmosphere on our satellite.

However, there are some well-known and respected astronomers who cling to the hope that there may be vestiges of life upon the distant moon. Dr. William Pickering, after a decade of study of certain craters, feels sure that changes he observes there are more than the effects of the passage of the lunar day. He is ready to assert that they are manifestations of some type of plant life which alternately springs up with the lunar day and dies out with the approach of the lunar night.

In support of their proposition, the champions of lunar life call attention to several unusual things upon the earth. There is the fact that locked within the rocks of the earth are gases. Why couldn't this be true of the moon, the composition of which is very similar to the earth's? Then, too, there is life which exists upon the earth under circumstances long believed to preclude life. In the Valley of Ten Thousand Smokes there live blue-green algæ, which are forms of life so low that they are at once claimed and rejected by both the plant and the animal world. They thrive on emanations of gases at the brink of fumaroles where the temperature is as high as 200 degrees. If these lowly creatures can keep their tenuous hold on life under such unfavorable conditions here on earth, could not some relative of theirs

survive at the depths of the lunar craters? There, near to the heart of the moon, which is perhaps still hot, active volcanic vents might squeeze gases from the rocks and provide a home for lunar life.

But while one conjures with the idea of life upon the moon, that distant body vitally affects the life of thousands of people upon the earth. All the countless persons engaged in maritime activities—from the Polynesian sailor of a fragile bark to the Nordic master of a great ocean liner—are subject to the moon, master of the tides. As the sailor waits to "come in on the tide," he waits for the moon to pile the waters high at his point on the earth. Directly on the other side of the world is high tide, too, and halfway around on either side is low tide, where many a small craft is caught aground. He who sails the seas for commerce or for pleasure must know the rhythm of the tides, and his journey is patterned by the motions of the moon.

Except for those who live by commerce and its many branches, the moon has small influence upon the inhabitants of the earth. Of course, the moon has figured in the folkways of people the world over, but the actual facts about our satellite are far more intriguing than the superstitions which surround it. The so-called "ring around the moon" is far less thrilling to see than the instantaneous disappearance of a star behind the passing moon. The myth of the crescent's "holding water" is much less provocative than the thought that on no part of the moon can there be even a pool of rain water. To look over one's left shoulder and wish is far less exciting than to look into the telescope and see the endless variety of lunar markings upon which no man has ever set foot.

Close at hand, the moon is of greater importance to the earth than any other body except the sun. But even in the solar system the moon is a midget; it becomes a mere molecule when considered in relation to the star system as a whole and counts for less than nothing in the vast expanse of the known universe.

However, it is far better to be a "big frog in a little puddle"—and the moon is major domo at many phenomena near home.



Yerkes Observatory

(Above) The old moon in the new moon's arms. The dark part of the moon, barely visible in earthshine, is rimmed by the slender sunlit crescent

(Below) The Crater Theophilus in the light of the setting sun

Mt. Wilson Observatory



Mt. Wilson Observatory

(Above) Mare Imbrium. The smooth expanse of this lunar plain is bordered by mountain ranges, pitted by craters, and streaked by rays from the great walled plain, Copernicus. The towering peaks that ring the area outline the 750-mile-wide "Sea of Rains"

Science in the Field and in the Laboratory

*Astronomy, American Museum Expeditions, Nature Trails, Education,
Research, Accessions*

Edited by A. KATHERINE BERGER

Henry Dill Benner

Opening of the Hayden Planetarium

On Thursday, October 3, the Hayden Planetarium of the American Museum of Natural History will be opened to the general public. On every day of the week except Sunday, the public lectures will be held at the following times: 11 A. M., 2, 3, 4, 8, and 9 P. M. On Sundays there will be lectures at 2, 3, 4, 8, and 9 P. M. The price of admission to morning and afternoon performances will be 25 cents, and to evening performances, 35 cents. Reserved seats in the afternoons will be 50 cents, and evenings 60 cents. While the lecture to be given during the first few weeks will be of a general and elementary nature, it is planned that later on other types of lectures may be given, as well as some on specialized subjects. The staff of the Planetarium consists of: Dr. Clyde Fisher, curator; Mr. William H. Barton, Jr., associate curator; Miss Dorothy Bennett, assistant curator; Miss Marian Lockwood, assistant curator; Mr. Arthur Draper, assistant curator.

Amateur Astronomers Association

Because of a conflict with the opening date of the Hayden Planetarium, the first meeting of the Amateur Astronomers Association for the season 1935-36 has been postponed to Wednesday, October 9. At this meeting Dr. Clyde Fisher, president of the society, will speak on the subject, "The Hayden Planetarium." The second meeting of the society will be held on Wednesday, October 16, when there will be a forum meeting open to general discussion by the members. Both of these meetings will be open to the public, and anyone who is interested is most cordially invited to attend. At the meeting of October 9, announcement will be made of plans for the classes and special activities of the society for the season.

Members of the Amateur Astronomers Association and their friends will learn with regret of the passing of Mr. Henry Dill Benner. Mr. Benner had been for many years a staunch friend and advisor of the Association, and had brought to many people an interest in the stars. He devoted a great deal of his time to popularizing astronomy in the last thirty years, both by personal interview and by letters to the newspapers. Mr. Benner was never too busy or too tired to talk with those who were interested in the stars. Amateur astronomers the world over have lost a good friend!

The Vernay-Hopwood Chindwin Expedition

The Vernay-Hopwood Chindwin Expedition, organized and led by Mr. Arthur Vernay, completed three months in the field and returned to Rangoon on April 5, 1935, from which point shipment was made of the numerous specimens collected in Burma. All the collections have now been received at the American Museum of Natural History and distributed to the various departments.

The work of identifying and studying some of the collections is already under way. Preliminary study by Doctor Mayr of the collection of birds shows that among the nearly 800 specimens of this group there are represented more than 200 species.

Study of the collection of mammals will await the preparation of the skulls and the tanning of skins, some of which have already been prepared.

The collection of reptiles and amphibians consists of 430 specimens and contains several species new to the Museum's collections; the most striking among the latter are a large banded krait and other snakes and two or more species of river turtles.

The collection of fishes, comprising nearly 600 specimens, contains, according to Mr. Nichols, considerable material new to the Museum's collections though related to species obtained by the

Asiatic Expeditions of the American Museum in China.

The anthropological collection consists of a variety of objects, such as baskets, pottery, bows, bark cloth, hats, etc., from the Kachin and Chin tribes of Northern Burma, and some will be put on exhibition. The face molds, some of which have already been cast, show the features of the peoples of Northern Burma, namely, Kachins, Chins, Nagas, Shans, and Burmese.

The motion pictures give a very good idea of the character of the country and some of the activities of the people. These include several views of women weaving on hand looms and spinning, the method used by Chins and Kachins in pounding rice, etc. Some of the pictures taken in a head-hunters' village show these people at various tasks, ending with the kind of dance which concludes a head-hunt.

There are a few scenes showing gibbons, the smallest and by far the most active of the apes, swinging through the treetops by their long slender arms.—H.C.R.

Auto travel on deserts

Those who have followed the Mongolian explorations of the American Museum's Central Asiatic Expeditions under the leadership of Dr. Roy Chapman Andrews, now the Museum's Director, will be interested to know that he will talk about his experiences with Mongolian bandits on the Socony-Vacuum program at 8 o'clock Friday evening, October 4, over the Columbia Broadcasting System. At the same time Doctor Andrews, who was the first explorer to penetrate the Gobi by auto, will speak about the problems of auto travel in the desert. An idea of the extent of his travels may be had by the fact that Doctor Andrews' expedition consumed about 30,000 gallons of gas.

"We transported the gasoline by camel, for there are no filling stations in the Gobi," said Doctor Andrews. "Many camels died and we suffered severe losses of gas through leakage. The change of 70° between night and day temperatures caused many tins to burst at night. They went off like firecrackers but, luckily, did not catch fire. The leakage on the 1922 expedition was almost 50 per cent, but by 1925 we had reduced this loss to 25 per cent."

The Bear Mountain Nature Trails

The Bear Mountain Trails, Trailside Museums, and zoos, operated jointly by the American Museum of Natural History and the Commissioners of the Palisades Interstate Park, have been maintained since July first by the state of New York. The following separate Trailside units have been open to the public during the season: the original Trailside Museum, the Trailside Botanical Museum, the Historical Museum and the Geological and Crafts Museum. The main Nature Trail has been com-

pletely re-labeled and has been open continuously since January first.

During the winter the trails and the Historical and Geological Museums will be opened daily from 9 A. M. to 5 P. M. The Trailside Botanical Museum will house the zoölogical collections during the cold months, and the Crafts Museum will be used for the storage of materials.

There have been many new developments during the summer. All trail signs are new and, in addition, the Acorn Trail has been doubled in length. It is to be used by high school groups during the fall as a biology test trail, and will include 150 test labels to be answered in connection with a mimeograph sheet. During the winter a new "snow trail" will be built. Particular attention will be given to winter buds, snow forms, animal and bird tracks, identification of trees by bark, etc.

A nature school was held on the Trailside area under the auspices of the Trailside Museum from July 1 to August 15. Group work was conducted for five days each week, with an eight-hour period daily. The students ranged in age from fourteen to twenty. The subjects given included the fields of zoölogy, botany, and general biology. Field trips were made and the students learned to trap small mammals, and to prepare study skins. Dissections were made of mammals, fish, reptiles, and insects. Attention was also given to the care and feeding of animals.

At the conclusion of the course the students were permitted to build a museum of their own in the Craft House. The students also operated the Trailside Museum for a period of four days. The teaching program resulted in several splendid collections for the Botanical Museum and also assisted Trailside employees materially in their daily work. Practical experience was the keynote of the course.

Activity in the Botanical Museum included the daily preparation for exhibition of at least fifty species of flowering plants. An exhibit of systematic botany proved popular with visitors. Living plants and colored diagrams told the story of plant development, "from algæ to flowers."

The Trailside Historical Museum was unofficially opened on August 15. The generosity of many local donors made possible the exhibit of fine historical material ranging from colonial household articles to revolutionary rifles. The building is completely equipped with exhibition cases and the interior construction is finished. The Hyde Memorial Library is in working condition, with a total collection of 6000 books and pamphlets. Archaeological field trips in the Hudson Highlands resulted in the collection of Indian implements now on exhibit. This material included many arrow points, pottery fragments, and similar items.

For the first time in several years the original Trailside Museum was enabled to present a "living check-list," of all amphibians and reptiles of the

Hudson Highland region. The entire interior of this museum was re-arranged to demonstrate the possibility of giving a fairly complete representation of local animal forms in a systematic manner. Wild life conservation and life history instruction were emphasized throughout the exhibit. More than 300,000 persons visited the trails and museum from January 1 to September 1.

The Trailside Museum staff for the 1935 season included William H. Carr, director; Anthony L. Roos, general assistant; Kenneth L. Lewis, zoölogist; Carl Steckert, assistant zoölogist; John H. Pierce, George W. Swenson, and Warren W. Wilson, botanists; Richard Koke, and Frederick C. Barron, historians; James B. Burggraf, archæologist; Raymond F. Torrey, librarian; Andrew T. McKee, secretary; Richard L. Manville, field zoölogist; Jessie L. Dennison, field archæologist. Miss Betty Ertel, of the American Museum Library, arranged the Hyde Library. Volunteer workers included William Dedrickson, Alwin Tabor, Valentine Clay, Nina Thomas, and Robert Ossman. In addition there were eleven workers supplied by the T. E. R. A. including two cabinet makers and six gardeners.

A new American Museum bird group

In May of this year Dr. Ernst Mayr (who was in Europe at that time) went to Switzerland to collect material for an Alpine Group for the Birds of the World Hall. The season proved to be too early for the successful negotiation of this task, but Doctor Mayr was fortunate enough to meet M. Olivier Meylan, well-known Swiss ornithologist, who gave him valuable advice toward the selection of the site of the group and the composition of the bird fauna of that region.

Mr. Francis L. Jaques, staff artist of the department of preparation, left New York on July 6 to get the material and the sketches for this group. He selected a site in the Zermatt Valley at the upper tree limit, right opposite the magnificent peak of the Matterhorn. Excellent weather during much of the stay facilitated his work, in which he was assisted by Mrs. Jaques and M. Meylan. The group will contain a panorama of the mountains of the Matterhorn and Monte Rosa chain, and in the foreground a cliff, a pine tree, and rhododendron bushes with their typical bird life.

This group, like that of the New Forest, next to which it will be placed, is the gift of Mrs. Carll Tucker.

The Whitney Wing, American Museum

The transfer of the study collection of birds (including the Rothschild collection) from the north wing to the Whitney Wing, which was begun in February last, was completed in September. While the arrangement is still far from final, all the specimens are now accessible. The first

guest student, Dr. Josselyn Van Tyne, curator of birds of the Museum of the University of Michigan, occupied quarters in the Whitney Wing for a week in mid-September while studying East Indian birds in the Rothschild collection, and specimens have been loaned to other students both in this country and in Europe.

Skipjacks

The dolphin, not the cetacean mammal (porpoise) so called, but the fish, ranges the high seas seeking what smaller fishes it may devour and thus collects many interesting specimens. Through Dr. E. W. Gudger, the American Museum has received from Mr. Aycock Brown two little fishes, skipjacks (*Caranx ruber*) taken from the stomachs of dolphins of ten or fifteen pounds weight near the whistling buoy on Cape Lookout shoals, North Carolina, the beginning of June, which are of interest as they are the smallest individuals of this species we have seen. The larger is slightly more than two inches and the smaller slightly under an inch and one half long without fins, and a little the deeper-bodied of the two. Evidently these young lead much the same life and have colors similar to those they have when larger, whereas the young of their close relative the yellow-jack (*Caranx bartholomaei*) at this size are decidedly deep-bodied, with a mottled concealing color, and hide about drifting gulfweed where a hungry dolphin could hardly seize them without obtaining a mouthful of weed at the same time, and, indeed, probably seldom even sees them.—J. T. N.

Madagascar fishes

The American Museum has just received from the British Museum (Natural History) through Dr. Errol I. White the first consignment of Lower Triassic fishes collected in Northeast Madagascar during the Vernay-Archbold expedition in 1929.

The particular interest of these fossil fishes from Madagascar is that they have many elements in common with those found in beds of the same age in South Africa on one hand, and with those of Greenland on the other, so that they suggest a uniformity of climatic conditions in distant parts of the world in that far-off age.

The American Museum owes much to the care with which Doctor White has identified and classified this collection, which he made as a member of the Vernay-Archbold expedition. Several other instalments will be sent later, making in all three to four hundred specimens for this Museum.

Local insects and spiders

Two of the charms of entomology are that its study has been far from exhausted in even the most-studied regions, and that there is an abundance of material at our very doors. This latter point is exceedingly well shown at the American



THE AMERICAN MUSEUM BOOK SHOP

The Book Shop, with a view to making available to Museum members and visitors other sources of information on natural history subjects, now has on hand, besides books allied to Museum interests, miniature yet practical

collections of butterflies, shells, minerals, small aquatic specimens, etc.

Special emphasis is being placed on books and material on natural science, suitable for children

Museum by an exhibit of some of the insects that were collected in a certain yard in a suburb of New York. It is an "open secret" that the yard in question contains the residence of Curator Lutz but, beyond saying that the total is "well above five hundred," he is not yet telling how many species actually have been found there.

This year, as in several previous seasons, Doctor Lutz turned a part of his residence into a "field laboratory" of the Museum's department of insect life. His work largely concerned the effect of infra-red radiation upon insects, but he also conducted some experiments on the still unsolved problem of the extent to which hearing is a part of the lives of insects. In each of these studies he had the helpful coöperation of Mr. E. N. Grisewood of New York University. Mr. Watson of the Museum staff, and Mr. C. B. Lewis, Jr., a volunteer assistant, worked on the life-histories of butterflies and moths. Also, Mr. Gertsch of the Museum staff, living in the same town, used the basement of his residence as a laboratory for observations on the life-histories of spiders.

Truly, "the study of insects has been far from exhausted in even the most-studied regions and there is an abundance of material at our very doors."

Rare human skeletons from Athens

Four human skeletons from Athens have been received recently by the American Museum through the courtesy of the Greek Government and Dr. Leslie Shear of the American School of Classical Studies. The earliest one dates from the Neolithic period, prior to 3000 B. c., the others are Mycenaean (1200 B. c.), Protogeometric (1000 B. c.) and Geometric (eighth century B. c.). These very rare and scientifically valuable remains were found in the Athenian Agora during the course of excavations which are being undertaken by the American School for Classical Studies.

American Northwest Indian study

Doctor Clark Wissler visited the Blackfoot Indian Reservation in Montana and the Glacier National Park, conferring with the Naturalist Service of the Park on methods of presenting information concerning the Indian tribes originally ranging through the Park. Two field assistants, Messrs. C. E. Schaeffer and D. G. Mandelbaum were working on adjacent reservations, the former with the Kootenay and Flathead west of the Park, the latter with the Cree of Southern Canada. The coördination of these three field trips is expected to increase

our knowledge and collections for the Indian tribes formerly residing in the vicinity of Glacier National Park.

A resignation

On July 1 of this year Dr. and Mrs. Robert T. Hatt resigned from the staff of the American Museum in order that Doctor Hatt might accept the directorship of the Cranbrook Institute of Science at Bloomfield Hills, Michigan.

Mrs. Hatt (Marcelle Roigneau) was first assistant in charge of exhibits in the department of human and comparative anatomy, and the Hall of the Natural History of Man owes much of its artistic groundwork and arrangement of exhibits to her talents and ability. She also collaborated with the curator in the preparation of the Guide Leaflet for this hall. At the time of her leaving she had been appointed assistant curator after serving for thirteen years as artist and staff assistant.

Doctor and Mrs. Hatt will be greatly missed by the Museum and especially the departments with which they were so long associated.

New Reptiles and Amphibians from Chindwin

The collections of reptiles and amphibians secured by the Vernay-Hopwood Chindwin Expedition comprise more than 400 specimens. Among the many interesting species in the collection is a series of very large fresh-water turtles, *Kachuga*. This turtle is rare in museums, because of the difficulties of collecting and transporting so

large a form. A large series of giant gecko was obtained showing all stages in the development of the individual. The snakes include two species of banded krait not previously represented in the American Museum collections.

Annual exhibit of The Aquarium Society

The Aquarium Society held its annual exhibit in the American Museum early in September. This year's exhibit was characterized by the large number of reptiles and amphibians on display. One of the more interesting demonstrations was a series of minute frogs hatching directly from the egg. This species is a West Indian form which skips over the tadpole stage. The eggs are laid on land and in no stage of the life cycle do the frogs enter water. There are several species in the group. The material on exhibition was reared in the biological laboratories of the American Museum.

Botanical Garden free lectures

Saturday afternoons at 3:30 the New York Botanical Garden is giving a series of free autumn lectures in its Museum building. For October the subjects include, in the order of presentation, "Fall Work in the Garden," by T. H. Everett; "Autumn Coloration," by A. B. Stout; "Mushrooms, Edible, Poisonous, and Otherwise Interesting," by F. J. Seaver; and "Fungi and Our Food Supply," by B. O. Dodge.

RECENTLY ELECTED MEMBERS

A REPORT from the membership department lists the following persons who have been elected members of the American Museum:

Life Members

Miss Anna Murray Vail
Doctor Clarence Thomas Lansing
Mr. Edward S. Pettigrew

Sustaining Members

Mrs. Edward L. Ryerson, Sr.
Mr. William A. Johnson

Annual Members

Mesdames Frederic T. Parsons, Charles H. Sabin, Edith D. Thomson.

Misses Martha A. Jamison, Ellen D. Sharpe.

Messrs. Samuel H. Kaufman, Frank H. Lee, H. A. Obst, George O'Neill, Frank H. Parsons, Grant G. Simmons, Jr., William M. Sperry, 2d, Ralph Talamo-Rossi, John C. Weadock.

Associate Members

Mesdames Olena J. Bristol, Russel Chesebrough, Sally Lane Erskine, William Frederick Finney, J. P. Fourqurean, Ferdinand C. Lee, Frederick L. Leining, C. E. Morrison, Jr., Wolcott Ely Newberry, Peter Reiss, Robert Baird Riggs, L. W. Robinson, Jr., Ruth Ruh, Lida F. Scott, J. G. Shedd.

Misses Lillian R. Daus, Maria Luisa de Leon, Joan DeRoy, Annah P. Hazen, Lillie B. Hudepohl, Orda M.

Mawhor, Lillian Parker, Sylvia Petrovsky, Leora F. Quinn, Adele Roeder, Alla Ross, Josephine Toon, Gladys E. von der Goltz, Helen Walcott, Elizabeth C. White, Hazel E. Woodward.

Doctors B. J. Brzenski, Waite A. Cotton, J. V. Gilbert, S. Crawford Gillespie, W. H. Hall, Werner Marchand, Robert B. McNutt, Donald H. Miller, Franklin Mittau, Edwin J. Nestler, A. Kendrick Osgood, G. H. Proper, Charles Radack, Leo L. Rubin, Benjamin Schwartz, C. Herbert Smith, Louis Stahl, Tracy B. Sturdevant, Frank E. Taft, Byron H. Weeth, William A. Xiques.

Honorable Harry Stewart New

Messrs. William P. Abbott, Merle Boyd Brusso, R. C. Caskey, Edward C. Congdon, Alfred A. Cordes, John Crucini, Saul Fischer, Henry Fisher, William J. C. Grant, L. P. Hancock, Richard T. Harriss, David E. Harrower, Edward A. Harris, Robert C. Hildale, Lloyd B. Jeffrey, F. C. Koch, Clifford La Roca, Lewis B. Lawrence, Victor Wilhelm Lindauer, T. A. Lupton, Chas. E. Maps, Garfield David Merner, Geo. A. Morava, Jr., A. Edward Morrison, James B. Neal, Alfred Roman Neff, W. F. Nelson, Raymond T. Parrot, James R. Patterson, Lynn R. Rich, Herman E. Riddell, J. Clifford Rosengarten, Juan M. Rosso, George J. Schreiber, 3d, John A. Shaw, Jr., John Lambert Siple, Harland Soper, Jr., C. J. Sullivan, Paul Svendsen, Matthias Thorsteinson, Edward E. Tompkins, Henry C. Triggs, Walther B. Trost, Charles J. Wagner, Theodore J. Werle, Arthur M. Wickwire, H. J. Wolff.

Reviews of New Books

Relativity, Stars, Psychology, Birds, Fishes, Hobbies, Exploration

RELATIVITY, GRAVITATION AND WORLD-STRUCTURE. By E. A. Milne, M.A., D.Sc., F.R.S., at the Clarendon Press, Oxford, 1935, 364 pages, \$8.60.

THIS book is the latest in the "International Series of Monographs on Physics" edited by R. H. Fowler and P. Kapitza. It contains the material originally delivered as lectures at the University College of Wales. The book is divided into four parts: I. Kinematics and Relativity, II. Kinematic World-Models, III. the Career of the Universe, IV. World-Pictures. In addition, there is an appendix of mathematical notes. It is obviously intended only for mathematically trained people, and the somewhat lengthy character of the monograph may deter the casual reader.

Professor Milne shows that an expanding Universe can be described in terms of the Special Theory of relativity only. All the important facts connected with our expanding Universe in particular can be described without the introduction of General Relativity and curved space, and this book should be recommended to students of "Special Theory." The mathematics is clear and rigorous. As a contribution to cosmology, however, the physicist may have serious objections to some of the essential deductions. Milne's description postulates an infinite Universe, something that astronomers had hoped to have escaped since the recognition of curved space. Milne does not believe in curved space and claims to prove that it does not exist. He especially attacks some of the analogies given in the semi-popular writings of Eddington as being misleading. The reviewer is of the opinion that Milne at this point is not doing justice to Eddington's artful verbal illustrations. The attempt to rule out a Universe consisting of a finite number of stars so that every star would have neighbors on all sides is not stringent and unsuccessful. The curved Universe is not more difficult to imagine than Milne's masses at infinite distances, and as to a dynamical understanding of the Universe Milne's theory gives very little hope. It is interesting to know, however, that Milne has succeeded in establishing a flawless mathematical structure as a

"map," representing the kinematical features of the observed phenomena.

Some of the subjects dealt with in the last parts of the book are: cosmic rays; cosmic clouds; the career of the Universe; the world picture on the simple kinematic model; Newtonian and relativistic cosmology; comparison between simple kinematic systems; the systems of current relativistic cosmology.—J. SCHILT

THE EARTH AMONG THE STARS. By Marian Lockwood and Arthur L. Draper. Basic Books, Inc., New York City, 1935. 35c.

HERE is a book for beginners in Astronomy. It is a readable, non-technical introduction to the subject, written by two enthusiastic students who have not lost the layman's point of view. The best book for beginners in any field is not usually written by a specialized research student or by a profound university professor, but generally by some one who has lately traveled the trails over which he wishes to lead his readers.

The senior author has been for several years secretary of the Amateur Astronomers Association, and both are members of the editorial staff of *The Amateur Astronomer*. Both Miss Lockwood and Mr. Draper are assistant curators of astronomy and The Hayden Planetarium at the American Museum, and will lecture in the Planetarium. By answering innumerable and various questions in astronomy that have come to them in these capacities, they have had abundant opportunity to learn what the layman—both juvenile and adult—wishes to know. The value of this experience is evident in the selection and arrangement of the material.

There are eight chapters in the book, namely, "The Earth Among the Stars," "The Solar System," "The Interstellar Messenger," "The Stars," "The Milky Way," "The Spirals," "The Universe," and "Astronomy for Amateurs."

The last of these answers the question so often asked, "What worthwhile work can an amateur do?" Among the suggestions here are: observing

meteors, with information concerning the American Meteor Society; locating and studying meteorites, with information concerning the Society for Research on Meteorites; observing variable stars, with information concerning the American Association of Variable Star Observers; and suggestions on making one's own telescope.

These chapters are followed by a brief, well-selected list of books and magazines. Following this is an indispensable index. The interesting and unusual drawings and the fine astronomical photographs from the Mt. Wilson and Yerkes observatories add much to the value of the book.

After a careful reading the reviewer is reminded of the hope—here realized—of the author of a well-known classic for a book “written by a pen that not only shall accuracy govern, but imagination inspire.”

This little volume of scarcely one hundred pages should find wide use among amateurs, both young and old.—CLYDE FISHER

ANTHROPOLOGY IN ACTION. By G. Gordon Brown and A. McD. Bruce Hutt. Published for the International Institute of African Languages and Cultures, by the Oxford University Press, London, 1935. 264 pp. map, 4 appendices. Price \$2.75.

ENGLAND is not only the great mother of colonies, but has evolved a profession of colonial administration the like of which is not found elsewhere. She has led in the applications of anthropology to the handling of native races. The volume under review deals with an actual experiment in which a professional anthropologist was assigned to the colonial governor's staff in Tanganyika Territory, Africa. The duties of the anthropologist were to give reports and answers to questions formulated by the administrator. Among the questions reported upon were the following: What is the smallest unit of local government in this tribe? What is the native concept of law? What aspects of the marriage customs of this tribe should be known in connection with the new rule enforcing the registration of marriages and divorces?

A fairly long list of such questions was submitted and investigated. The text of the book not only gives answers but presents many other interesting facts about the life of the people in question.

While this book may be considered technical, nevertheless, readers of this magazine should be interested in the general method of procedure because our own Department of Indian Affairs has adopted a similar policy in appointing young anthropologists to its staff to perform similar service. A number of these investigators are already stationed on the various Indian reservations, and the institution of this policy promises a more rational and effective administration of our Indian tribes.—CLARK WISSLER

ALPHABETICAL GUIDE TO BIRD EXHIBITS.

AN “Alphabetical Guide to the Bird Exhibits,” recently issued by the American Museum, supplies in pocket form, at the cost of five cents, information in regard to exhibits which tells the visitor what is on display as well as exactly where it may be found.

OCEANIC BIRDS OF SOUTH AMERICA.

TOWARD the end of the year the American Museum will issue as a special publication a two-volume work by Dr. Robert Cushman Murphy, entitled *Oceanic Birds of South America*. It will be illustrated by upward of fifty maps, many other text figures, photographs, and sixteen plates in color from paintings by Mr. Francis L. Jaques.

The book is based upon field work by Doctor Murphy and other representatives of the Museum, and particularly upon the circumnavigation of the continent conducted during the years 1912 to 1917 by Mr. Rollo H. Beck, an undertaking supported by two Trustees, Mr. Frederick F. Brewster and Dr. Leonard C. Sanford. The scope of the study includes the islands in all oceans around South America, even to points as distant as Ascension, St. Helena, Juan Fernández, the Galápagos, and the American quadrant of Antarctica. In no other single book are maps and chapters on the regional geography of such localities to be found.

Part I of the publication deals with American Museum expeditions, the physiography, meteorology, and oceanography of the several environments, and the physical characteristics of the four oceanic life zones of the southern hemisphere with regard to the ranges of sea fowl. The distribution of reef corals, kelp, mangroves and seaboard vegetation, invertebrates, fishes, seals, and other organisms is discussed in correlation with that of coastal birds. There are sections devoted to guano, to ocean currents, to the nutritional basis of marine life, and to a topical description of the entire South American shore line.

Part II comprises life histories of about 170 species of marine birds, with special emphasis upon interpretation of behavior and the factors which have determined the ranges. The text for each family is preceded by a general account describing the place of the group in South America, with reference to ultimate source and the routes of dispersal in so far as these are indicated.

EXOTIC AQUARIUM FISHES. By William T. Innes. Innes Publishing Company, Philadelphia. 460 pp. 290 illustrations, 41 color plates. Price \$5.

DR. INNES has achieved the author's dream. His book has appeared as he wrote it and in the form he planned. The mechanical production was done by the author's own firm, and he has thus

been able to give full justice to his subject in details of paper, printing, and the reproduction of his pictures, even to having the pictures where they belong, instead of pages away from the fish to which they refer. As a final touch, the handsome binding is waterproof!

The technical (taxonomic) details of the book were edited by an ichthyologist, Dr. George S. Myers of the National Museum, who also helped with the distribution maps. These maps show the world distribution of the more important families, and the end papers form world maps to which a key reference indicates the points from which each species has been collected. This is a very complete book, and contains a wealth of information about collecting, transporting, selling, breeding and caring for tropical fishes. The photographs are adequate and very beautiful. It is a well-made book both externally and in content.—F. LAMONTE

FISHES AND THEIR WAYS OF LIFE. By Louis Roule. Translated from the French by Conrad Elphinstone. W. W. Norton & Company, New York, 1935. 312 pages. 52 text-figures. Price \$3.75.

DR. ROULE, who is on the faculty of the Natural History Museum in Paris, has covered an immense range of subjects in his latest popular book. The nineteen chapters, dealing with everything from the ingredients of that famous fish stew, bouillabaisse, to sharks' teeth, poisonous fishes, and the mechanics of respiration, are brought into some sort of unity through the author's personal philosophy derived from his experience as a naturalist.

Due to his pleasant, unhurried style, everything Doctor Roule writes is good reading, and in this connection high praise should be given to Mr. Elphinstone's fine translation. There are, however, three chapters of the book that stand out particularly—those concerned with organic correlation. To quote from the chapter entitled "The Sun-Perch and the Catfish," which is in the form of a conversation between a father and son on the subject of acclimatization:

"Think, for a moment, of the body which all creatures possess. It is made up of juxtaposed organs . . . All are fashioned for the work they have to do and their particular condition is thus determined by that of its neighbours. To this state of affairs we give the name 'organic correlation'. There is equilibrium among all. If one were to increase out of proportion, or were replaced or taken away, its neighbours would feel the consequences, and a new equilibrium would have to be established. So with species living in a definite place; they are in mutual relation as it were, as the organs are to the body.

"Nature has a biological correlation as well as an anatomical correlation. The species coördinate

the needs of life as between themselves. They have a toleration and a balance of their own. This equilibrium varies in its details, but is maintained as a whole . . ."

This equilibrium relates to all the external circumstances reacting on the creatures—water temperature, composition, content, etc., but the main consideration is that of food supply. In this chapter and the chapter on carp farming, called "Scales, Mirrors, Leathers," Professor Roule discusses the points to be considered in the introduction of foreign species, both in respect to the new fishes, and the upsetting of balance for the old. In the interesting chapter on "The Whitefish of Lake Geneva," he uses this lake as an illustration of a limited area with a material equilibrium of its own.

The author's enthusiasm and his kindly, comfortable philosophy seem to be the natural result of having himself attained the balance he so clearly explains in the concrete and so obviously considers necessary to life in any aspect.—F. LAMONTE

COMPARATIVE PSYCHOLOGY. By F. A. Moss and others. Prentice-Hall, Inc., N. Y. C.

IN recent years the number of colleges offering courses in behavior has greatly increased. Graduate laboratories have been making so many important contributions to the field that a text book summarizing these recent discoveries has been very much desired. At last twelve eminent students of animal psychology have coöperated in producing a work which is both stimulating and authoritative. Naturalists will be especially interested in the chapters by Doctor Stone of Stanford University on motivation of animal behavior and the maturation of instinctive functions. They will also be attracted by the chapter on social psychology by Doctor Tinklepaugh, formerly of Yale University. Moreover, they will find a wealth of information in other chapters which could profitably be made to form a basis of their thinking when analyzing the behavior of animal life in the wild state.

Animals are often described by naturalists as being conditioned to certain stimuli. Doctor Liddell of Cornell University has reviewed in one chapter the field of conditioned reflexes, including his own important studies, and has shown that the concept has a wider application than formerly assumed. Considerable space in the book has been devoted to the problem of learning. The late Doctor Franz, of the University of California, has a chapter on the relation of learning to brain structure. Doctor Heron, of the University of Minnesota, has two chapters which give a splendid review of the forms of apparatus employed and the results secured in the study of animal learning. Doctor Tolman, of the University of California, has reviewed the theories of learning. Especially

significant is his discussion of the "field theories" of learning, including the much discussed Gestalt theory.

Animal psychologists have borrowed very heavily results from the physiological laboratories. It is to be regretted that they have found so little of use from the voluminous writings of modern naturalists. The reason for this seems to be that with few exceptions naturalists have not introduced experimental methods into their studies. Until some experimental check has been made of their conclusions, the animal psychologists prefer to ignore them. It is to be hoped that the naturalists will remedy this situation by studying the data which these psychologists have presented and then show their relation to their own field. For the present the intelligence of an animal must be rated in terms of its ability to master and remember complex problem boxes or other laboratory apparatus. There are hosts of problems which the animal in nature is called upon to solve, and surely these must be taken into consideration if one is to secure an adequate picture of the animal's mental life. In brief, the book stands as a challenge to naturalists to summarize and correlate their data in order that such data may be utilized by serious students of animal behavior.

As Professor Thorndike states in the first chapter of the book, "A human mind is the product of original unlearned tendencies and the experiences of life. The former, man possesses as part of his human inheritance, just as he possesses a backbone, erect stature, small forelimbs, and a large brain . . . The study of animals not only supplements human psychology and helps to solve problems arising therein: it also suggests new problems and new methods for human psychology." Doctor Tinklepaugh in his discussion of "gifted" animals adds: "Though great caution is necessary in the interpretation of animal behavior, Morgan's Canon has led to anthropomorphic phobia that have no place in scientific psychology. The discovery of a type of behavior in animal that is present in man seldom justifies redefining and renaming the behavior of the animal on the *a priori* basis that animals are incapable of behavior at such a level." For example, frequent reference is made in the book to the recent discoveries of insight or reasoning in lower forms. It was not so long ago that only man and the apes were supposed to be capable of sizing up a situation at a distance and coming to a conclusion on the basis of the relations of the objects one to another. Again only recently it was taught that kinaesthetic or muscle sense was the chief sensory modality employed in maze learning, but the new data show ". . . that the best explanation . . . is that the maze habit is controlled by some sort of central mechanism that will function independently of all sensory cues." Even in many of the lower animals ". . . learning

appears to involve something more than the mere formation of new stimulus-response connections or the stamping in and stamping out of old ones. The final response in all such cases appears rather as in some degree independent of present stimuli, and as controlled in part by temporarily absent, or by indirect, relatively distant features of the total situation."

Briefly, the recent discoveries in animal psychology have shown that the mind of animals is more like that of man than has been hitherto supposed. The textbook which these twelve psychologists have produced will be of great service not only to the student of animal behavior but also to the naturalist and nature lover who wishes a summary of the recent discoveries in the field of animal psychology.—G. K. NOBLE

HOW TO RIDE YOUR HOBBY. By A. Frederick Collins. D. Appleton-Century Co., New York. 298 pp., \$2.

ANYONE who may believe that collecting stamps, coins, or autographs practically exhausts the possibility of a hobby for the average person, will be greatly enlightened by a perusal of *How to Ride Your Hobby* by A. Frederick Collins. Since new economic conditions tend to give business men and women more and more leisure time, the book is especially timely.

Mr. Collins has compiled an exhaustive collection of things to do for pleasure that should suggest a hobby to anyone who is interested in finding one. He does not attempt to give detailed information about each occupation—just enough to catch the imagination and start the interested reader on the path of research. It is pleasing to see that a considerable number of ideas have been included that are in the line of nature study and scientific work.

—D. L. E.

RICHARDS CYCLOPEDIA. Edited by Ernest Hunter Wright and Mary Heritage Wright, 24 vo. in 12 books, pp. 6540. J. A. Richards Inc., New York, 1933.

WITH the publication of *Richards Cyclopedia* comes a new meaning to the old verse, "The world is so full of a number of things, I think we should all be as happy as kings." This set of twenty-four volumes bound into twelve books gives a colorful and interesting picture of important information in the fields of human endeavor and knowledge, including history, art, science, industry, travel, exploration, government, economics, invention, and biography.

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A child would find nothing irksome or hard to understand, nor would an adult find anything to affront a sophisticated intelligence. Its 6540 pages radiate clarity and charm, and the 12,000 illustrations would delight even the least visual-minded person. Many of these illustrations are taken from American Museum material and will serve to disseminate the importance of Museum groups and exhibits in the inventory of human knowledge. In addition to the many four-color plates there are 164 pages of maps printed in six colors, including a complete atlas of the world. An excellent bibliography of readable and authentic books, including the author's name, the age level to which the book is adapted, the name of the publisher, and the price will be found to be of invaluable assistance to parents, teachers, and librarians.

A new and rather unique arrangement has been used in the compilation of this cyclopedia. Long articles, such as "The Magic of the Camera" or "The Story of the Sea," have been divided into chapters which are printed all in one volume but with various unrelated subjects interspersed between them. The purpose of this is to enliven the interest in one comprehensive subject by cutting it to bits and serving it to the reader on a silver platter of imaginative captions. In the "Story of the Weather," for example, the first chapter commands our curiosity by the captions, "How the Weather Makes History—We have learned to outwit the weather, though we should never have become civilized men without its whims"; and the next chapter on the weather reads, "An Ocean of Air—Floating in thin substance that we cannot see, we get all our weather from it"; and still a later chapter is headed, "Blow, Winds, Blow—The

breezes that fan our farms and cities are just as useful as those that bring the sailors home from the sea." At the beginning and the end of these separate chapters will be indicated to the reader the page from which the story was continued and on what page the next chapter will be found, though for a child's mind one short exciting phase of the subject may suffice his curiosity. The entire story can be found without further reference to an index and without taking another volume from the shelf. Although I can appreciate the advantages of this curious arrangement for an immature mind unable to focus attention on one subject through the entire treatment of that subject, nevertheless I find it a bit disconcerting to have my "Story of the Weather" punctuated by articles on the "History of France" and the "Art of Swimming."

The importance of *Richards Cyclopedia* as a distinct contribution to modern educational methods cannot be overstressed. It is tangible evidence that the fields of learning can be translated into a popular and dramatic story, dignified, accurate, and equally helpful to young and to old.

—AGNES G. KELLY

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Henry Fairfield Osborn

Educator, Administrator, Scientist, who guided the American Museum for a generation

[This outline of Professor Osborn's life was presented at a meeting of the Scientific Staff of the American Museum of Natural History, November 7, 1935. A special memorial is being planned with the collaboration of the well known scientists who have been associated with Professor Osborn. This conference covering various phases of his great life and work will be fully dealt with in a future issue of NATURAL HISTORY.]

OUR beloved former president, Henry Fairfield Osborn, died suddenly of heart failure at his home at Garrison-on-Hudson, New York, on Wednesday, November 6, 1935, at the age of seventy-eight. It is exceedingly difficult to express adequately our sorrow in losing this steadfast friend and great leader. His human contacts were so numerous and so uniformly helpful to others that a great many people will deeply mourn for him. In fact, his good deeds on every side were so manifold that we know not where to begin. Nevertheless, we must attempt a brief outline of his life, as follows:

He was born on August 8, 1857, at Fairfield, Connecticut, the son of William Henry Osborn and Virginia Reed Sturges Osborn. His ancestry on both sides was of the best and his very able and devoted parents left nothing to be desired in the influences that moulded his childhood. While he was still quite young, his father built a smaller house, "Wing-and-Wing" (1881) near his later residence, Castle Rock, at Garrison, New York, overlooking the Hudson River, opposite West Point. In this delightful home and environment the young Fairfield early showed his interest in natural history. As a student at Princeton he

came under the influence of the famous Doctor McCosh and was so much attracted by the subject of philosophy that he undertook several studies in psychology and philosophy which were published as brief papers at intervals from 1880 to 1884.

Palæontologist

Meantime, however, through Professor Guyot of Princeton, he became interested in palæontology, and in 1877 he, together with his friends W. R. Scott (who was destined to remain as his life-long colleague) and Francis Spier, Jr., organized and carried to a very successful conclusion the Princeton scientific expedition of 1877; this expedition explored the Bridger Basin in Wyoming and brought back many important specimens of new and little known Eocene mammals. From 1878 to 1880 he worked as a graduate student and (1881-1890) instructor at Princeton. In those days evolution was the burning topic of interest in all universities and before palæontology had supplied the direct evidences of evolution, embryology and comparative anatomy were looked to as its principal supports. Osborn at that time, as later, saw that all three sources of evidence should be studied together.

In 1879-80 therefore he went to England for advanced graduate work at Cambridge University with the great embryologist Balfour. Later he went to University of London, where he became the pupil of T. H. Huxley and ardently studied comparative anatomy under that inspiring teacher. We see in his early study on the foetal membranes of the opossum and other marsupials signs of his ability to choose subjects of strategic importance. The same is true of his studies on the

origin of the corpus callosum of the mammalian brain; in his rather extended paper on the principal fibre tracts of the brains of amphibians he opened up a line of investigation which has been carried on by, among others, Prof. C. J. Herrick, who gladly acknowledges the importance of Osborn's pioneer studies. In fact, between 1883 and 1887, comparative neurology may be said to have been his principal subject, and with the assistance of Dr. Oliver S. Strong, he planned to write a general work on comparative neurology.

Gradually, however, his papers in vertebrate palæontology became more numerous and, after another extended residence in England, he completed his memoir on Mesozoic Mammals (1888), which again demonstrated his ability to choose a subject of major importance and to extract from it far-reaching results. For it was the Mesozoic Mammals that carried back the history of the mammalian molar teeth to a very distant date, when the triangular or so-called tritubercular molar crown was in its initial stages. He therefore endorsed Professor Cope's theory of the origin of the tritubercular molar, adding many original evidences and observations of his own and early developing an ingenious system of naming the principal cusps of the upper and lower molars, which system has since been adopted by the palæontologists of the world. While giving every due credit to Cope, he proceeded to apply his own nomenclature in detail to the complex molar patterns of ungulates and showed how, with this tritubercular key, as he called it, one could unlock and open up the most complicated molar patterns, analyzing their parts and reading the history of the group.

Zoologist

In 1891, through the coöperation of President Seth Low of Columbia University and President Jesup of the American Museum, Professor Osborn was invited to take up his residence in New York and to become, on the one hand, Da Costa professor of zoölogy at Columbia University and on the other, founder and curator of the department of vertebrate palæontology in this Museum.

At Columbia he was the leader in organizing the new department of zoölogy. With the assistance chiefly of Doctors E. B. Wilson, Bashford Dean, and Oliver S. Strong, he soon developed a very progressive and successful de-

partment. During this period he founded the Columbia University Biological Series and brought out therein his book *From the Greeks to Darwin*, which attracted wide attention. He also arranged the publication in the same series of Willey's *Amphioxus and the Origin of the Vertebrates*, Dean's *Fishes, Living and Fossil*, and Calkins' *The Protozoa*. For almost a decade he served actively as Dean of the School of Pure Science, and as the time came nearer for Columbia to move to its new site at Morningside Heights, he became responsible for the planning of the lecture rooms, laboratories, and offices of the department of zoölogy in Schermerhorn Hall, the corner stone of which was laid in 1896. Meanwhile he was conducting courses in neurology, comparative anatomy and palæontology in the department. Doctors Gary N. Calkins, J. H. McGregor, Henry E. Crampton and the present writer, all of the same department, were his own graduate students. About 1903 he began to transfer to the American Museum the greater part of the lectures and laboratory work of his graduate courses "Evolution of the Vertebrates" and "Mammals, Living and Fossil." In 1907 he handed over these courses to the writer for further development and they are still being conducted at the Museum. His regular teaching work at Columbia ceased in the year 1910, when he was appointed Research Professor in Zoölogy and generously turned back his salary into the department.

Chiefly through his efforts the Museum acquired the private collection of fossil vertebrates which had been amassed by his friend Prof. E. D. Cope of Philadelphia. He soon gathered around him an able staff: Dr. J. L. Wortman as assistant curator, Mr. Adam Hermann as chief preparator, and others. Then under his vigorous and efficient direction was begun that great series of field explorations for fossil vertebrates which has never ceased to this day. To make a very long story short, the building-up of the department of vertebrate palæontology through forty-five years of his continuous activities is regarded by some as his greatest single achievement.

He derived great inspiration and enjoyment from his numerous palæontological field trips, especially in the western states but also in Egypt and Mongolia and in his trip around the world.

At the time of his death he was the author of 940 articles, papers, books, monographs, etc., listed in his bibliography. It is obviously impos-

sible to refer in detail to this astonishing output; but it seems very safe to state that among his most important contributions to science were the following:

- 1) His initial studies on the origin of the corpus callosum of the mammalian brain;
- 2) His memoir on the Mesozoic Mammals;
- 3) His numerous contributions to the study of the evolution of mammalian molar teeth to and beyond the tritubercular type;
- 4) His many important papers and monographs on the fossil rhinoceroses, titanotheres, horses, and proboscideans;
- 5) His great textbook on "The Age of Mammals."

With regard to the theory of evolution, his outstanding principles, or laws, as he called them, include the following:

- 1) The law of continental and local adaptive radiation;
- 2) The law of *homoplasy* or parallel but independent evolution in related lines of descent;
- 3) The law of *tetraplasy*, whereby evolution results not from the operation of single causes, but as the resultant of forces from four principal directions (external environment, internal environment, heredity, selection);
- 4) The law of *alloiometry*, or adaptive modification of dimensions of the skull, feet or other parts, arising independently in different lines of descent;
- 5) The law of *rectigradation*, or *aristogenesis*; i. e., the gradual appearance during long ages of new structural units of adaptive value, predetermined in the germ plasm and in their initial stages independent of natural selection;
- 6) The law of *polyphyly*; i. e., the normal occurrence of many related lines of descent, derived eventually from a common stock, but coexisting throughout great periods of time.

Professor Osborn's contributions to science were recognized by his election as Foreign Member of the Royal Society of London, as Honorary Fellow of a long series of other distinguished societies in Great Britain, France, Belgium, Holland, Germany, Russia, Sweden, Italy, and other countries of Europe; also of China, Persia, Argentina, Mexico, Cuba. In this country he was an active member of the National Academy of Sciences, of the American Philosophical Society for Promoting Useful Knowledge, the American Academy of Arts and Sciences, the New York Academy of

Sciences and many others. He was president of the New York Academy of Sciences in 1898-99, president of the American Association for the Advancement of Science in 1928. For many years he was chairman of the executive committee and later (1909-1924) the very active president of the New York Zoölogical Society. He was the recipient of many medals awarded in recognition of his scientific labors, including the Darwin Medal of the Royal Society of London, the Wollaston Medal of the Geological Society of London, the *Prix Albert Gaudry* awarded by the Geological Society of France, the medal of the Pasteur Institute of Paris and many others.

Administrator

In 1899 Professor Osborn became closely associated with President Jesup in the administration of the American Museum and upon the death of Mr. Jesup in 1908 he was elected president of the Board of Trustees. From that day until his retirement to the position of Honorary President in 1933, he carried a vast burden upon his strong shoulders. During this period, and thanks in large part to his able leadership, many buildings were added in response to ever-growing pressure of collections and exhibits. Undoubtedly not even he could have accomplished all this if he had not budgeted his time so effectively and concentrated so intently upon one thing at a time.

On the personal side, Professor Osborn was sincere, benign, urbane, without guile, very loyal in friendship and highly appreciative of loyalty in others, extremely helpful, especially to his students and assistants. He consistently respected the right of his colleagues and assistants to differ with him in the interpretation of scientific problems.

He loved young people and delighted in furthering their education along broad and thorough lines. His wife, Lucretia Perry Osborn, until her death in 1930, was at all times a most able and enthusiastic partner. His children and grandchildren survive to cherish his memory.—W. K. G.



An Equatorial Wonderland

The Galápagos—a country of great volcanoes, giant tortoises, and flightless birds

By JOSEPH R. SLEVIN

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WHEN Dr. William Beebe wrote *Galápagos: World's End* he turned a spotlight on one of nature's outposts seldom visited by any but the whaler, buccaneer, man o' war's man, and last but not least the naturalist. Doctor Beebe's *The Arcturus Adventure* further whetted the appetite of several yachtsmen, and palatial yachts carried their owners there to have a first-hand view of this wonderland.

The Galápagos, or Tortoise Islands, furnish one of the world's last outposts where nature has, at least in part, been untouched by the hand of man, and were so named by the early Spanish explorers on account of the thousands of gigantic land tortoises which formerly inhabited them; *galápagos* being the Spanish word for tortoise.

Although these Enchanted Islands, as they were also called by the Spaniards, have been a land unknown to the world at large, they have been the object of intensive study by naturalists for the past one hundred years, beginning with the immortal Darwin, whose account of his voyage on the "Beagle" has become a classic, and ornithologists look with satisfaction upon the fact that it was his observations and study of the birds that first turned his attention to the various problems of evolution.

Whether Tupac Yupanqui, the eleventh

King of the Incas, when he set out to the westward to see what was beyond the horizon and to seek riches in unknown seas, was the first mariner to sight the Galápagos must always remain a mystery. The accounts of his voyage are merely legendary, the little we know about the Empire of the Incas being from traditions gathered by the early Spanish explorers.

The first description

Historians are more inclined to credit the discovery to Fry Tomas de Berlanga, the third Bishop of Panama, who, in the year 1535, at the command of his king, set out on an official visit to Peru. From the account of his voyage his little vessel must have been becalmed and caught in the current setting out toward the Galápagos; and as he mentions that on landing he found enough water to fill his casks, it is probable that he visited either Charles or Chatham islands. It is from the Bishop of Panama that we get our first description of the Galápagos when he speaks of the utter desolation before him, the tameness of the birds, and giant tortoises large enough to carry a man on their backs.

After the discovery of the Galápagos by the Bishop of Panama they were visited intermittently for the next three hundred years by the early mariners and the old buccaneers, and we read of such famous men as Davis, Wafer, Dampier, and Cowley, who made the first chart of the islands, having touched their shores.

It is no wonder that the early explorers spoke of the utter desolation of these great lava piles, for such is what they really are. Great mountains of lava reach skyward, some with craters six miles in diameter, lava-flows,

(Opposite page) Land iguana—South Seymour Island, Galápagos. Photo by W. C. Swett. Courtesy G. Allan Hancock Expeditions

like huge alluvial fans, stretch from the crater rims to the forbidding shores, making the entire scene appear as a land that God forgot. But this is only one view of nature's wonderland.

Lava-flows versus jungles

Delightful sea breezes carry the moisture-laden clouds from the south and bathe the southern slopes of the great volcanoes with mist and rain, causing the higher elevations to become almost impenetrable jungles. Here rank growth covers the lava flows of past centuries, and great ferns, morning-glory vines, and the beautiful Canna leaves remind the explorer of the tropical jungles of the mainland. Below him lie great stretches of arid country, with a heavy growth of cactus, or flows of barren lava too fresh for vegetation to have gained a foothold. Perhaps the traveler may pass through a belt of tropical growth and emerge upon an open grassland surrounding a crater rim, and with blue sky above, look down on the rain clouds drenching the forest below. These are the sights that will greet only the hardy traveler, as this wonderland has not fallen entirely under the hammer of a commercial world, and it requires hard work to enjoy its marvels.

Mangrove thickets along the shores hide from view immense lagoons, veritable marine gardens not excelled in any waters, where sharks, turtles, gaily colored fish, and an abundance of marine life may be observed.

Sad to relate, the unique fauna of the Galápagos has suffered considerably and it is now in the greatest danger of extermination. If drastic steps are not taken to preserve what remains, it will go the way of the dodo and the great auk, truly a sad fate.

Situated on the equator some 650 miles off the coast of Ecuador, to which country it belongs, the archipelago extends from Lat. $1^{\circ} 30'$ south to $1^{\circ} 40'$ north and from Long. 89° to 92° west. Albemarle, the largest of the group, is about seventy-five miles in length and about forty-five in width at its widest part. Nine smaller islands and many islets, many of which are mere rocks, go to make up the remainder of the archipelago.

The islands are strictly volcanic and besides the huge craters, such as are found on Albemarle, there are innumerable minor ones. Some of these show activity at the present time,

although no eruptions of great magnitude have been reported in late years. Probably the last to be reported was by Capt. Benjamin Morrell, who, when cruising about the islands in search of fur seals, observed a terrific eruption on Narborough Island in February, 1825. The heat from the eruption made the heavens appear to be one blaze of fire intermingled with millions of falling stars and meteors, and on Morrell's ship, the "Tartar," anchored ten miles to the northward of the erupting crater, the thermometer rose to 123° , causing the pitch to run from the vessel's seams and the tar from the rigging, while some of the crew complained of extreme faintness. Fortunately a light breeze sprang up and the "Tartar" got under way, sailing through the narrow strait between Narborough and Albemarle, where Morrell found the water to be 150° . Three days later, when the "Tartar" anchored at Charles Island, the crater was still shooting forth flames, appearing as a colossal beacon light and emitting a noise like distant thunder. Volcanic activity no doubt is frequent among the minor craters, especially on Albemarle and Narborough islands, and has been reported by several expeditions of late years, notably that of the California Academy of Sciences in 1905-1906, by Dr. William Beebe in 1925, and by the expedition of Capt. G. Allan Hancock in 1927-1928, when on passing Mangrove Point, Narborough Island, he observed molten lava pouring into the sea through a subterranean tunnel in the lava field.

Naming the islands

It was the custom of the early Spanish navigators to name their discoveries after the feast day on which they were made, so they gave to different islands of the archipelago such names as San Salvador, Santa Maria, San Cristóbal, Isabela, and Santa Cruz; in later years the English named them after their kings, earls, dukes, and ships of war; so, in addition to the Spanish names appearing on the charts, the English names, James, Charles, Chatham, Narborough, Indefatigable, and Daphne are given, the latter two islands being named after the British men of war "Indefatigable" and "Daphne."

The present-day charts of the Galápagos are based mainly on the surveys of His Majesty's ships "Beagle," "Egeria," "Daphne," "Pandora," and "Sappho," the additions and

corrections from year to year being furnished by visiting vessels.

As a land for colonists the Galápagos must be considered as negligible owing to the lack of soil and the great distance from world markets. Their greatest importance, other than a wild life sanctuary, lies in their geographical position in relation to the Panama Canal.

Notwithstanding the fact that the islands lie directly on the equator the climate is delightful. The cool Humboldt current, flowing from the Antarctic regions along the coast of Peru and setting to the westward when it reaches the latitude of Cape Blanco, bathes the shores of the Galápagos, creating a moderate temperature, the thermometer ranging between 70° and 80° Fahrenheit.

The prevailing winds blow from the southeast and are fairly regular from June until January, but at other times the waters surrounding the archipelago are subject to long periods of calms, and unfortunate is the vessel depending on sail alone for its motive power.

Later explorers

For much of the later knowledge we have concerning the natural history of this wonderland we are indebted, first, to Mr. Rollo H. Beck, veteran naturalist and explorer, who has made several visits to the islands, and who was in command of the expedition of the California Academy of Sciences in 1905-06, the most extensive scientific expedition ever undertaken to the Galápagos, and to Capt. G. Allan Hancock, patron of scientific activities, who, on his steamship "Oaxaca," and later his exploration cruiser "Velero III," has proved a generous host to various students eager to follow the trail of Darwin. Messrs. Templeton Crocker, Vincent Astor, and William K. Vanderbilt on their yachts "Zaca," "Nourmahal" and "Ara" have extended like courtesies, and Dr. William Beebe's writings on these Enchanted Islands have entertained innumerable book lovers.

The most curious and grotesque inhabitants of this wonderland are the giant land tortoises, huge reptiles modified for a purely terrestrial life and not to be confused with the sea turtle, a strictly marine reptile. Giant land tortoises were widely distributed over the earth during the Miocene and Pliocene periods, but the only places where they have existed in recent and

historic times are on certain islands of the Indian Ocean and on the isolated Galápagos which harbor the last remnant to be found in their natural or wild state. Ideal conditions no doubt cause these tortoises to assume such gigantic proportions and individuals weighing five hundred pounds have been recorded.

The giant land tortoises

Although Fry Tomas de Berlanga on his discovery of the islands was the first to mention the presence of the giant tortoises there, it is to the English freebooter and explorer William Dampier that we owe our first extended account of these aborigines of the Galápagos. In the year 1684 he wrote "They are extraordinary large and fat, and so sweet, that no pullet eats more pleasantly." Many other of the early navigators speak of these huge reptiles, and Captain David Porter, of the U. S. Frigate "Essex," wrote "We began to lay in our stock of tortoises for which every vessel anchors at the Galápagos Islands. Four boats were despatched every morning for this purpose, and returned at night, bringing with them from twenty to thirty each, averaging about sixty pounds. In four days we had as many on board as would weigh about fourteen tons, which was as much as we could conveniently stow."

The giant land tortoises are strictly vegetarian and feed on cactus, grass, and almost any type of vegetation that may be at hand. They do not absolutely need water for their existence, but drink large quantities when it is available. The heavy showers during the rainy season fill the depressions in the soil and lava boulders and make semipermanent water holes, enabling the tortoise to drink its fill.

In their endeavor to reach these water holes the tortoises made trails through the thick undergrowth of the jungle, tearing the vines and crushing down the vegetation with their enormous weight. Along the trails to some of the more frequented water holes the lava boulders have been worn smooth by countless numbers of tortoises sliding over them as they went their way, and it was by following these signs that the hunters were able to locate their prey.

After drinking, the tortoise may seek the shade of some protecting bush and remain throughout the day or lie directly in the pool

from which it had been drinking, provided the sun is not too warm. At times it takes a trained eye to find them, as some of the old patriarchs resemble the rocks about them, both being covered with a growth of lichens, making detection difficult.

During the breeding season, in March and April, the male tortoises become quite active and make a loud bellowing noise which can be heard at a considerable distance. The female, it is said, never uses her voice, and the male only at this particular time. The giant land tortoise is oviparous, laying from eight to seventeen white, globular eggs, with a hard, porous shell, and about the size of a billiard ball. These the female deposits in a hole dug in the soft earth, preferably along a cattle trail or in some opening, where the sun will shine upon the nest for at least part of the day. After covering the eggs with loose earth, she turns about on the nest, packing the earth down by her own weight and leaving a hard crust three or four inches thick. The natural heat of the earth then hatches them.

These huge reptiles can go for long periods without food and for this reason the whalers were able to stow them 'tween decks, where they would live for four or five months without the least nourishment. One tortoise is reported to have lived for two years in the hold of the ship "Niger," of New Bedford. It had disappeared shortly after the vessel left the Galápagos and two years later was found among some casks in the hold.

Enemies of the tortoises

The natural enemies of the land tortoises are the rats and the wild dogs, both importations from visiting ships. The rats are very numerous on some of the islands and are the greatest enemy of the newly hatched tortoises, while the dogs destroy both these and the adults. These dogs have developed wonderfully strong jaws and by breaking off pieces on the edge of the shell work in toward the flesh and tender skin, when they literally eat the tortoise out of its shell.

However, two great causes led to the near extermination of these aborigines of the Galápagos; one was the fact that they proved to be a valuable food supply for the whaling fleets of the United States and Great Britain which cruised the waters of the South Seas from 1800 to 1860, and the other was the oil

hunters, by far the worst enemy, who came after the whaler's time. In the year 1793 the British Government despatched Captain Colnett on His Majesty's ship "Rattler" to report on the waters surrounding the Galápagos and to search for anchorages in the quiet waters of the archipelago where ships might haul out for repairs and cleaning. His reports were evidently favorable, for from that time on whaling fleets were constantly in Galápagos waters until the decline of the whaling industry about 1860. The captains of the various whale ships took advantage of the fact that these tortoises were an invaluable supply of fresh meat, and landing parties were sent ashore to hunt "terrapin," as the tortoises were known to the whalers. Occasionally men from these shore parties were lost and abandoned to their fate when searching parties failed to find them, their captains hoping they would be picked up by another ship.

Food value of the tortoises

Logbooks of some of the early whalers show that they took on board more than two hundred tortoises at a time, so it can be easily seen what inroads were made upon them when we consider that the fleets of both the United States and Great Britain cruised these waters for over sixty years. American whalers took more than ten thousand tortoises off the islands between the years 1831 and 1836. It is quite evident that the slaughter must have been appalling when we add to the American whalers the British whalers, men o' war, and buccaneers who frequented the islands for many years.

Some of the early navigators transplanted tortoises to other islands, notably Delano, who, in 1818 took three hundred tortoises to Mas Afuera Island off the coast of Chile, where unfortunately most of them perished. Capt. David Porter carried a number to Rotumah Island on the U. S. Frigate "Essex," where he distributed some among the chiefs and turned others loose. One of these tortoises had a particularly interesting history. In the year 1866 it was brought to Sydney, Australia, on the whaling schooner "Ida," where it lived until 1896 and then was removed to London, where it died in 1898.

The worst enemy of the tortoises, the oil hunters, carried on a ruthless warfare against

all the large-sized individuals, as they possessed the greatest amount of fat. The simple equipment of the oil hunter—a few casks and a boiling pot—enabled him to move with ease from place to place, and the killing off of the tortoises in a particular locality was only a matter of days, or at best weeks. It was this that caused the appalling slaughter around the water holes and was the chief factor in their near extermination.

The sea iguanas

Next to the tortoises in the point of interest is the sea iguana, a large marine lizard, reaching a length of five feet, and the only one in the world solely dependent on the ocean for its food. It never leaves the immediate vicinity of the water and is generally found basking in the sun along the barren lava coastline, where it feeds on the sea lettuce uncovered by the outgoing tide. The sea iguana may be found individually or in pairs, or perhaps in great herds, which when moving give the impression that the ground under one's feet is in motion. Although armed with strong, sharp teeth, it is extremely docile, never offering to bite. It is abundant on most of the islands and outlying rocks of the archipelago, being most notably absent on Chatham and Charles islands, where the wild dogs have either driven it off on to outlying rocks or killed it for food.

Although an excellent swimmer, the sea iguana does not take readily to the water and, if thrown in, will immediately swim to land and climb to safety, its timidity being due no doubt to the sharks infesting these waters and which would find a sea iguana quite a tempting and dainty morsel. A somber black and red during most of the year, the iguana, during the breeding season, is covered with large blotches of green which become metallic in their lustre as the sun's rays strike them. The large conical scales on the top of the head become a pure white and the iguana is then a real study in color. The sea iguana is not eaten by the natives, but Lieutenant Shillibeer R.M., of the British Frigate "Briton," who visited the islands in 1814 says the sailors esteemed them as a most delicious food.

The land iguana, with its red body and bright yellow head and feet, is a grotesque looking creature as it sits on top of a lava boulder, bobbing its head up and down while

keeping an eye on the intruder. Too close approach will send it shuffling off with an awkward gait as it makes for the shelter of a friendly rock pile. In captivity it becomes quite docile, but on its native heath it has rather a ferocious disposition, and with its sharp tricuspid teeth and powerful jaws can bite clean to the bone, inflicting serious injury. Like the sea iguana the land iguana is a vegetarian and feeds on the leaves of the cactus and various plants that have succulent leaves, thereby getting sufficient moisture, as no water is available.

It apparently has no natural enemies, and only occasionally is it used as food by the natives; but dogs introduced by visiting ships have run wild over some of the iguana islands and have exterminated whole colonies of the animals, so that they survive in any numbers only on South Seymour and Narborough islands, where fortunately no dogs have ever been turned loose. When the famous naturalist Charles Darwin landed on James Island in 1835 during the cruise of the "Beagle," the burrows of the iguanas were so numerous that he had difficulty finding a spot on which to pitch his single tent. At the present day a few scattered and deserted burrows are all that remain to show where these great colonies had been.

Other reptile population

The widely distributed marine turtle commonly called the green turtle, the yellow-bellied sea snake, the little nocturnal lizards known as geckos, a few species of small, harmless land snakes, and the lava lizards make up the rest of the reptile population. Probably all of them would be of only casual interest to the visitor, with the exception of the lava lizards, whose tameness and curiosity might excite his wonder and attract more than passing attention. However, to the student these lava lizards are of particular interest as they furnish strong proofs regarding the formation of the archipelago and the breaking up of a single large land mass to form the group of islands that exists at the present day.

A visitor to the Galápagos will be attracted at once by the tameness of the birds; this is one of the things that so strongly attracted the attention of the Bishop of Panama on his discovery of the islands that he made mention of it in his narrative. Other early explorers made the same remarks, and Cowley, in his

journal, speaks of the little turtle doves as being so tame that they alighted on the gun barrels of the sailors. The same may be said today on the islands that have been the least visited and which have been fortunate enough to escape cats and other pests that have been introduced by visiting ships.

Peculiar native birds

Although there are a few birds of brilliant plumage, such as the little vermilion flycatchers and the flamingos, most of the birds are of somber color and the gorgeous birds associated with the tropics are conspicuous by their absence. However, the peculiarity of some of the birds attracts the visitor, for nowhere else in the world is found the flightless cormorant, a large bird about three feet in height, with rudimentary wings and incapable of flight, as the name suggests, but a fast and wonderful swimmer. With a range restricted to Narborough and the northwest coast of Albemarle this bird would soon become extinct if continually molested. On land it is extremely awkward, waddling along in an ungainly fashion until hampered by rough ground or other obstacle, when it proceeds by a series of jumps until it reaches the edge of the rocks and tumbles off into the water, at once becoming a marvel of grace and speed; lucky is the fish which escapes it. Its bill is a powerful weapon of defense and one which it uses with both force and effect, being able to inflict a severe wound when the bird is thoroughly angered.

The little Galápagos penguin, about twelve to fourteen inches in height, is a never ending source of amusement to visitors, and has been carried off in considerable numbers to be placed in various zoölogical gardens. It is not so restricted in range as the cormorant, but its chief habitat is along the west coast of Albemarle Island. While on land the penguin crawls on all fours, so to speak, using both its flippers and feet, and is anything but graceful; once in the water, however, it is marvelously so and a speedy and powerful swimmer.

Thousands upon thousands of sea birds make their homes in the great bird rookeries of the Galápagos, and the man o' war birds, boobies, pelicans, gulls, etc. are a constant source of wonder to those who have never been fortunate enough to see these feathered creatures in their native haunts. The red-billed

tropic or bosun bird—as it is sometimes called on account of its two long tail feathers which are supposed to resemble a marlin spike—the silken sheen of whose feathers is so admired, is a resident of many of the smaller islands, Daphne in particular, and may be found tucked away in some crevice in the rocks, probably sitting on a beautifully marked egg or protecting its young from the heat of the mid-day sun. Often it is seen high in the air in an irregular and erratic flight, its two long tail feathers clearly visible against the blue sky.

On Hood Island, the southernmost of the archipelago, is found the only known nesting site of the Galápagos albatross. As this bird is absent from the archipelago for part of the year, one wishing to see the colony at the height of the nesting season should time his arrival for about the month of June, and then may witness the curious dancing or fencing of the birds as they stand before each other bowing and rubbing their bills together in a most dignified manner.

Land birds

Of the little land birds, the mocking bird whose unbounded curiosity is astonishing, to say the least, is most amusing. It may follow an intruder around, watching every movement, and if one should stop to rest or take a noonday meal, the mocker will also halt and take the liberty of hopping upon one's foot or knee and pick up the crumbs dropped on the ground. The flycatchers also are inquisitive little fellows and can be approached quite closely without their showing the slightest fear; they may even attempt to alight on one's hat or shoulder.

In other countries hawks are considered shy birds; but not so here. To say that it is possible to approach them with impunity and push them off a limb with a stick seems to out-rival some of the famous fishermen's stories; but such is the case, and we have the camera to prove it—provided you believe that cameras do not lie!! The Galápagos hawk is quite a friendly bird and at times requires considerable persuasion to make it move on.

The little Galápagos pintail, a native duck, shows little or no sign of fear and will swim calmly about, while migrant ducks will be off at the first sound of gunfire.

The great blue heron, one of the wariest of birds in northern countries, while not quite as

friendly as the hawk, will nevertheless allow a close approach. It is found commonly in the lagoons in company with the flamingo and the egret. Its curiosity will sometimes lead it to follow the intruder about and perch on a near-by limb, craning its neck to see what is going on. However, the egret is far more wary, no doubt owing to the fact that it has been shot at by natives anxious to secure the beautiful plumes worn during the breeding season. These are only a few of the feathered creatures of this wonderland, and the bird-lover will find every minute spent here a pleasure and a joy to be forever remembered.

Big game fishes

As a spot for the fisherman it is not to be surpassed, for big game fish abound in the waters about the Galápagos, and fleets of tuna fishermen are almost constantly on the fishing banks in the vicinity of the archipelago. Other great game fishes such as the sail fish, sword fish, and wahoo are also to be found for the devotee of the hook and light line, while the giant mantas or devil fish resembling a huge skate and measuring some sixteen feet across will furnish sport for those who like the excitement of hunting with a harpoon. Shovel-nosed sharks, hammer-headed sharks, and the dreaded tiger shark are abundant and can furnish great sport for the angler.

Those who enjoy the beautiful in nature can spend some time about the tide pools, viewing the minute inhabitants therein. Little fish, no more than an inch in length, will be seen darting about, glistening like jewels in the blue waters and outrivalling the butterfly in variety and beauty of coloring. Minute crimson crabs, brilliantly colored starfish, to say nothing of the numberless grotesque forms of marine life will be a never ending source of wonderment to the explorer.

Although a rendezvous for whalers and buccaneers since their discovery, the Galápagos had no permanent inhabitants until about 1809, when Patrick Watkins, a deserter from an English ship, took up his abode on Charles Island; he finally escaped in a boat stolen from a vessel that had stopped to purchase some fresh vegetables from Watkins, who sold what he could to passing whaling captains. The first real attempt to colonize the islands was made in 1832, when General José Vila-

mil founded a small settlement on Charles Island in the vicinity of what is now known as Black Beach Roads. This colony met with little success and all that remains now to show where it had been is a great lime thicket which has covered the little plateau on the southern end of the island, a few orange trees, and the descendants of the cattle, pigs, dogs, burros, and goats, which run wild over the island. At about the same time a small settlement was on the west side of Indefatigable Island, but all traces of this, with the exception of a few agave plants, have been obliterated. The only permanent settlements for many years which still exist, are located on Chatham Island, in the vicinity of Wreck Bay, and on the southern coast of Albemarle at a point called Vilamil, named after General José Vilamil, founder of the Charles Island settlement. The former consists of a small sugar plantation, served by a trading schooner from Guayaquil; the latter is a still smaller settlement, whose inhabitants ship a small quantity of hides which they secure from wild cattle, and a few tons of sulphur a year dug from a deposit within the rim of the huge crater of Vilamil Mountain.

A few colonization schemes in late years have proved failures, and all that is left of them is the remnant of a party of Norwegians who took up their abode at Academy Bay, Indefatigable Island, where they make an attempt at drying fish in commercial quantities.

A Post Office

Despite the isolated position and the lack of population the Galápagos for many years has had a post office. This consists of a barrel mounted on top of a post and erected at an anchorage called Post Office Bay, Charles Island. When and who erected the first one is not known, but it was in existence in 1813, for it was from this post office that Capt. David Porter of the U. S. Frigate "Essex," while cruising the waters of the Galápagos in search of British whalers, found letters and papers that gave him direct information as to the enemies' ships he might expect to find.

It was the custom to deposit letters in this barrel and ships that were homeward bound would call and pick them up as they were taking departure for their home port. Often they would leave them at their first port of call if this promised quicker transportation to

their destination. Thus whalers two or three years out of port were able to send news home to their owners.

As the barrel became weatherworn and unserviceable, replacements were made from time to time by visiting ships. In 1905 an inscription on the barrel stated that it was erected by His Majesty's ship "Leander." Carved or painted on the post or barrel were the names of His Majesty's ships "Amphion" and "Virago," the French cruiser "Protet," the U. S. S. "Oregon," and the U. S. Fisheries Steamer "Albatross."

A letter's travels

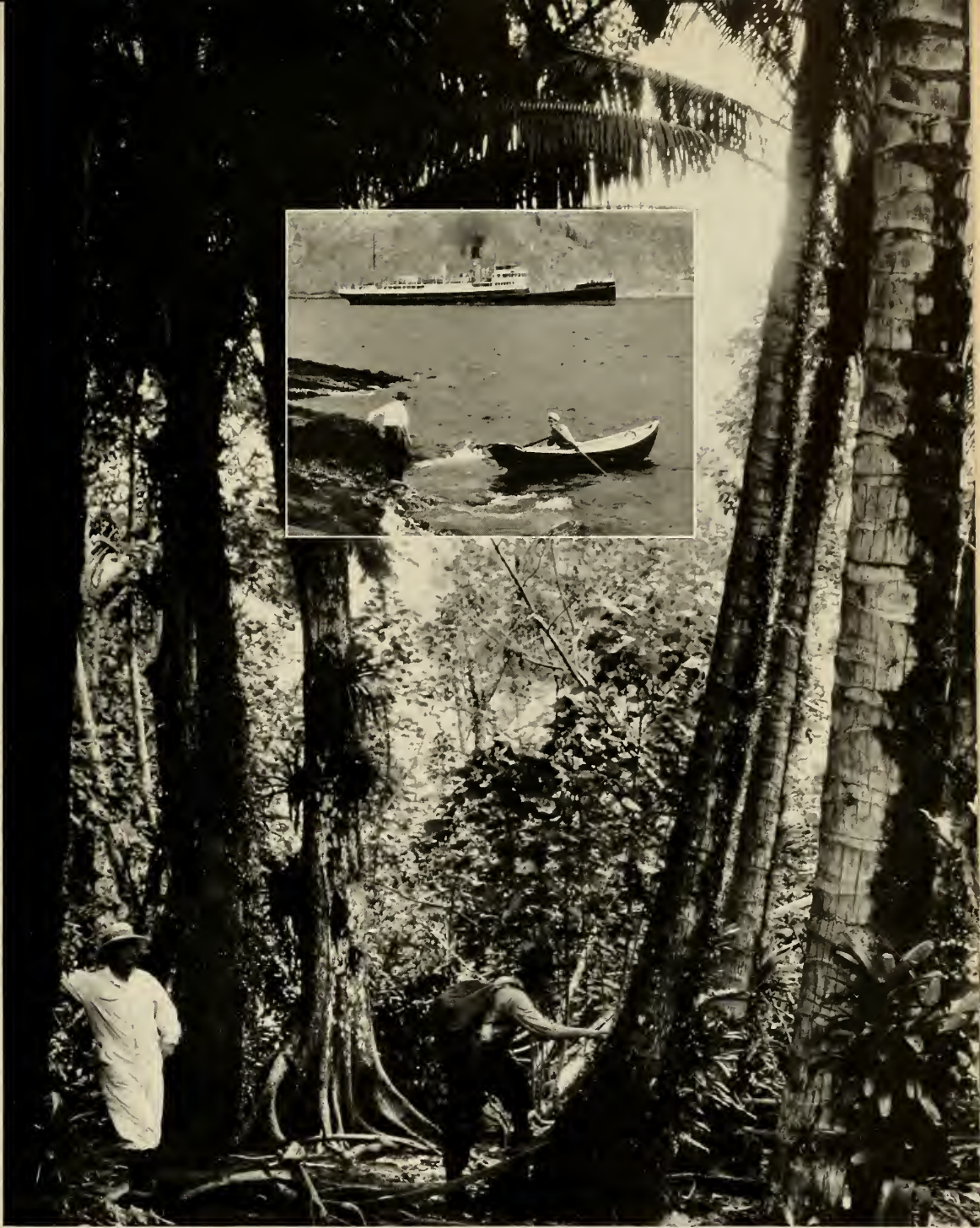
When the expedition of the California Academy of Sciences to the Galápagos Islands visited this anchorage some thirty years ago, October 3, 1905, to be exact, a letter was mailed in the barrel and on the return of the expedition a little over a year later it was found that it had been picked up by the British Yacht "Deerhound," and had reached the office of the Postmaster General in Washington, D. C. At the time of mailing, the barrel was somewhat weatherworn and the rust from the hoops obliterated all of the address with the exception of two words—the surname of the

addressee and the city in which he lived. The Post Office Department traced the addressee, finally delivering the letter just about a year after it was mailed. The Charles Island Post Office is still in use, though service seems to be somewhat better, the author having received a letter about six weeks after it was mailed. In this case it was picked up by the Vincent Astor Expedition on the yacht "Nourmahal," carried to Tahiti, and despatched on the regular mail steamer for San Francisco.

A plea for conservation

These Enchanted Islands are a land worth conserving, and as time goes on and more and more visitors become interested in seeing them, there is the greatest danger of many of the unique creatures inhabiting them becoming extinct. We have already seen the damage done in other lands by turning loose domestic animals to run wild and what has already been accomplished in the Galápagos, so let us hope that some day in the near future this may be a place set aside where nature can remain undisturbed and protected from all outside influences before it is too late.





Photographs by Frank Jose

JUNGLE AND SEA IN THE GALÁPAGOS

Captain Hancock, on the left, surveying the Cocos Island jungle when his first expedition to the Galápagos stopped at the Treasure Isle. This impenetrable forest covers the entire

island, making exploration most difficult. In the insert above, the "Oaxaca" rides at anchor in Tagus Cove, Albemarle Island. Hancock's cruiser Valero III visited the islands later



Before the arrival of the oil hunter, these huge aborigines of the Galápagos roamed about the summit of Vilamil Mountain, Albemarle Island, and could be found around the water holes of the rolling grass lands. Below is pic-

tured the devastation wrought by the natives in the slaughter of these harmless creatures for the few paltry pesos they received for the oil by trying out the fat. The Galápagos Archipelago is now a game sanctuary



*Photos
by
Frank
Jose*



*Photo by Frank Jose,
Courtesy of
G. Allan Hancock
Expedition*

Because the flesh of these sea iguanas is not so palatable as that of the land iguana, and they can escape the ravages of wild dogs by taking to outlying rocks, they have survived their less fortunate relative, which is now practically exterminated on all but three of the islands



A "close up" of the grotesque sea iguana to be found on almost every island of the archipelago. Compare portrait of land iguana on page 374

*Photo by courtesy
of G. Allan Hancock
Expeditions*



*Photo by W. C. Swett.
Courtesy
G. Allan Hancock
Expeditions*

*Hood Island, the southernmost of the Galápagos Archipelago, is the only known nesting site of the Galápagos albatross (*Diomedea irrorata*). This beautiful bird, decidedly awkward on terra firma, is the personification of grace and beauty while on the wing*

The Galápagos penguin has its chief habitat along the west coast of Albemarle Island. It is a speedy and powerful swimmer



Photo by W. C. Swett. Courtesy G. Allan Hancock Expeditions



*The swallow-tailed gull (*Creagrus furcatus*) may be observed on many of the islands of the Galápagos throughout the entire year. Its beautiful coloring and a conspicuous crimson ring around the eye immediately attract the attention of the visitor*



*The Galápagos fur seal (*Arctocephalus galapagoensis*) was almost exterminated in the early days by the sealers. It is now extremely rare and only a remnant of the once vast herds inhabits Tower Island, one of the smaller islands to the northeastward of the main group*

Photo by W. C. Sweett.

Courtesy G. Allan Hancock Expeditions



This photograph of a hair seal taken at Tagus Cove, Albatraz Island, shows with what impunity the photographer may approach the animal, as it shows no fear of man

Courtesy G. Allan Hancock Expeditions



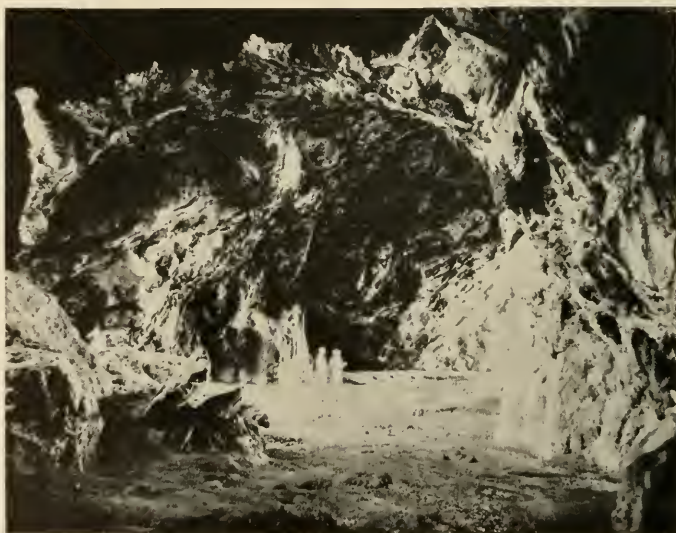
BRICK DE S. M^{TE} LE GENIE
NOV 1846

Frank Jose. Courtesy of G. Allan Hancock Expeditions

From time immemorial it was customary for sailors to leave a record of their visits to distant lands, and the rocks at Cocos Island bear testimony to the fact that it was a much frequented spot. The above inscription, at Chat-ham Bay, records the visit of a French brig

under the command of the Count of Gueydan, November 1, 1846. The insert shows the home of Captain Gissler on Cocos Island, with the Captain, Mrs. Gissler, Rollo H. Beck, in charge of the California Academy of Sciences Expedition (1905), and J. J. Parker

*Frank Jose.
Courtesy of
G. Allan Hancock
Expeditions*



*A cave on the
Tres Marietta
Islands, on the
route to the
Galápagos*

The Golden Diggers

Wasps that make remarkable provision for feeding offspring that they will never see

By ROY L. ABBOTT

*Professor of Biology, Iowa State Teachers College,
Cedar Falls, Iowa*

IT is early June. Just outside my office window along the old limestone wall of the building, there is a little plot of sandy-clay soil, grassless, weedless, baked hard by the sun. To my eye it is a desert in miniature, a dead thing; to my mind it is a spot about to spring into life, for I know that in fifty places at least, each in its tiny cell barely seven inches beneath that hard-packed soil, there is a little pulsing creature that in a few days will burst the door of its prison and come forth wriggling, clawing its way up through the soil to spread its wings in the air.

I know this because almost a year ago I saw anxious mothers laboring mightily to dig and provision the dens in which the germs of this soon-to-be risen generation were planted; because I sat in the sun for sixty days last summer by this little desert patch to learn the story I am now about to tell.

The beginning of the story

The July sun was intensely hot, and I believe I would have passed without seeing her that morning, but for the glint of the sun from her steel-blue wings. Wasps have always inspired me with a vague mixture of interest and fear, so this big black and red-brown creature pulling powerfully with her jaws at a stick larger than herself caught my attention at once.

It was a female wasp of the kind called *Chlorion*, commonly known as the golden digger. She was digging a hole in the earth about the diameter of my middle finger, and

at that moment the stick was hindering her work. I stooped to watch her more closely. With a final tremendous tug, she tore the stick free, dragged it back a few inches and dropped it, giving it a strong backward kick with her hind legs as she did so. Then she raced back to her work.

She would grab a mouthful of dirt with her great jaws, support it by means of her front legs, back swiftly on her four free legs, drop it several inches from the opening, finally sending it flying by a parting kick from her hind legs. Now and then she would turn and push the dirt still farther backward with her head, something in the manner of a pocket gopher.

Hard work

Once in my eagerness to see, I bent too close. As my shadow fell upon her, she whirled quickly, turning her yellow, alert face squarely toward me, and elevating her antennæ in a warlike manner. Then she sprang into the air and circled buzzing about my head. She made no effort to sting me, however, and soon alighted again at her den. But the site she had chosen didn't seem to suit her. As if torn by indecision, she would momentarily leave her job, and race off a foot or so, making tentative bites at the soil in various places. Finally she abandoned the original site altogether, and for five minutes did nothing but dash frantically about in a wild and distracted manner, making herself a general nuisance to the thirty or forty other females like herself who were busily digging on the same plot. Once, in fact, she made the mistake of attempting to usurp the den of another wasp, but she didn't repeat the offense. The owner was upon her almost

instantly, and for a moment I felt that a tragedy was imminent. Over and over they rolled in a confusing tangle of legs and bodies, but it was apparently more of a wrestling match than anything else, neither attempting to sting the other so far as I could see. Presently they untangled themselves, and the would-be usurper retreated precipitately, leaving the outraged owner standing with erect wings and heaving abdomen before her door.

But my wasp did not retreat far. Her wanderlust seemed to have departed from her and in a moment she had chosen a new site, though by what criteria I have no knowledge, and was soon digging hurriedly as before. In exactly eleven minutes she had excavated a hole as deep as her body was long, and in half an hour was down so deep that I could not see her except when she came backing out with her load of dirt.

Obstacles

Several times as she worked, I amused myself by placing obstacles in her path. She would seize these with her jaws and carry them away. One of these, a pebble of twice her weight, she carried six or more inches away, giving it a final annoyed push with her head. Once some red ants came pestering about. She ignored these for a time, but finally becoming seemingly exasperated, she sprang right and left at them and they scattered hastily as she laid two of them low with savage nips from her great jaws.

After four or five hours of steady toil, during which she had excavated fifty or sixty cubic centimeters of dirt, the nest or burrow was finished. At least I inferred this from her behavior, for she came out, wiped her antennæ, shook her wings, and seemed to go through a general tidying up process, as one might do after completing a task. She then walked briskly about the entrance for a moment, suddenly took off, and began a slow, more or less circling flight, now lower, now higher, about the entrance to her burrow, seemingly making a close observation of the landmarks by which she might know the place on her return. . . . probably getting a memory picture or making a "locality study" as some one has said.

I watched her carefully as she flew, drawing my pencil round and round on a bit of paper, attempting to trace her path, but her

flight was altogether too rapid and erratic for me to obtain more than an approximate diagram of her trail. After a moment of this preliminary study, she spiraled high into the air and passed in almost a straight line out of sight. I followed her with my eye for nearly a hundred feet until she disappeared in the general direction of a weed patch.

There was then nothing to do but to wait patiently to see if she would return. While waiting, I passed the time in measuring her den by means of a broom-straw. It was approximately seven inches deep and one-half inch wide, or six times the length of her body in depth and three times the thickness of her body in width. Imagine a man digging a circular hole thirty feet deep and three feet wide in four hours! And with no tools but teeth and feet, and with no way of getting the dirt out, except by carrying it in mouthfuls and walking up a vertical wall backward. It was incredible, yet there was the ocular proof.

But Madam Wasp did not compel me to wait too long. In exactly twenty minutes she reappeared, flying heavily as if greatly burdened. She was carrying something which was hanging beneath her body like the landing gear of an *aéroplane*. With a great circling swoop she alighted near her den, and went waddling awkwardly up to her door, half carrying, half dragging a big green grasshopper larger than herself, which she deposited with its long antennæ almost touching the entrance. Then to my intense surprise, she abandoned her prey and went hurriedly head first down the hole. What now?

Storing the food

In a second or two she came backing out, whirled suddenly as she cleared the entrance, seized the grasshopper by the antennæ, and drew it quickly out of sight. I listened and tried to speculate on what was going on down below, but all I could hear was that same low, contented humming which she had kept up all morning even while digging hardest at her den.

In a few minutes she came out again, seemingly as fresh and alert as ever, ready for another grasshopper hunt. This time she "took off" with little or no locality study.

While she was away, I interested myself by watching the thirty or forty other wasps

who were busily working around me. The following drama then unfolded before me as I sat and watched:

Some of the wasps have finished their dens and are already bringing in green grasshoppers. But each and every one behaves exactly as my wasp did with her prey. Each one drags the grasshopper up so near to the burrow that its long antennæ actually or nearly touch the entrance, each then momentarily abandons her prey to dive into her burrow on a preliminary inspection trip, each then comes backing out only to whirl quickly, seize the victim by its long rope-like antennæ, and drag it instantly out of sight. A stereotyped action! Stupid creatures, blind slaves to instinct! Each is fatally bound to behave exactly as her parents have behaved before her!

Experiments

Then a happy thought strikes me. Is this beautiful creature purely a machine? What will she do if I modify the circumstances under which she normally finds herself? What will she do if I move the grasshopper back several inches from her den? I have not long to wait for a chance to try the experiment. A heavily burdened wasp alights near by, drags her prey to the entrance, and true to form, dashes down her burrow. While she is within, I quickly pick up the grasshopper, and lay it six inches back from the entrance. What now? Out she comes backing hurriedly, whirls quickly at the mouth of the burrow, and makes a grab at empty air. What's this, no grasshopper? Why she left it there not thirty seconds before! Her expression—if an insect can be said to have expression—is comical. Elevating her antennæ, she dashes frantically about, finally coming upon her victim. Springing astride it, she waddles quickly to her den, abandons her prey, and goes down the hole. While she is within, I place the grasshopper six inches away as before. But it is of no use! Forty-three consecutive times I lay the "hopper" back, and just as often does she drag it back to the entrance, abandon it, and go in for her inspection. On the forty-fourth trip I do not move it, and she comes out and takes it in as if nothing had happened. What abysmal stupidity! She simply cannot take that grasshopper in except in her own way.

I sit and marvel upon the inviolability of instinct, then something flashes before me and

my own wasp alights at her door with a grasshopper. The hunting must not have been good. . . . she has been gone an hour. But I am resolved to test her also. While she is within, I remove the grasshopper as before. Six times she obeys her instinct, but on the seventh, something happens. As if becoming disgusted with the proceedings, she marches boldly to her den and walks head first, carrying her "hopper" with her. I am astounded. She has done two new things: she has carried prey into her den without a preliminary trip of inspection, she has gone in head first dragging her prey with her—two things which her ancestors probably never did.

I wait anxiously for her next return. Has she really learned something or was her seemingly intelligent action purely an accident? Will she take the "hopper" in after fewer trials next time? She does not keep me long in suspense. In twenty minutes she is back again, and this time she carries her "hopper" in on the fourth trial. I am overjoyed! She is learning, there can be no doubt. Once again she comes with her prey, and this time she takes the creature on the second trial. How differently she behaves from the first one I tested. That wasp seemingly was dull, could not adapt herself to a new condition. This one is intelligent, adapts herself to a new condition, and more intelligently each time she meets it. Can it be that wasps, like people, show varying degrees of mentality? And will this particular one remember next morning what she learned the day before?

Further intelligence tests

But I do not test this wasp any further. The sun is getting low and she has evidently decided to quit for the day, for she comes out and begins to kick dirt into the burrow—a temporary protection for the night. I do not know where she sleeps, but at least never in the burrow, for that is usually filled at the end of each day's work. I hasten to be with her early the next morning, but somebody has unwittingly trodden upon her nest and I lose track of this particular female. There are plenty of others, however, and for the next two months I do little but apply my intelligence tests to various members of the clan.

They show great individual differences in meeting the same problem. One, for example, requires forty-five trials before taking her

"hopper" in without stopping, while another takes her "hopper" in on the third trial. Several different ones take the prey in on the fourth trial, and one particularly intelligent one seemingly retains a memory until the next day. At any rate she takes her "hopper" in on the second trial one evening, and repeats the action on the second trial the next morning. But I must not forget the slower ones. One wasp makes eighteen successive trips, and then refuses to come out of her den, remaining sulking down below for more than two hours. Two others pick up their "hoppers" on the eighth or ninth trial and fly off with them and do not return.

Reactions to new problems

Noting that when left to themselves, they always drag the prey in by the long, rope-like antennæ, I try to confound them by cutting off the antennæ close to the head. But although each wasp is more or less perplexed by finding only a smooth surface where there has hitherto been a pair of convenient handles, not one is baffled by this new problem. Some, it is true, strive for minutes on end, to grasp the prey in the accustomed place, their jaws clutching senselessly at the point where the antennæ should be, before they bethink themselves to turn and seize the creature in a new place. Others sense the problem more quickly, turning after a few ineffectual nips at the head, to grip the long ovipositor, and to drag the victim by that.

But enough of such experiments. What do they mean? Simply that a wasp can modify its behavior to fit a new condition—and this statement in the face of a vast weight of scientific opinion. But whether they behave as pure automatons as many believe, or by taking thought, as my experiments seem to tell me, my wasps are always interesting. I can never be quite sure what they will do under a given condition. For illustration, after watching them for thirty days, I am positive that no wasp will ever alight with her prey and carry it into her den without a preliminary trip of inspection. "This," I say to myself "is instinct in-violate." But I am mistaken.

I am stooping in the midst of a colony of diggers, anxiously watching a large wasp's antics in trying to handle an antennæless grasshopper, when my attention is suddenly diverted by another wasp which keeps up a con-

stant circling about my head. I notice that she is carrying a huge "hopper" and I am curious to know why she is so long in finding her nest, for usually each wasp comes with but little preliminary circling to her own door. What is the trouble? Happening to glance down, I observe that I am stooping almost directly over a freshly dug burrow. I step back instantly, and with a great swoop the tired aviatrix alights at her very door. And here I have the surprise of my life: She goes in at once, dragging her "hopper" with her. I am fooled again!

As I watch, two wasps, both carrying grasshoppers, alight near by. As they disappear below for their senseless trip of inspection, I exchange the booty. One grasshopper is three times the size of the other, surely the one wasp will object to the substitution. But I am again mistaken. Each accepts the proffered victim without a sign of hesitation. Two more bring in their prey simultaneously. I take both of these and offer them to another wasp who has just stored a victim. She accepts both in succession and without show of surprise, although here is something that never happened to her before. But she does one curious thing. On accepting the third grasshopper, she drags it to the entrance, and goes in first according to custom. Then she comes out, but instead of dragging in her prey directly, she strolls about a moment, then suddenly seizes the "hopper" and walks in with it head first. This is a new action, and so unconventional that she seems to think better of it herself, for in a moment she comes out dragging the "hopper" with her. She then stores it in the usual manner.

No respecter of her kind

Some careless person has trodden upon one of the wasps and she lies crushed, but feebly struggling near by. I pick her up and lay her at the door of another wasp that has just taken in her "hopper." The crippled wasp wriggles until her body obstructs the entrance. Then out comes the owner, springs upon the injured intruder, and after a brief struggle, picks her up and flies off with her. I lose sight of them, but in a moment she is back again still carrying the injured wasp. What will she do now? A most astonishing thing! She drags the injured one up to the burrow, goes in momentarily, then coming out, seizes the helpless creature and drags her down out of sight.

Surely she does not intend to treat one of her own kind as she does a grasshopper! Surely she will come out presently dragging the injured wasp with her. But she does not. Instead she reappears alone, dusts herself with a complacent air, and then takes off on another chase. I am again mistaken. Two days later when I dig up this den for examination, I find the injured wasp dead, but stored neatly in a cell with seven grasshoppers.

Tricking the digger

Once as I experiment in placing the prey back from the entrance, I am too slow, and the owner catches me in the act. But she pays no attention to me, merely springs upon the "hopper" and pulls strongly in the opposite direction. She evidently thinks it is trying to escape, for even as I hold the insect she stings it several times. This intimidates me, and I relinquish the "hopper." The next time I tie a string to it and when the wasp comes out, I drag it slowly away, the vexed owner following after it yards away from her den just like a dog after a bone. She is oblivious to every thing except her seemingly recalcitrant victim. She springs upon it and stings it repeatedly but she cannot stop this creature which is acting as no grasshopper ever acted before. Presently she abandons the chase, and goes off sulkily after another victim.

I repeat this trick upon another wasp. If I suddenly lift the "hopper" just as she attempts to seize it, she will spring into the air, and fly round and round my head holding the "hopper" at the end of the string. It is like flying a kite. Then she, too, gives up in disgust and goes in search of another.

A powerful huntress

How does she catch her victims? I have never seen her do this, but it is doubtless not much of a trick for my powerful huntress. Like an *aéroplane* from the sky she probably darts down upon the luckless grasshopper as he sits exposed on a weed stalk; a long, jabbing sting is thrust through his thin armor, and before he has time to make more than a single lusty kick or to expectorate a few drops of grasshopper molasses, he is paralyzed, seized with jaw and leg, and wafted on powerful wings into the air. In another moment he is deposited at the door of a tunnel, and in a

few seconds is dragged head first down into the depths.

But what does my golden digger want with the grasshopper? She, herself, is no meat-eater. If I open one of these subterranean dwellings and see what disposition has been made of the victims I shall perhaps find the answer. It is no easy task, but I mark out a space around the hole, fall to work with chisel and spade, and in an hour have cut out a solid cube of earth fifteen inches on each edge. This I carry to my laboratory where I can examine it without injury to its contents. I have chosen a den which is still in the provisioning process, hence, the main tunnel is wide open. I place a broom-straw down this to guide me should I accidentally fill it with dirt, and with a feeling somewhat akin, perhaps, to that of an archeologist knocking at the tomp of a Pharaoh, I carefully begin my excavations.

The nest

I first make a section through the nearly vertical shaft, and find that it ends blindly seven inches below the surface. It is empty, and the soil seems hard-packed. What! Have I chosen an unprovisioned nest, or has some marauder despoiled the place before me? But no, I cannot be mistaken! Not less than twenty grasshoppers have I watched disappear down that dim passageway, and nothing has stolen them I am sure. They must be there! So I search carefully, and soon find a cylindrical column of softer earth leading off nearly at right angles to the main shaft. Ah! I have it now. My probing forceps have disclosed an oval cavity about the size of a pigeon egg, and packed full of green grasshoppers. A veritable sarcophagus! Carefully I lift them out, and lay them in a row, two males and ten females.

The great French naturalist, Fabre, says that the digger wasps he studied always chose female grasshoppers as prey, but here is proof that such is not the case with my wasps.

But male or female, these "hoppers" are here for one purpose, to serve food for a young wasp. Where then, is the heir to all this provender? Carefully, I search among the victims, and on the breast of one, near the front legs, and at right angles to the body, I find a white cylindrical egg nearly a quarter of an inch long. It is not more than half a wheat grain in bulk; the twelve grasshoppers are in comparison to it, a veritable mountain of flesh!

Yet from this tiny, pale blob of living stuff will come a monstrous, feasting, battenning thing that will transform the whole of the twelve into itself!

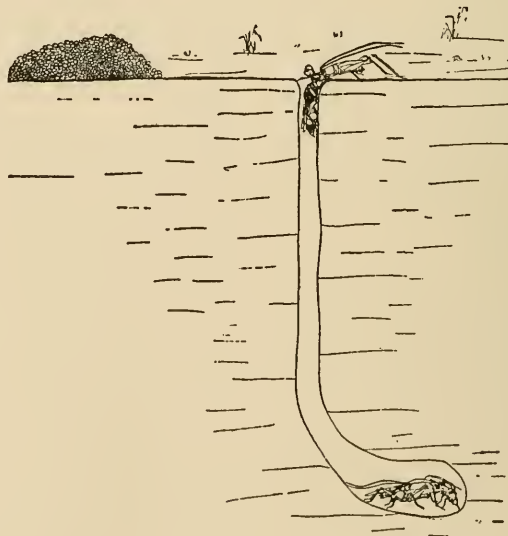
Suspended animation

As I examine the victims, one of them moves! I look more carefully, and I find they all can move! I place one out in a tumbler on my desk and it remains alive for ten days. I have been mistaken. A sarcophagus? No. This is no house of the dead. It is a veritable Sleepy Hollow of Rip Van Winkles. But with one difference—these "Rips" will never waken; they have unwillingly partaken of euthanasia. The poisonous sting of their captor has rendered them helpless, but not dead. Their jaws and legs wiggle feebly, but can offer no defense against the fat grub which will soon feast upon them. Being thus alive, they will not putrefy, remaining fresh meat for this creature which is on its way to become a wasp. All it needs to do now is to eat to satiety, lay on fat, and go through the transformations Nature has fatally blocked out for

it, becoming at last a wasp which will dig its way out into the air.

Fruits of labor

All this which I have been telling took place during July and August of last year. Ten months have now passed, and the summer sun is once again shining intensely upon that small plot of hard-packed soil. The rains and snows of the past year have leveled away all signs of the dens, but they and their occupants are still there. In a few days now these occupants will come forth to disport themselves carelessly for awhile in the sun. The males will fertilize the females, and then disappear to live a care-free, monastic life until they die in the fall. No family burdens for them! But upon the egg-bearing females will now come a powerful urge. Each will begin digging as if her very life depended upon it. Each will sink at least half a dozen shafts deep into the soil, fill them with grasshoppers, and deposit an egg within each shaft. All this for the sake of offspring that she will never see—just as her mother did for her. For this is the way of the diggers.



THE GOLDEN DIGGER'S BURROW

Representing *Chlorion ichneumoneum*, her burrow, and her prey—a grasshopper. This sketch is from "*Wasp Studies Afield*," by Phil and Nellie Rau

Wasp Food Chambers

*From Hutchinson's
"Animals of All Countries"*

There are many kinds of wasps besides the golden digger that provide fresh animal food for their offspring, choosing, according to their species, beetles, locusts, crickets, flies, spiders, and caterpillars as provisions

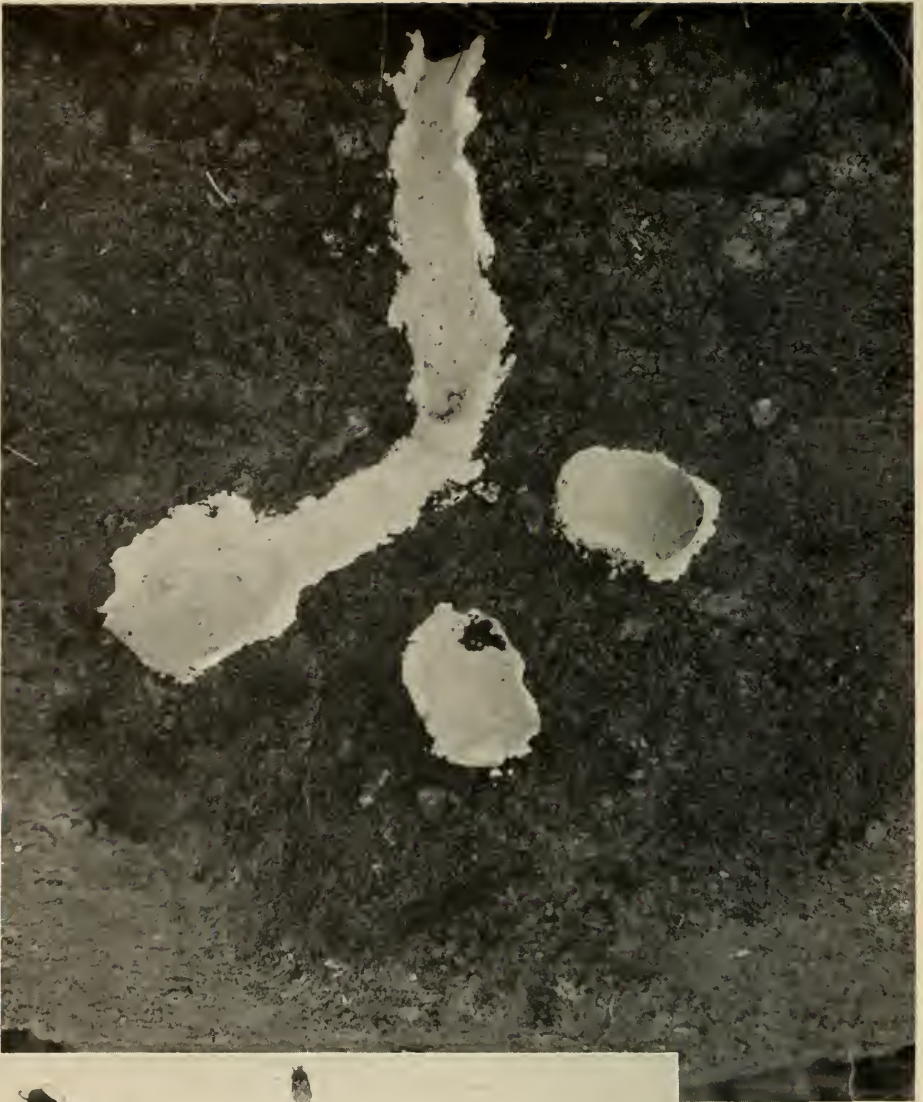
At the right is an ichneumon wasp which has just emerged from its cocoon in the skin of a caterpillar victim



Photo by H. A. Riebe

Within the white circle is a golden digger dragging a bit of grass from her path. The burrow may be located by the weed stalk thrust into it. Note the large pile of earth (upper right) excavated by the wasp

*Photo by
H. A. Riebe*



Vertical section through the nest of a golden digger, showing the main tunnel and three cells at the sides and bottom



Photo by H. A. Riebe

The contents of one cell. Note the wasp larva (upper center) feeding on a grasshopper



Photo by Cornelia Clarke

A "close up" of two golden digger wasps, giving a detailed view of the powerful jaws

Photo by Cornelia Clarke

(Below) This female wasp is taking a rest. She has a firm hold on an iris leaf with both jaws and feet

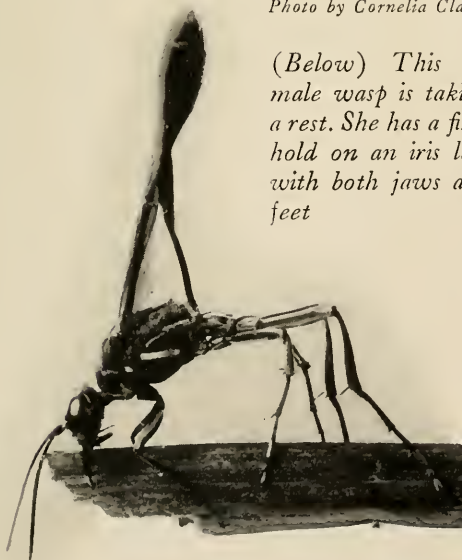


Photo by H. A. Riebe

Attached to the thorax of this female grasshopper is the egg of a wasp

The Ancient Buried City of Kentucky

A recently discovered stage in the unfoldment of American civilization

By LORINE LETCHER BUTLER

THE motorist traveling along U. S. Highway 60 through Kentucky, will note among the signs beside the road pointing this way and that—to Louisville, Henderson, Paducah, and points south—another sign fresh and up-to-date as the rest, that reads, “The Ancient Buried City.”

Following the direction indicated by its sharpened end, he continues along the modern paved road past fields and woodland, through towns and villages and cross-roads hamlets, now and then coming upon a sweeping view of the Ohio River as it hurries to keep its rendezvous with the Mississippi, and so on into Paducah and beyond, to Wickliffe.

A sleeping city

Just before reaching Wickliffe he passes Future City, and a short distance farther, West Future City. The distinction seems to be that Future City has a dwelling attached to its store, while West Future City has only a store. Through the sleepy village of Wickliffe and a turn to the right—and the traveler enters a city that is asleep, the Ancient Buried City that has been asleep perhaps a thousand years or more. And he feels a bit like a modern Æneas as he explores this city of the dead.

The Ancient Buried City of Kentucky holds the remains of a people who vanished before America had been discovered by the civilized world. Abundant evidence of these people has been found through the Mississippi Valley in the mounds which they built and which frequently yield archaeological treasure. The Ancient Buried City is important among such remains first because of the proof it fur-

nishes that it was once a commercial city of importance, and second, because of the clues it yields respecting the religious and ceremonial customs of the Mound Builders.

History in kitchen middens

In all the relics of the Mound Builders that have been unearthed no single bit of writing has been found. But their history is written in the earth—the soil and its content—the minerals, rocks, and the charred wood and bones—kitchen midden.

Situated at the confluence of the Ohio and Mississippi rivers, on a bluff overlooking this mighty mingling of waters, no better site could have been selected for a commercial center. The two great waterways afforded communication over a wide area, and travel by water was quicker and safer than over foot trails.

The Mound Builders were a sedentary people, but the commercial contacts of the Ancient Buried City were wide. This we know from the minerals and objects found in connection with the burials. There is a conch shell from the Gulf of Mexico. There is copper from the Lake Superior region, mica from North Carolina, fluor spar from Illinois, and lead which may have come from Missouri. The fine workmanship of some of the articles fashioned from these materials indicates that their civilization was of a high order.

There are nine mounds in the group that constitutes the Ancient Buried City. Three are partly excavated and work on the fourth has been begun. The largest is the Burial Mound, the excavation of which has revealed one hundred and fifty three burials; and when completed, there is reason to believe that there

may be as many as one thousand. The other two works represent a temple and a council house, or chieftain's dwelling, respectively. Buildings about forty feet square have been erected over the excavated portions to protect them from the weather, and as one approaches the Buried City, the group, together with other buildings that serve as office and laboratory, also cottages for visitors, presents the appearance of a neat little summer resort.

Gazing backward into Time

But when one enters the doorway to the Burial Mound, he leaves the Present behind, and awe-struck gazes backward into past centuries. At his feet lie the skeletal remains of one hundred and fifty three persons who lived on this particular portion of the earth ages ago—just how many ages the archaeologist has not yet determined. Efforts are being made to establish the exact period of their flourishing by a comparison of the tree-rings of timbers of ancient buildings found in the mounds with the living trees in the region. The oldest living tree found thus far dates from 1300, yet does not seem to compare in age with the buried trees.

Beside each skeletal person lie the articles with which he was buried—the ornaments or implements with which he started his journey into Eternity. Water bottles from which he might quench immortal thirst. Whistles for calling—what? Tools that might be useful in that strange country whither he was bound. And from these concomitants of death we know that the Mound Builders, like most primitive peoples, believed in a very material life after death.

From the nature of the articles it is learned that these people possessed a keen artistic sense. The coincidence of certain designs occurring in the work of the Mound Builders and of the Mayans even indicates a possible connection between these peoples.

The pottery of the Burial Mound is symmetrical in outline and is both plain and painted, sometimes painted inside. There are fanciful creations representing animal or human figures, a bear, fish, frog, or the plumed eagle that is a familiar design in Mayan art. There are human effigies, and an owl water bottle whose brown and white painted feathers stood out distinctly until re-acquaintance with

surface air faded the long buried colors. The tools for making the pottery are also here. A collection of pottery trowels and other implements lie at the head of a woman—she is Number 87—which suggests that Number 87 was an expert potter, perhaps the potter-in-chief of the community. And there is the man who was a leather worker, Number 60, with the tools of his trade about him—bone needles, punches, and an awl made from the heel of a deer.

Somewhat in the center of the group lies a person of importance, still in possession of the imposing earrings that so long ago dropped from their fleshly moorings. They are large wooden earrings covered with copper, circlets surrounding seven-pointed stars—again a suggestion of Mayan culture. The oxidation of the copper preserved the ornaments for our admiration. And between the feet of the august one is a human skull. Trophy, or slave? Or dutiful wife?

A family group is Numbers 1, 2, and 10—a man, woman, and infant. Number 76 lost all of her teeth, the only old person in the assemblage. Her age has been fixed at sixty, which was extreme age among the Mound Builders, whose years averaged thirty-five or forty. Number 38 is a woman accompanied by her six-year old child, Number 27. Numbers 8 and 9 are a couple, man and woman.

Burial ceremonials

The remarkable preservation of the bones is due to the fact that the burials were accompanied by a ceremonial of fire, and the charcoal so plentifully intermixed with the soil has prevented decay. The bodies were placed on the top of the ground and dirt heaped upon them. Often one was buried atop another—in some instances there are as many as five burials, one above the other.

Differences in the method of burial attract our interest. Besides the prone figures that suggest peace and hope—facing the sun, there are the bundle burials and evidence of cremation. The bundle or basket burial, as known to archaeology, is the gathering of the bones of a body into a bundle after the flesh has disintegrated, then placing them in the burial mound. There is evidence of cremation in a small heap of charred bones resting in a crematory basin containing charcoal.

Leaving the Burial Mound, the visitor enters the temple building. Five feet below the top of the tallest mound a hard clay floor has come to light, outlined by a row of well-preserved post holes. Charred posts, that fit the post holes, lie on the floor; and over all are the charred remains of a thatched roof made of split cane bound with grass.

Beneath the fallen roof and its beams were found three rectangular sacrificial altars of burnt clay, and between two of them a charred post with braided rope attached, indicating that humans or animals for sacrifice may have been bound here. Earth was heaped upon the structure while this was burning, as is evident from the burnt condition of the soil above it, and its reduction to charcoal rather than to ashes.

Excavation beneath a portion of the temple floor revealed another temple building, five feet below the first. And here again are to be seen the hard clay floor, the baked post holes, and charred remains of a building.

One temple superimposed upon the other, both burnt in the same manner and covered with earth to the same depth, seems to tell the story of religious atonement. An angry god to be placated, or petitioned for surcease from famine, or drought, or plague.

We look next upon the civil affairs of the community. A third mound excavated to a depth of eight feet, revealed the remains of another structure which might have been a council house, or perhaps a chieftain's dwelling. It is rather spacious, the clay floor measuring twenty-one by twenty-five feet, as outlined by the post holes. Within the area there are other post molds, which may have held supports for benches, a platform, or the roof.

Prehistoric engineering

Outside the walls of the building there is a drainage ditch—a bit of prehistoric engineering. A space between the holes on the side must have been a doorway, and within there are three fireplaces. Near by is a heap of charred maize cobs, the remains of an ancient feast. Water jars and pottery vessels, nine of them, were found, that no doubt contained liquid accompaniment to the corn feast. A turkey caller of bone also was picked up, a useful article in the days when wild turkeys were abundant in the land. The kitchen midden of

the region has produced a plentiful supply of the bones of deer, fowl, squirrel, raccoon, and land terrapin.

The discovery of the Ancient City on its imposing bluff was made by Mr. Fain W. King, of Paducah, who purchased the land and entered its exploration in 1932. Mr. King is a member of the board of regents of the Alabama Museum of Natural History, which institution has engaged in the excavation.

Fragile remains

Begun with picks, the work is continued with trowels; then orange sticks and camel's hair brushes are employed, so numerous and so minute are some of the objects; a thumb nail portrait sculptured in fluor spar; tiny shell ornaments, and frail bits of mica. It is the exceeding care with which this work is being done that is responsible for the wealth of treasure.

An additional attraction is the King collection of aboriginal relics of the surrounding region: an extensive array of objects, utilitarian, ceremonial, or of war, the observation of which enables the student to trace the relationship of the early peoples of the continent.

It has long been the established theory that North and South America were peopled by adventurers from Asia—the dispersal center of the human race—who crossed into North America by way of the Bering Strait, which at that time may have been a strip of land. Making their way down the Americas, these first inhabitants attained various degrees of culture in their different centers of habitation—the Toltec, Miztec, Cliff-dwellers, and the Mayan which was superior to all.

Science has done much to unveil the mysteries of the earth. Work such as is being done at the Ancient Buried City, in the fitting of innumerable facts into a great picture puzzle, enables us to look upon the history of humanity with increasing understanding.

Gazing down into the Ancient Buried City from the rim of the outside world, we see a stage in the unfolding of American civilization. We have had a glimpse of the panorama of the ages. And leaving the Buried City—by way of Wickliffe and U. S. Highway 60—we pass Future City and West Future City and again enter the Present.

A Mound

• • •



Photo, courtesy of Murray State Teachers College

• • • and What Lay Beneath It

(Upper picture) The first excavation of the Temple Mound, one of the group of nine which constitutes the Ancient Buried City in Kentucky
(Lower) The Burial Mound, the ex-

cavation of which has revealed, to date, one hundred fifty-three burials, the remains of a people who vanished before America had been discovered by the civilized world



(Above) The tent which was placed over the Burial Mound during excavation work. It was later replaced by a permanent building

Uncovering

(Below) A portion of the charred temple building. The floor of this building came to light five feet below the top of the tallest mound





*(Above) A mound in an early stage of excavation. This photograph shows the fourth mound; five more are as yet un-
tombd*

he Past

*(Below) An altar in the Temple Mound.
Three sacrificial altars of burnt clay were
unearthed beneath the fallen temple roof
and its beams*





Photo, courtesy Murray State Teachers College

Pottery and other objects found in the Burial Mound. From the nature of the articles discovered

it is evident that these ancient people possessed a keen artistic sense and were skillful workmen



(Right) A painted owl effigy water bottle excavated from the Buried City

Attacking Ocean Problems

Work on the multitude of unsolved questions concerning the sea and life within it, as carried on by the Woods Hole Oceanographic Institution

By GEORGE L. CLARKE

*Instructor in Biology, Harvard University,
and Junior Biologist, Woods Hole
Oceanographic Institution*

IN FORMER times little was known about the sea. The causes of storms, tides, and currents were mysteries, and the activities of sea creatures often were sources of superstition. Today we like to think of these matters not so much as mysteries to be treated with caution but as problems which challenge our ingenuity.

It must be admitted that our understanding of even the basic questions about the ocean is still very poor indeed. The charting of ocean currents, the determination of the chemical and physical properties of sea water, the analysis of the mud at the bottom of the ocean and of the blanket of air on top of it, the growth, migration, feeding, and breeding of fish, lobsters, and whales—these and many more are problems which are being attacked at the present time.

An exacting science

The study of the ocean from all these points of view constitutes the science of oceanography and is fraught with such difficulties that it can be successfully pursued only with the aid of methods and equipment especially selected for the task. The investigators must be not only trained in several branches of science but also familiar with boats and the ways of the sea. An ocean-going ship suitably designed for the use of scientific instruments at sea is necessary, and specially constructed apparatus must be prepared. To meet all these requirements and

to provide a center from which the oceanography of the western part of the North Atlantic Ocean could be conveniently studied, the Woods Hole Oceanographic Institution was established. This was made possible by a grant from the Rockefeller Foundation in 1930 which provided for a permanent and independent endowment.

Coöperating laboratories

The scientific staff of the Oceanographic Institution consists of the director, Prof. Henry B. Bigelow of Harvard University, and fourteen other investigators, most of whom hold university appointments as well. The Institution maintains its own laboratory at Woods Hole near the Marine Biological Laboratory and the United States Bureau of Fisheries Station. The three laboratories are entirely independent but their close proximity to one another makes coöperation feasible in many valuable ways.

The laboratory of the Oceanographic Institution is a well-equipped modern building. As we shall see, the real work of oceanographers is done at sea, but a shore laboratory is naturally necessary for the laying out of programs of investigation, for the construction and testing of special equipment, and for the analysis and study of the data and materials brought in from various parts of the ocean. In addition a considerable amount of experimental work can be done on shore, and various parts of the laboratory have been laid out to meet the requirements of special experiments in the physics, chemistry, and biology of sea water.

The location of the laboratory building on the harbor front at the water's edge makes access to the boats extremely easy. In the protected basin behind the Institution dock a fleet of small boats is moored, including the "Asterias"—a forty-foot power boat which is used for inshore work, particularly in the neighborhood of Woods Hole. Sufficient depth of water exists on the offshore side of the dock to permit the ocean-going research vessel "Atlantis" to tie up there between cruises, lying at a distance of only 150 ft. from the door of the laboratory.

The "Atlantis" was specially built for the Woods Hole Oceanographic Institution and was so designed that long trips to sea could be made and every type of oceanic investigation undertaken. A practically indefinite cruising radius has been obtained by making the "Atlantis" primarily a sailing vessel, although she possesses a serviceable Diesel engine for auxiliary use. This type of ship enjoys the other advantages of the greater stability provided by the sails—an important point when delicate instruments are being used—and the saving of space below decks, for a relatively small part of the 400-ton displacement of the "Atlantis" is taken up by fuel oil tanks. The vessel is 142 feet long, and although her hull, which is of steel, was designed for stability and commodiousness rather than for speed, her marmconi sails will drive her as fast as ten knots in a good breeze. Her ketch rig is especially suitable for heaving-to at sea. She is manned by a crew of fifteen.

Floating laboratories

Six scientists may go to sea on the "Atlantis" and find comfortable living accommodations and plenty of space in which to work. The ship possesses two laboratories which are located one above the other amidships where the greatest stability is found. In the lower laboratory apparatus for chemical and for bacteriological work is securely screwed to the benches or stowed in specially constructed racks. The upper laboratory is equipped particularly for biological and hydrographical work. One may step directly from this laboratory out on to the deck, and it is from this point in the waist of the ship that most of the oceanographic apparatus is operated.

Heavy gear, such as dredges and trawls, is towed from a half-inch steel cable which is

run from the end of a boom guyed at right angles to the ship's hull. There is enough of this cable to reach the bottom of the ocean anywhere and when not in use, its 30,000 feet are kept reeled on the drum of a huge winch in the bottom of the hold. Lighter instruments are lowered into the water on a more slender cable which is run out from a small deck winch. Both these winches, as well as much of the rest of the ship's gear, are run by electricity generated by the Diesel engine. The small winch is usually spoken of as the hydrographic winch because it is used to lower the hydrographer's principal instrument—the water bottle.

How ocean currents are studied

Since hydrography—or the study of ocean circulation—is basic to the other branches of oceanography, let us begin our discussion of the specific ocean problems which are being attacked by the Woods Hole Oceanographic Institution with a glimpse at ocean currents and how they are studied.

Interest in ocean currents was first aroused in connection with navigation. After years of experience and observation ship captains have become familiar with the more pronounced movements of water along routes of travel which tend to set them off their courses, so that today knowledge of this subject is sufficiently accurate to enable courses to be followed with satisfactory precision. For example, knowledge of the position of the Gulf Stream off the Florida coast enables skippers to take advantage of the current when sailing north by steering their ships into the middle of the stream, whereas when proceeding south they take pains to avoid the current by holding to a course close in shore.

Stay-at-homes, as well as mariners, may be profoundly—though indirectly—concerned with ocean currents because of the influence they have on climate. Thanks to the Gulf Stream, England enjoys temperatures characteristic of New Jersey, although it is in the latitude of Labrador.

But ocean circulation has a much more fundamental importance in the ocean itself in relation to the equalization of temperatures and the distribution of chemical materials and living organisms. The well-defined ocean currents such as the Gulf Stream and the Labrador Current are familiar to everyone,

but these relatively swift movements of water are but a very small part of the whole picture. The water of the entire ocean is constantly moving (although the circulation in some regions is extremely slow) and this is fortunate, for were it not so, the sea would soon become stagnant and life could no longer exist in it. The sea is continually being heated in the tropics and cooled at the poles. Dissolved substances and sediment are washing into it from the land. Rain water is being added to it at the surface and putrefaction is taking place on the bottom. Everywhere living organisms are extracting substances from the sea water with which they build up their bodies and from which they derive energy for their life processes. Thus it is obvious that if the water in the ocean were not continually mixed, harmful temperatures would be established and poisonous products would accumulate in some regions while necessary nutrients would be exhausted in others.

Circulation of sea water

Mixing is accomplished in three ways, namely, horizontal circulation, vertical circulation, and turbulence. In the North Atlantic Ocean, for example, the horizontal movement consists of a huge eddy—of which the Gulf Stream is a part—which revolves in a clockwise direction. The primary causes of circulation in the sea are the differences in the density of different water masses and the driving force of the wind acting upon the surface. The density of the water can be calculated from its temperature and its salinity, or saltiness. Accordingly, the hydrographer's first problem is to measure the temperature and salinity of the water in the various parts of the ocean and at intervals from the surface to the bottom. This brings us back to the water bottle, mentioned above.

This instrument consists essentially of a tube which is attached to the deep-sea cable and lowered to any desired depth. A weight slid down the cable strikes a trigger on the tip of the instrument which causes valves at the two ends of the tube to close. A sample of water is thus sealed in the instrument and can be brought to the surface uncontaminated by the overlying strata through which it must be hauled. The water is then drawn off and its salinity and other properties may be measured

immediately on board ship, or it may be bottled and taken back to the shore laboratory for more detailed analysis.

Special deep-sea thermometers are attached at the side of the water bottle. These are constructed in such a way that when the valves of the water bottle are closed, the mercury in the stem of the thermometer is cut off from the bulb and temperature changes encountered as the instrument is raised to the surface do not influence the reading. By placing a series of ten or more water bottles at intervals along the cable, the hydrographer may obtain a sample of water and a measure of the temperature at as many depths in one operation.

Problems involving the surface of contact between the water and the air above it fall to the lot of ocean-going meteorologists. It is extremely difficult to measure the driving force exerted by the wind on the water in the production of ocean currents, but an estimate can be made of the acceleration of the water by measuring the retardation of the air. This is done by studying the change in speed of pilot balloons from the moment they are released near the sea surface until they reach the upper air.

Sea evaporation

Another problem which meteorologists are attacking is the measurement of the rate of evaporation from various parts of the ocean. This is important because evaporation from the surface tends to increase the salinity and to decrease the temperature of the water left behind, and, as every schoolboy knows, the water taken into the air as vapor is transported long distances by winds until it is finally precipitated as rain or snow at some later time. At first the evaporation rate under various weather conditions and in different regions of the ocean was measured directly from pans on the deck of the ship. It has recently been found possible, however, to obtain the data much more simply from calculations using the relative humidity and wind velocity measured by suitable instruments placed at different heights above the sea surface.

Another set of problems in oceanography centers about the sea bottom. The "Atlantis" is equipped with a sonic sounding apparatus by means of which the depth of water beneath the ship's keel can be instantly ascertained. This remarkable instrument not only is an aid

in navigating the ship, but also makes it possible to chart unexplored parts of the sea with rapidity and precision.

Deposits on the sea bottom

The nature of the ocean bottom itself and the rate and manner in which deposits are laid down are of particular concern to geologists. Devices constructed for obtaining samples of the bottom vary from huge dredges with sharp cutting teeth for breaking off rocks from the walls of submarine canyons to long tubes for obtaining vertical cores several feet in length from which the stratification of the mud can be studied. With the aid of another instrument a regulated amount of the bottom mud is scooped out and sealed up—thus preventing washing out on the way to the surface. From this sample a quantitative estimate of the various materials making up the bottom deposit can be made. The rate at which sediment is transported through the water or accumulates on the bottom is studied by measuring the material deposited in pans suspended for a certain number of days near the bottom or placed directly on the bottom. All this information is useful not only in interpreting the present situation on the sea bottom but also in understanding the formation ages ago of sedimentary rocks from ancient deposits.

Although the mixing produced by currents keeps the water fairly uniform in all parts of the ocean, variations in the physical and chemical properties of sea water do exist from place to place and from time to time, and these relatively slight changes have been shown to be of profound importance to the plants and animals living in the ocean. Of the physical factors temperature appears to be important for every type of organism, regulating its rate of development and limiting its distribution. The pioneer oceanographers were astonished to find that deep hauls of their nets in the Sargasso Sea brought up many kinds of organisms which were familiar to them as surface dwellers in Arctic waters. This situation is now understandable since we have discovered that the temperature near the bottom of the ocean in the tropics is just a few degrees above freezing and that this cold water mass is continuous with the northern surface water which is sinking and moving toward the south.

The green plants of the sea require light for their growth just as their terrestrial cousins do, and the measurement of submarine illumination is another item on our program of work at the present time. For this purpose photo-electric cells, mounted in water-light cases and provided with long insulated cables leading to delicate instruments in the ship's laboratory, are lowered into the water and readings are made at increasing depths until the light becomes too weak to be measured. Transparency varies greatly in different regions of the sea. In inshore waters, for example, the illumination at a depth of about twenty-five feet is reduced to 1 per cent of its value at the surface, whereas off our eastern seaboard an equal diminution of the radiation does not occur until a depth of one hundred feet is reached. And in the clear blue water of the Sargasso Sea, light penetrates to the extreme depth of five hundred feet before it is reduced to 1 per cent of its surface intensity. Plant life is limited to the "photoc zone," and since the illumination may be too strong for growth as well as too weak, the vertical distribution of oceanic plants varies from place to place in accordance both with the transparency of the water and with the brightness of the sun. Below the photoc zone perpetual night exists—except for occasional flashes of the weird phosphorescent light from deep-sea animals.

Chemical analysis of sea water

The sea water which is brought up in the hydrographer's water bottles is subjected to every conceivable treatment by the chemists. The chemical substances which are found in sea water are altogether too numerous and complex to be discussed here; suffice it to say that they are being intensively studied one by one. Information regarding the total salinity is useful to the hydrographer in helping him identify water masses and trace their origin, and it is important for the biologist in relation to the distribution and migration of fish and other organisms, particularly near the mouths of large rivers. Probably every known chemical element will some day be found to exist in sea water in minute amounts at least, and it is not necessarily the most abundant substances which are the most important. Particularly prominent from the biological point of view are the amounts of oxygen and carbon-dioxide present since these are essentially

concerned in the life processes of all living organisms. The relatively small quantities of nitrates and phosphates in the sea are also especially significant since they are necessary for plant growth. These substances frequently become reduced or even exhausted at certain seasons in some regions with the result that the wheel of life is stopped until fresh supplies of the necessary nutrients are available.

Food for sea animals

The plant life of which we have been speaking consists chiefly of minute floating unicellular forms known collectively as the phytoplankton, for, taking the ocean as a whole, the familiar seaweeds of the tidal zone are relatively insignificant in amount. A survey of the diatom population (the most abundant and important element of the phytoplankton) can be made by centrifuging water taken at different depths in the water bottles and counting the organisms thus obtained under the microscope. The tiny plants form the ultimate source of food for all the animals in the sea, just as the more familiar terrestrial plants do for land creatures, because the green plant alone knows the knack of harnessing the sun's energy to synthesize the elemental food compounds from inorganic substances. Thus the phytoplankton serves directly or indirectly as nourishment for the smaller animals of the sea, some of which live on the bottom and are familiar to everyone who has visited the sea shore, while others, spoken of as the zooplankton and much greater in abundance though generally smaller, live drifting about in the water. Copepods—primitive crustaceans less than a quarter of an inch long—are probably the most numerous and most important members of the zooplankton considering the ocean as a whole. These small animals exist in such numbers off the coast of Norway, for example, that the commercially valuable Sei-whale feeds on them almost exclusively.

Bottom-living organisms are caught with dredges and trawls of various kinds, while plankton animals are procured by towing fine-meshed nets through the water. A rough quantitative estimate of the abundance of animal life in the water through which the net was drawn may be obtained by measuring with a current meter the actual amount of water which is strained by the net during the period of the tow. Sometimes the plankton net is

lowered to the bottom and pulled straight to the surface, making what is known as a vertical haul. The catch in this case reveals the number of organisms present under an area of sea surface equal to the size of the mouth of the net.

It would not be safe to generalize too greatly from this single catch, however, because a second haul made immediately after the first would probably catch a distinctly different number of animals. In other words, the floating life in the sea is not dispersed uniformly throughout the water but seems to exist in irregular swarms. The reader will at once perceive that to obtain a census having any real quantitative significance of the abundance of plankton in a given part of the sea is one of the most baffling problems of oceanography. The effect of irregular distribution is somewhat mitigated by making long horizontal tows, but unless a great many of these are undertaken at different depths, there is always the possibility that the intervening unsampled strata differ widely from those in which the net has fished.

An ingenious device

Another complication arises from the fact that in attempting to study the lower water layers the catch will be contaminated by organisms taken while the net is being lowered to the desired depth and while it is being hauled to the surface again. To circumvent this difficulty it has been necessary to resort to specially constructed nets which could be kept closed except when they are towed at their correct depths. The mechanical difficulties to be overcome in building a device which will perform satisfactorily under the rough conditions experienced at sea and which will operate a net at a depth of say three thousand feet need no comment. Nevertheless, although our present closing nets are not ideal, much valuable information about the vertical distribution of plankton has already been obtained and our technique is continually being improved. At the present time we are able to operate simultaneously as many as five closing nets attached at intervals to the same cable.

One extraordinary fact about the plankton, revealed through the use of closing nets towed at different levels, is the occurrence of a vertical migration which takes place twice each day in many parts of the ocean and perhaps universally. It has been found that copepods and some other kinds of zooplankton swarm

toward the surface at night but as soon as daylight reaches a certain intensity, these animals start swimming rapidly downward. With the waning of the illumination in the afternoon the animals move toward the surface again and the diurnal migration continues. Careful measurements of the intensity of the illumination at various depths at different times of day revealed the fact that the animals are forced to leave water strata in which the light has become stronger than a certain value and are thus caused to move progressively downward as the sun mounts the sky. Precisely what causes the animals to return to the surface again when darkness falls is as yet a mystery and there are other complications in their behavior which are still to be explained.

Interrelationships

The interrelations of the various plankton organisms constitute another problem in oceanography. From the seasonal changes in the population certain inferences can be drawn as to the dependence of one type upon another. The problem is being attacked in another way by culturing the organisms in the laboratory and studying their food requirements. While the animals are living in the laboratory where conditions can be carefully controlled, the effect of other environmental factors such as light and temperature on their growth and development can be tested. This work is just being begun.

All of these primitive types of organisms are of practical importance to man in relation to the commercial fisheries. In the first place the newly hatched young of both fish and shellfish are so small and weak that they are easy prey for larger animals. Furthermore, it has been shown that the larvæ of certain types of fish feed upon diatoms, then, as the fry grow larger, a shift is made to an animal diet. When adult, certain commercially important fish and whales live exclusively on plankton animals; others feed on the more familiar bottom fauna, but most of these latter are de-

pendent upon the plankton for their subsistence at some stage of their development. Temperature, currents, and other physical and chemical factors in the environment, as well as the food supply, play prominent rôles in the control of growth, spawning, and migration of fish.

A pyramid in the sea

Thus we see that, broadly speaking, a pyramid exists in the sea, with the smaller organisms at the bottom and each type serving as a source of food for the type above. As these various forms die, their bodies are decomposed through the action of bacteria, and their chemical components appear again in solution in the water. These are taken up once more by the plants and thus the cycle is begun anew. The bacteriology of the sea is, accordingly, another essential branch of oceanography and one which—though of fundamental importance—is still in its infancy. But even the bacteria, hunted down in the sea water itself, in the mud on the ocean bottom, and in the bodies of both living and dead organisms, are now being forced to yield up their secrets.

This fundamental interdependence of the various organisms living in the sea is characteristic of the science of oceanography as a whole. Every branch of the subject touches upon every other branch at some point. Currents, temperature changes, evaporation, sedimentation, chemical reactions, distribution of plants and animals, and the physiological activities of these—all are related.

To attack successfully any of the problems roughly sketched in the foregoing pages, co-operation from other branches of oceanography is not only an advantage, but in many cases a necessity. Accordingly the founding of such a working unit as the Woods Hole Oceanographic Institution, possessing a staff of oceanographers who are specialists in the various component sciences and equipped with the necessary boats and instruments, provides a hopeful outlook for the solving of these important problems.



Photo by E. E. Watson

LABORATORIES ON LAND AND WATER

Photo by C. E. Renn

(Upper) The "Atlantis" leaving the dock under sail, a hazardous undertaking for such a large vessel

(Lower) The Woods Hole Oceanographic Institution. Behind the dock may be seen the protected basin for small boats



Rough weather is the bane of the oceanographer's existence, but strong winds are useful in getting from station to station. All but the most



WEATHER

Photograph by C. E. Renn

The bow of the "Atlantis" on a cruise in winter. The ship is in operation all year round, but observations in the north during cold weather are extremely difficult



*Photograph by
Marshall Schalk*

*ugged instruments would be smashed
o pieces if an attempt were made to
se them when the weather is whip-
ing up a sea like this*

HAZARDS



Photo by C. E. Renn

Snow and ice and numb fingers make hydrographic work precarious in mid-winter both for the men and for the valuable equipment aboard ship

ACTIVITIES ON BOARD



Studying the change in the velocity of the wind at different elevations above the sea by means of the pilot balloon. Photo by T. S. Greenwood



Snapper for obtaining small samples of the bottom. The jaws close automatically when the instrument strikes the bottom. Photo by C. E. Renn



The plankton net is hoisted on board and the catch removed from the bottom end. The coarse net protects the finer net within. Photo by E. E. Watson



Petersen Grab bringing up a sample of the sea bottom, from which it is possible to interpret its present and often past formation. Photo by E. E. Watson



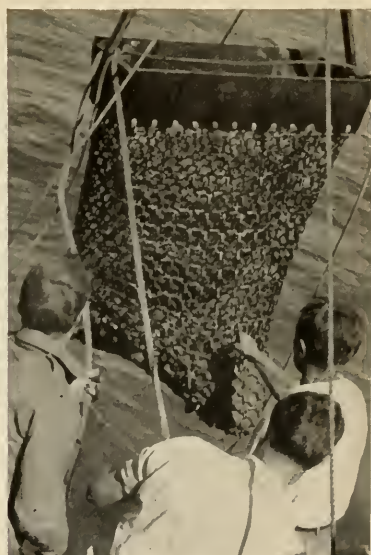
This man is following the movement of free floating buoys with a range finder, in the study of surface currents. Photo by E. E. Watson



One of the "otter boards" of a big fish trawl just coming out of the water. Various dredges and trawls are important aids. Photo by T. S. Greenwood



A weighted metal tube for procuring a vertical core of the bottom deposits, from which the stratification of the mud can be studied. Photo by C. E. Renn



Dredge for obtaining samples of a rocky bottom or for breaking off chunks from the walls of submarine canyons. Photo by Marshall Schalk



Here the hydrographer's water bottle has been clamped to the cable and a "messenger" weight is being attached beneath it. Photo by C. E. Renn



Attaching a current meter to the cable before lowering it into the water for an investigation of the problem of ocean currents. Photo by C. E. Renn

Specific ocean problems are being successfully attacked by the Woods Hole Oceanographic Institution with the aid of methods and equipment especially selected for the task



A bottom sampler for quantitative work. The curved tube describes an arc through the mud and then its contents are automatically sealed up. Photo by T. S. Greenwood



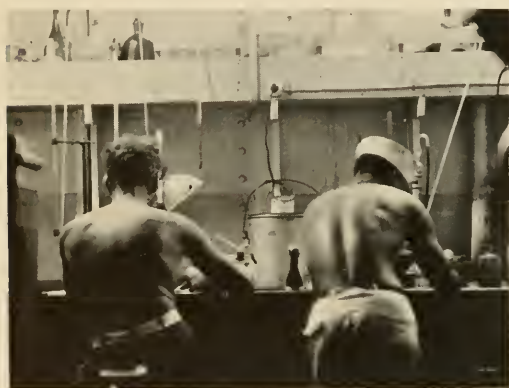
The catch from the plankton nets is emptied into suitable containers where it may be studied and a record made of the organisms present. Photo by T. S. Greenwood



Passing one of the hydrographer's water bottles to the man on the platform. The water is then drawn off and analysed in the laboratories. Photo by T. S. Greenwood



The hydrographic winch in operation. As the cable passes over pulleys mounted on gallows at the rail, the amount of wire out is recorded on the dials. Photo by E. E. Watson



Chemical analysis being carried out in the lower latoratory of the "Atlantis." Plenty of light and head room has been provided below decks. Photo by T. S. Greenwood



Net for collecting Sargassum weed in a study of its distribution. This famed seaweed also harbors an abundance of fishes, crustaceans, and mollusks. Photo by T. S. Greenwood

Across Newfoundland

Fine scenery and fine people add zest to a search for pre-glacial fauna

By STANLEY TRUMAN BROOKS

*Curator of the Section of Recent Invertebrates,
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NEWFOUNDLAND, the New-Found-Land, is the oldest land, geologically, of the North American continent, the oldest of the British colonies, and the beginning of the British Empire. It was discovered only five years after Columbus discovered the New World, by John Cabot who in all probability was accompanied by his son Sebastian. What history could this grim northern island tell if it could but speak!

It is surprising that even in the nineteenth century no white man had crossed this island; no one knew what was "inside," or what treasures were there in store for the hardy adventurer. William Epps Cormack was the first to make this trip, and in the fall of 1822 set out from nearly the same spot where Balbo landed his fleet to make his way across the island on foot. His experiences were those of any pioneer; he lacked food and was chilled by the winds and snow. He suffered the same torments from the blood-sucking insects as one does today in that land. However, he found iron and coal, other minerals, and marble. His findings were the basis of many of the present industries of that still wild and untamed wilderness.

Interior is little known

Fundamentally a land of fisheries, the interior is still much less known than is the coast line. Today there are few maps of the 43,000 square miles of tundra, barrens, and forests. Information is scanty, and it was with some trepidation that I set out from St. John's to collect animals. However, after talking to

many government employees and with fishermen and a few woodsmen I was able to lay out a fairly satisfactory itinerary for my journey, the purpose of which was to collect molluscs.

Pre-glacial creatures

Newfoundland received her fauna of land snails long before the appearance of the great ice cap that covered North America. While the waters of the northern Atlantic were warm and the inland seas of America were teeming with the scaly reptilian forms, the lowly land snails were migrating, forcing their way over the two great northern continents. Then, eons later, when the ice came out of the north and destroyed the fauna of our northern regions, a few isolated peaks on this new-found-land still stood above the snow and ice. The great ice sheet that covered North America did not force its way across the strait from Labrador; hence only a series of local glaciers covered most of Newfoundland. This condition enabled the surviving land fauna to live through this cold period and repopulate the verdant slopes upon the dispersal of the ice-sheet.

My task was to find these survivors and bring them back for study. In the laboratory these few thousands of specimens will help to piece out the story, I hope, of this early migration and cast further light upon the antecedents of the fauna of our own America.

Approaching St. John's by water, one is awed by the great cliffs that rise up from the sea like sentinels. No entrance can be seen in this seemingly continuous wall of stone until one is almost in the narrow entrance of St. John's harbor. The entrance is less than a quarter of a mile wide and at one time in the

past was protected by a huge chain hung from cliff to cliff. Upon these rock walls towering some five hundred feet above the water are the ancient ramparts of both French and English forts. Now standing upon the crest of the northerly head is Cabot Tower. The first wireless message was flashed across the Atlantic from this stone building, and the eyes of many aviators have beheld this as the last of American soil to be seen as they faced the vast Atlantic and the vaster unknown.

Old world quaintness

St. John's is a city of nearly 50,000 inhabitants and is the metropolis of the island. Its cobblestone streets resound continually with the rattling and bumping of the two-wheeled carts that are so characteristic of its water front. These carts, drawn by the small Newfoundland horses, are interspersed here and there with motor cars. One expecting them to proceed on the right side of the street as in the United States will unwittingly step out from the curb at the wrong time, for they follow the opposite rule. It takes some time for one to reverse one's pedestrian habits.

The streets have an old world quaintness. Many of them are steep and are bordered by long flights of steps. The houses open on to the sidewalk and their somber fronts reflect the British respectability of their inhabitants. Walking along the streets, one is especially impressed by the youthfulness and high character of the police. Only recently reorganized, this force is expecting to become the "Mounties" of Newfoundland. They are in reality both the police and the standing army of this island. They are "sold" on their jobs. Like the English Bobby, they can answer your questions. This is also illuminating to the tourist.

This city is the cultural center of Newfoundland, and is full of historical interest. Old guns and the remains of French and English forts dot the cliffs near Cabot Tower. From that eminence one can look down on the city and harbor; the long, tortuous water front with its ships of all sizes and the "flakes" of the fishermen that live along the shore. The flakes are the drying racks upon which the catch is spread to dry. If one walks along the water front, one will meet many a stray zephyr wafted up from these industries.

With my plans completed and shopping done, the start to the interior was made. The Newfoundland Railway is a narrow gauge road that meanders for some five hundred miles before it ends at Port-Aux-Basque on the west coast. The first stop was made about seventy miles from St. John's, at Whitbourne. Here one gets the first fragrance of the early summer planting. Every plot of ground and every field either planted or to be planted in food stuffs reeks of decaying fish.

These fish, the caplin, come into the shoal water in great numbers about the first of June. The fishermen-farmers drive their two-wheeled carts to the beach. There, with a throw-net, they are soon filled and the scaly fertilizer is taken back to the fields and gardens. Every pasture and every garden glistens with their slender, silvery bodies. The odor becomes increasingly terrific day after day until one passes the last seaport on the trail to the interior.

The caplin is one of the most delicious food fishes produced in Newfoundland. Being a fish-lover, I groaned to see all of these fish wasted while I was being fed upon "bully beef" and canned rabbit. Later, upon insisting, I had two fine meals of caplin. But, according to my landlady, they never have more than one meal of them a year. A small quantity are pickled or dried for export.

Collecting in this region was disappointing, and after a few discouraging days I caught the bi-weekly train for the west.

Language difficulties

While in this region, and in my first contact with an "outport," I found several peculiar modes of speech. A seasoned Newfoundlanders is able to tell the various outporters by their speech. This, of course, I could not do. But among those I had for guides and among the children of the village who followed me on my quests for snails and insects were many peculiarities. Snails that I collected were "wrinkles," dragon flies were "horse-stingers," mussels were "pussels," and any insect or animal not bearing a common name was a "machine." Imagine my surprise the first time one of my companions hallooed to me that he had a "machine" for me. There is an inbred courtesy among these people, and most questions directed toward me were prefaced by the usual "Sir?"

Half a night on the train brought me to Clarenville and its neighbor, Shoal Harbor. These two villages meander along the coast for several miles, losing themselves in either direction in the vast forests. The smooth waters of the bay are now famous, for it was there that Italo Balbo landed his fleet on its epoch-making flight to America. The villagers are still talking about that time, when the eyes of all the world were on this isolated water and the Italian battleships lay at anchor at their very doors; and many feminine hearts still beat faster when they think of the gallant ship's officers and sailors who for a time made their home there.

A disturbing discovery

The first day or so of my stay in this place was marked with cold rains and fogs, but finally these lifted and I set out into the woods with my guide, Leslie Tuck, a young school teacher. The day was not profitable but interesting. The wild iris blooming so profusely enticed butterflies and clear-winged moths. A little lake of brownish water yielded water beetles and dragon flies. After wading in this hilltop pond for most of the afternoon and returning to the hotel I learned that this prolific bit of water was the unpurified source of our drinking water. It was a light tea-color and, believe me, after that I watched very carefully for beetles or insect larvæ in my glass.

Through a faint memory which my guide had of "wrinkles" seen in the past and a trip of some eight miles through swamps and underbrush I was able to collect my first land snails of the kind valuable to me. One of these is a large species of the form common to Europe, also found in the eastern United States and Canada. It is called *Helix hortensis* and has been an article of food of the European from time immemorial.

Some theories as to how these snails got to Newfoundland are interesting. Some have said that a ship carrying straw, etc., was wrecked upon the shore and that these unsuspected stowaways survived and spread over the land. Another was that Leif Ericson brought them with him as food on his voyage of discovery. This species was perhaps the last immigrant to make its way across the Atlantic and populate the islands of the St. Lawrence embayment and our eastern states.

This first success was heartening. Other kinds found with this large species varied in size down to less than the width of a small pinhead. It is a thrill to go so far and then find these minute animals that we knew must exist there.

Mine was not the first journey of discovery to set out with Random Sound as a portal to the interior. Cormack on his trip across the island in 1822 began his advance into the unknown at this point. When he started, he and his guide were on foot, the interior was unknown and inhabited only by redskins. He knew not what he would meet or whether he would ever see the west coast. I also did not know what I would find, but the path was smoother. I rode a "trans-islandic express," he "shank's mare." He suffered from the same blood-sucking insects that I did. The forest, the bogs, the hills and mountains have not changed, and the average citizen of St. John's still looks upon the outports as the beginning of nowhere.

In the pulp wood center

My next stop to the west was a day's ride on the "express," and landed me in the valley of the Great Exploits River. This is the largest river in Newfoundland and is the center of the pulp wood industry of this island. Grand Falls is the third largest city in Newfoundland and is a mill town, being ruled by the large paper mill of the *London Daily Mail*. Grand Falls is a city unique in that it has known no depression. Newfoundland in general has been hard hit by the depression, but this city has continued its busy way. The trained "paper makers" are still paid high wages and a happier and more carefree group would be hard to find.

Here I found hospitality and coöperation, and a happier, busier, and more profitable week could hardly be imagined. Days were spent along the shores of the Exploits where for five miles up its turbulent surface fleets of logs were floating and tossing on their way to the mill. This constant flow of timber, all cut to the proper size, is regulated by the huge booms, or chains of logs, that stretch out across the more quiet parts of the river. Above some of these booms the water is solidly covered and appears as a river of wood.

Along the roads, in the streets of the city,

and in all vacant areas, goats, the small Newfoundland horse, and the remnants of the strong Newfoundland dog run loose, hampered by no barriers but those erected by the people to preserve their gardens. It was not uncommon to see a dog team, not hitched to a sleigh, but to a small wagon, drawing large loads of kindling (splints) along the roads and streets.

Summer was now coming on in earnest; the dragon flies, butterflies, and other desirable insects were emerging in great numbers, and we were kept happy and busy in their pursuit. A day of collecting always meant an evening of work in preparing the material for packing. Everyone was helpful and hardly a day was spent alone in the field. Through the kindness of one of my new found friends, Albert Green, a paper maker, I was allowed the use of the company club, and there to my delight I found the first American newspapers and magazines, and sad to say, the last I was to see until my return. The first letters from America arrived during this busy week and added much to the occasion.

Up the social ladder

I must mention that my tour so far had been made in overalls and high leather boots. These were an open sesame to the people and they accepted me not as a foreigner but as a prospector. An amusing incident occurred in Grand Falls. When I arrived dressed in the field-soiled clothing, incidentally the poorest dressed man I had observed with the exception of some lumbermen returning from Labrador, and registered at the leading hotel, I was immediately put at one of the side tables. I found my companions at the table good fellows and thoroughly enjoyed them. Later, when my first mail arrived bearing the name and the seal of the Carnegie Museum, the landlady asked me to change to another table and escorted me to one set for four. I thought immediately that I had offended someone and that they had asked for my removal. Then I met the men at my new table as they arrived, the one the minister, and the other the banker. I was still in my overalls and blue shirt, but at this table I received orange juice for breakfast while at the other tables this was not served. In spite of the overalls, boots, and my ever-present odor of fly-

dope which was indispensable, I was elevated to my proper (?) place in society. Naturally I enjoyed the orange juice.

On the day of my departure rain came down in torrents, tropical in amounts, but glacial in temperature. This rain seemed to spell the end of summer as from then on the weather was colder and collections were not as prolific although more valuable.

A native trait

Honesty is as characteristic and as widespread as one would imagine Roman noses to be in Rome, and a good example was my experience at Grand Falls. I left the taxi quite hurriedly at the Grand Falls Station and took shelter in the small station waiting room. I piled my eight or ten pieces of heavy baggage on the floor and threw my leather coat down with them. The waiting room was crowded with lumbermen, as the night before quite a group of striking and penniless workmen were ejected from the train at this station. Most of them were poorly dressed and in need of clothing. In the rush to get all of my baggage on the express, I dropped my leather coat, and I did not realize my loss when the train began to pull out. Looking out of the window I noticed a poorly dressed individual holding a leather coat. It looked very familiar and I began to rummage around. It was my coat!

I informed the conductor. He told me to get off of the train at the next stop and telegraph. Nearly an hour later this was done and I resigned myself to my loss, as a leather coat in Newfoundland is a handy and necessary article of apparel. If my coat was found it would be sent on to me at Corner Brook. At Corner Brook I was to take the steamer north to Bonne Bay. The boat left in three days and the next train from the east was also three days away.

To make the story short, I arranged for it to be placed on the boat at Curling if it missed the boat at Corner Brook, and sure enough it was waiting for me on the steamer "Sagana." My pipe and new wallet of tobacco were still in my pocket and untouched. All over Newfoundland one will find such honesty. During the entire two months I never slept behind locked doors and for that matter there were no keys to fit the doors; not even at my hotel in St. John's.

The few days in Corner Brook waiting for the upcoast boat, the "Sagona," were spent in shopping for a few necessities, taking photographs, and dodging the four hundred automobiles that this region boasts. There are about twenty miles of road for this number of vehicles so that the dust in the streets is never still.

A cross section of life

The "Sagona," a bi-monthly boat of the Newfoundland Railways Company, is one of the few connections that the people of the west coast of Newfoundland have with the outer world. Food stuffs, supplies for the fisheries and for the lumber camps are disgorged from her holds at each stop. Persons ill and in need of hospitalization await her arrival, visitors to and from the various ports crowd her decks. All in all, the life aboard the "Sagona" is a cross section of the life of the west coast.

On the cruise to Bonne Bay we left Corner Brook and Curling in the growing dusk. The beautiful Bay of Islands with the snow clad table-lands in the distance is like a vast enchanted lake with the greens and browns of the forested hills blending into the gray of the distant fogs. The plants and homes of Curling lose themselves in the distance, a mere line between the frowning hills and the placid water of the bay and river. The setting sun silvers the waters at the bow with a dazzling brilliance and then changes to the red and gold of twilight.

The purple shadows lengthen across the water, and as the hills and valleys of the fading landscape darken, we make our first brief stops. The peace of the tiny port is disturbed by the whining of the cargo hoist as the precious boxes and barrels are lowered to the dock. The whole village is in attendance; some recognize friends and soon the deck is crowded, greetings are exchanged and gossip of the fishing or logging conditions occupies the time until the short blast of the whistle sends them scurrying ashore. We are off to the next port and the performance is repeated.

All night long this occurs. In some places the harbor is too shallow and the boat cannot reach the dock. Then the cargo is lightered out to the ship along with the passengers for the north. The fishermen's faces in the dim

light shed from the cargo deck are animated white splotches upon the inky blackness of the water, and as they are tossed up and down by the swell of the sea, they present an unreal, eerie picture. Only their skill born of the years on the sea prevents the heavy cases and barrels from going overboard as they are lowered from the swaying ship's boom.

Morning approaches and I am still pacing the deck. There is too much to see in such a short time, passengers to talk to, odors of the sea to be detected, to sleep away this precious bit of existence. The cabins are filled with the women and children. Most of them are able to sleep the night through. Others not so fortunate "bed down" on the upholstered seats around the combined dining room and lounge. Women with their children in the protection of their out-thrown arms sleep and toss with the roll of the boat. Here and there one awakens and repairs the damage to her coiffure, others awaken and do not seem to care. A restless baby arouses a toil-worn mother and she sleepily arises to nurse it or to search for the evaporated milk in the pantry. Several times I helped prepare the milk for the crying infant or obtained drinking water from the cask on deck for a seasick person.

The goal in sight

All of this was life to me. Men in homely postures, sleeping on the dining room tables spread-eagle upon their backs, their mouths open, the harsh schlup, schlup of their stertorous breathing mingled with the creak and crash of the tackle overhead. Morning awakens hazy, misty, with the ever-present fog wraithlike over the distant mainland. An entire night's journey, a dozen stops for cargo and passengers, and we are still within a hundred miles of our starting point. But, we are in Bonne Bay, among the mountains of the Long Range, the final goal of my journey.

On the peaks, barren and wind swept, lived the present fauna throughout the long glacial period. Here my animals were preserved by fate to tell us more of the history of that great era. Here I was to spend the last month of my trip and here I was to find the answer to some of my questions.

With a long blast of her whistle, the "Sagona" drew into the dock. I was introduced to my landlord by the lumber boss with

whom I had traveled from Corner Brook. Mr. Tapper, as his name happened to be, took me under his wing and soon I was settled in the Staff House of the lumber company. Later I was to present my credentials to the superintendent of the company and ask his permission to remain in this village, which like others is controlled by the lumber company. It consists of the homes of the workmen, a company store, and a combination telegraph-post-office.

An impressive wilderness

Life in Lomond was ideal; interesting companions, excellent cooks, plenty to eat, and all day for work or play. Naturally I was here to collect and not to play, but for that matter, collecting is so pleasurable that it may sometimes be play. However, the insects would not let you get too rosy a feeling about life. In the mornings, even though wet, foggy, and chilly, the tiny punkies or biting midges were out in great numbers and the burning sensation that they produced seemed to engulf the entire body. They are small but cause a large amount of misery! The woodsmen at this time of day suffer greatly. With the exception of two men, one the Swedish woods' boss, Mr. Johnson, and the other an Indian, every one was bitten by these pests. Later in the day, this species lets up its torture and gives way to the black flies, mosquitoes, deer flies, and a large species of horsefly or "stout" as the inhabitants call them. One may wear a head-net, but it is a nuisance in the brush and is early cast aside. The only other protection is "fly-dope." This usually consists of oil, tar, and citronella or other ingredients repulsive to insects. This dark and oily mixture is applied to every exposed surface. Perhaps this sounds forbidding, but after one has gathered a goodly crop of bites it becomes highly desirable.

From my bedroom window I could look for miles across the bay where a waterfall, springing from a snow-bound ledge, spent itself in a deep valley between the mountains. It must have been some distance away, but on quiet nights one could hear its rumbling torrent like the pulse of that wild country as it swelled and died away on the breeze. From all that I have said, the land does not sound very wild and untamed. I have only spoken of the area spanning the trans-islandic rail-

road and the coast line. The part that you can see in the distance, between the towering hills, is almost impossible to reach in the summer, completely uninhabited but for bear, moose, caribou, and penetrated only in the winter when one can make one's way *over* the underbrush on the deep snow. Strange as it seems, the interior is more accessible during the winter months. The inhabitants also look forward to this time when on snowshoes and with dog team they make their way into the hills in quest of game.

All my daily excursions out of this place were either on foot, by boat along the shore, or in the company truck that made the trip to the logging depot on the "inside" daily. By boat we cruised past great heads and vertical cliffs, long, sloping forested hillsides, and through quiet coves and miniature harbors. Some of the spots were jewel-like with their softly tinted flowers and shrubs, like some forgotten English garden. Other landing places were rough and strewn with boulders; each, however, yielded specimens to my ever rapacious knapsack. Every valley we passed echoed with the thunder of waterfalls and leaping streams.

The tallest peak ascended

During the month, one excursion led me to one of the tallest peaks in Newfoundland, Gros Morne. This is one of the glacial islands, which, as I have mentioned before, was the supposed place of survival of the local flora and fauna. It was my hope that upon its lower wooded levels specimens of plants and animals would be found that would aid me in my researches. This hope was gratified to some extent, but the trip was less productive of material than I had expected.

Arising early, I boarded the motor boat that I had hired for the day, and landed about eleven o'clock in a shallow bay. It was about a mile to the house of the guide, a Micmac Indian by the name of Lawrence Mitchell. Obtaining his services and after "boiling up," as the Newfoundlander calls tea making, we set out along the beach. The Indian said, "Here is the trail." But my inexperienced eye saw little difference between the trail and the surrounding thicket. It is as Cormack has aptly said, "The Indian idea of a road is to Europeans little more than the possibility of reaching a distant place alive."

Nearly three hours of labor through the thick underbrush brought us high up on the side of the mountain and out of the forests that cover its sides. Another hour of scrambling over the huge rocks and sliding talus finally brought us to the top and there we rested.

A panorama

Off to the left of us lay the faint coast line nearly hidden in the haze and fog; the land between the mountain and the sea was dotted with marshes and lakes. Back of us the other mountains flattened out into mere hills and the springs gushing from the rocky sides more than a thousand feet below formed lakes that appeared like so many silvery pools. Directly below us two thousand feet down a precipitous wall of rock and clinging shrubs lay a cobalt-blue lake. Across from us was a table-land flanking the lake, its sides rising hundreds of feet in the air and streaked with mud slides and long gray slides of rubble and stone. To the north, the mountains, like waves of the sea in endless march, stretched out in serried rows until lost in the haze of the distance.

This range, the Long Range, continues along the northern peninsula to its tip. There at the Strait of Belle Isle it faces the precipitous Labrador shore. A land of mystery with a spell of enchantment; what is beyond the next peak and what is beyond that?

My Micmac guide had traversed this entire range on foot and knew it all. He was not bothered by the flies, and the wilderness was his home. No matter what the labor of the day consists of he is ready to turn to the solitude of the forest and may spend days within it only to reappear later and take up his work where he left off. This was illustrated when first my companion and I met him. He had not known we were coming nor had he planned on making a trip that day. But when my boatman introduced me and told him that I wished to go up Gros Morne, he paused in his work (he was building a new house for the winter), and answered that he would be glad to go as soon as he drove in the nail he had in his hand.

While we were sitting on top of the mountain and later when we were gathered around his camp fire as we "boiled the pot," he spoke of his people, the Micmac tribe which came from Cape Breton Island and are of the

Algonquin race, and of the aboriginal race, the Red Indians or Beothucks. He told me how one of his ancestors claimed the doubtful honor of having slain the last Beothuck. The story he told was as follows:

His ancestor and a friend had had bad hunting and during the long cold winter, as a last resort, had been forced to seek aid of the Beothucks who were camped near by. The friend was chosen and went to the Red Indian encampment to make his request. They invited him into their dwelling, they bade him sit and placed food before him. But as he squatted there on the floor and before he had time to eat, a powerful brave behind him drove his crude spear into his back; striking him in the neck and pinning his body, still upright and seated, to the earthen floor of the tepee. The Beothucks fled and Mitchell's ancestor, after waiting for his friend's return, came in search of him. He found him seated before the untasted food and swore he would kill every Red Indian in Newfoundland. He lived to his oath and killed many of them; the last one being shot from a tree where he had taken refuge.

The history of the Beothucks is a sad one and illustrates the crude human passion of cruelty. They were a fine race; tall, handsome, and of great intelligence. Their origin is shrouded in mystery. Some feel that they are of the earlier Algonquin stock that came to Newfoundland before the other groups. In the various books at my disposal I have found that there is a strong belief that the Red Indian is a product of the inter-mixture of the aboriginal Indian and the Norse immigrants that made their way to Newfoundland (Vinland or Markland of the Saga?), under the leadership of Leif Ericson. Several of their customs seem to point to this relationship: they made boats different from those of the mainland, they made puddings of suet that were contained in gut-casings, their wigwams were covered with skins and not of bark like those of the Micmacs, their hair was lighter, like that of the European, and their skin was more fair than that of the neighboring tribes. The name Red Indian came from the observation of their use of red ochre: their bodies, implements, boats, and habitations all were smeared with this pigment.

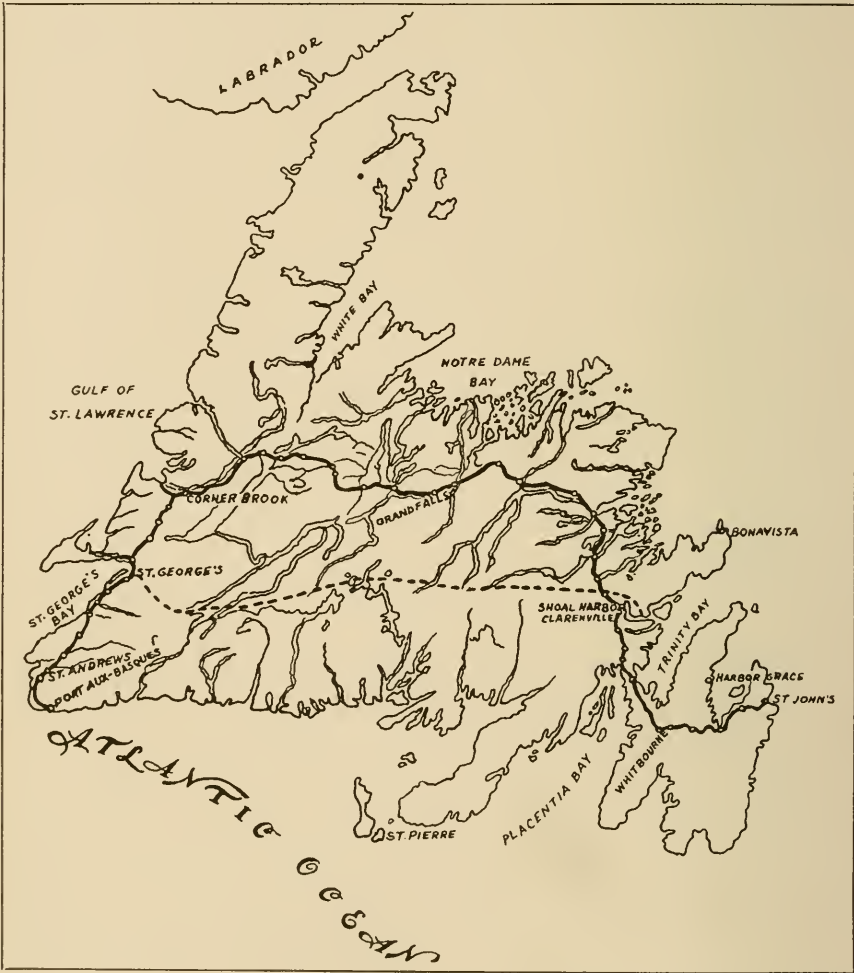
The presence of this group was observed by John Cabot at the time of his discovery of the island. The English lived fairly happily

with the Beothucks, but when the French began their settlements, the thieving habits of the natives brought down their ire upon them. The French, becoming exasperated, placed a bounty on the head of every Beothuck. The Micmacs hunted them as they would so many animals; and in 1830 the last known survivor (according to historical notes) of this race died in the hospital at St. John's. So passed a race whose origin and history died with them, and in their place remain but a few remnants of their conquerors.

* * *

After all of the interesting days of my trip across Newfoundland and the entrancing

beauty of Bonne Bay in its various moods, the day finally came when it was necessary to depart. I had learned to love the Newfoundlanders, their helpful friendliness and generosity. In passing I wish to pay them this tribute. Through all of the vicissitudes of climate, war, and the economic and political strife of these last years, the Newfoundlander has held his head high, full of hope and happiness, and has met his conditions with the minimum of despair. The hardy blood that conquered the icy northern seas and fed the nations of the world still speaks, demands life, liberty, and offers for them the sweat of his brow, the loyalty of his flesh, and his dreams of a future security and peace.



NEWFOUNDLAND—BRITAIN'S OLDEST COLONY

The broken line indicates the route of the first crossing of Newfoundland in 1822, while the

solid line follows the trans-island railway trip described in the above article



Photo from Ewing Galloceay

St. John's bottle-shaped harbor, showing the Narrows, a perfect gateway to the open sea.

The entrance to the chief city of Newfoundland is less than a quarter of a mile wide



(Above) Exploits River, near Grand Falls. Much of Newfoundland is rocky

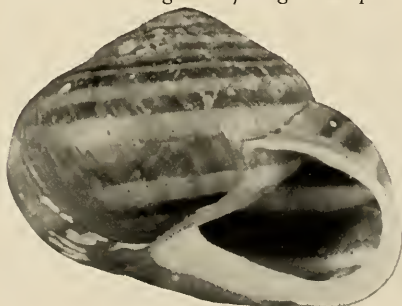
(Left) A type of snail found by the author near the above scene

(Right) Found near Whitbourne. Photographs about twice actual size

(Below) One of the latest arrivals to our shores during the pre-glacial period



(*Stagnicola palustris perpalustris*)



(*Helix hortensis* Müll)



(*Stagnicola palustris papyraceo*)



The beach of St. Pierre. This is one of two small islands south of Newfoundland where French is the language spoken



(Below) Dried cod being loaded into boats at Quidi Vidi to be taken to market. Photograph by Philip D. Gendreau



Exit of Quidi Vidi Inlet with the ocean beyond. Fishermen's dwellings, landing stages, and flakes for drying fish are at the right



(Above) Quidi Vidi fishing village, typical of the peaceful hamlets which nestle along Newfoundland's stern shores. Photograph by Philip D. Gendreau



Coves like this on Newfoundland's indented coast present welcome shelter from the boisterous North Atlantic. Philip D. Gendreau photograph



(Right) This old ship's figurehead in a St. Pierre street reminds the passer-by that many generations of seafaring tradition lie back of these islands



Photo by Ewing Galloway

(Above) A scene at one of the Newfoundland fisheries showing the cod fish spread out to dry. About three fourths of the annual harvest of fishes of our North

Atlantic coast reaches the markets in fresh condition. The remainder reaches the consumer as canned, smoked, and salted fish



*© Capt. Barillet
From Gendreau*

(Right) Gathering up the dried fish. A typical native in his workaday clothes. Notice his waterproof sealskin boots of Eskimo manufacture



From Ewing Galloceay

Torbay, a little fishing village nine miles from St. John's. As usual, many fences cut up the landscape into a complex

patchwork. The coastline of Newfoundland is exceedingly irregular and is indented by many deep bays and harbors



*Photo from
Philip D. Gendreau*

The fish are hauled from the shore to the flakes in two-wheeled carts like this one, drawn by the small Newfoundland horse. The horse will back the cart right out into the water to the boat's side

(Right) Looking from the summit of Gros Morne, the highest mountain in Newfoundland. This peak and a few other isolated ones on the island remained exposed during the Ice Age



(Left) Big Pond, near Lomond, Bonne Bay, where the author made his base for a month of field work

(Right) Salmon fishing near Lomond, Bonne Bay. Newfoundland's streams abound in various kinds of fish and many sportsmen travel there every year



A Strange Partnership

How Mayimba, a bird, and Kambole, a honey badger, combine their efforts to mutual advantage

By DON H. SELCHOW

FIGHTING my way through heavy underbrush for several miles one day in Northern Rhodesia, I unexpectedly came upon a small open space which was not more than ten yards across. Ordinarily I should not have noticed it as anything but a tiny natural clearing, but I happened to look down at the ground and saw that it was all torn up. The earth was almost powdered in spots and the grass and small vines had been torn up by their roots.

My rifle boy came up alongside of me from his usual station at my heels, took a look around and said "Kambole."

Other natives of my retinue drew up and talked among themselves; and from these conversations I gathered, strange as it may seem, that Kambole had been drinking.

"Who was this Kambole?" I began wondering, "and what had he been drinking?"

More discussion among my boys, a search around the ground, and a coarse black hair was tenderly picked up and brought for my inspection.

Another native called from one side of the diminutive clearing and we went over. I was shown a knot hole going deep into the trunk of a tree. In this hole were a few tablespoons of dirty looking liquid. My natives bade me to take a smell of this hole, which I did. One whiff was sufficient to tell me that alcoholic fermentation had been taking place therein.

This was my first introduction to the strange proceedings of Kambole whom I later found was known in English as the honey badger. Kambole is his Kaonde name and

since it was by this name I knew him during my three years in Northern Rhodesia, I shall call him that in this account.

Characteristics of a honey badger

There are several things which immediately characterize Kambole. The first of these is the fact that he is one of the few animals which are completely black on the underparts and white on top. His hair is coarse and shaggy and in the warm weather it is rather thinly distributed. His total length is a little in excess of three feet, but he appears longer because of the shortness of his legs. Any zoölogical garden which has tried to keep a honey badger in confinement will have wild tales to tell about him, unless perhaps they had been warned of his tendencies ahead of time. He will smash his way out of a cage that appears to be strong enough for a much larger animal. His wanting to get out does not seem to be due to a terror of confinement but rather merely to a curiosity to go and sniff around the other side of the room. Kambole makes a very fine pet, providing you can keep him from straying away. He is very friendly and quite original in his antics, according to those who have raised one. His diet consists of small prey, insects, and, quite naturally as the name implies, honey.

As I have said before, the honey badger has short legs, which are better adapted for digging than they are for walking. Consequently, he is not able conveniently to make the long excursions necessary for finding sufficient honey to satisfy his appetite. To overcome this, as my natives presently maintained, Kambole has a

partner in his enterprises: his friend Mayimba helps him.

Mayimba can cover mile upon mile each day and find every honey tree in the vicinity—for Mayimba is a bird. If he should whirl over your head and you should look up and see him, his appearance would not demand a second glance. Slightly larger than our American sparrow, he is built along much the same lines, and is of a brownish-gray color. Yet he is an extremely clever bird.

As to how his amazing partnership with Kambole came about, the natives would not say; but they blandly told that the bird finds the honey, then hunts around until he finds a honey badger, and proceeds to lead the latter to the tree. Mayimba is a real opportunist, however, for if he can't locate a honey badger to open his honey tree for him, he will try other types of wild life and will even appeal to humans.

Among the BaKaonde the honey guide figures in their story of Creation, consequently they consider him above the ordinary birds. A spirit of fairness might not prompt them to leave a share of the young bees and honey for Mayimba when he has led them to a colony of wild bees, but their superstition demands that he be thus rewarded.

A dependable guide

The natives have learned that it is always well worth while to follow Mayimba. When the latter comes around chattering, they know that he has found a tree, and they shoulder their axes and whistle to the bird and off they go. Whenever they lose Mayimba they whistle again, and back he comes to show them the way. This is repeated until the goal is reached.

A similar procedure occurs, we are told by the natives, when Mayimba has located Kambole, though we cannot say with certainty that a white man has ever witnessed it. He swoops quite close to the badger and chatters as loud as he is able. "Chatters" best describes the noise he makes, for while it comes from a bird's throat it sounds more like the chatter of a squirrel. When Mayimba has caught Kambole's attention, he flies in the direction in which the honey is located, as if to say "Come on, it's over this way, hurry, I am hungry and you would be, too, if you knew how nice that particular honey is." He continues to dart at and over Kambole until the latter either goes

or obstinately refuses to move. Whether the latter ever happens I do not know, but taking into consideration the honey badger's penchant for honey, I am inclined to believe he always listens to his bird friend. Once Kambole has started to follow Mayimba, the latter keeps leading him, chattering encouragement all the while, for Mayimba is a real salesman.

It may take several minutes, or perhaps even hours, for this couple to arrive at their goal. It is here that Kambole's real work begins. Of course if he has to come a long way he is probably fatigued, but there is no rest until the job of extricating the prize is completed.

Well protected hide-aways

The honey is usually located in a hollow tree trunk which has a very small aperture—perhaps about the size of one's little finger—where the bees go in and out. Sometimes the holes are so small that one way traffic seems necessary. The bees like to make themselves as secure as possible; and it seems the smaller the doorway to their dwelling, the better they like it. This entrance may be quite high in the tree but as a general thing it is about halfway up, because it is at that point that a tree is most likely to have a crack or small knot hole to serve as an entrance. The fact that the hole is up in a tree doesn't worry Kambole one little bit, for with his sharp claws he can climb right up.

Now comes a period of extremely vicious clawing and scratching in order to enlarge the hole enough so that the honey may be removed. The time necessary to accomplish this naturally depends on the thickness of the wood of the tree, but thick or thin, Kambole has strong claws with plenty of power behind them. It is for this reason that zoos have trouble in making a cage which will hold this innocent-looking creature. Cages which appear to be strong enough to hold animals twice the size of Kambole are just good fun to him.

Sometimes Kambole has it easy, for the natives make hives for the bees, hoping to have a private supply of honey, and these hives are very easy for Kambole to open. While the natives' diet is essentially farinaceous, consisting of meal made from corn or maize, their favorite delicacies are meat and honey. The latter is the only form of sweet they have and besides it can be used to make honey beer.

The natives make beehives from the bark

of trees. In order to do this, they make two complete cuts about three or four feet apart around the tree which is going to supply the bark for the beehive, and then they make a single cut parallel to the length of the tree. The bark is now pried off in one piece. This usually gives them a cylinder three or four feet long with a diameter of approximately ten inches, depending on the size of the tree used. Bark rope is used to tie the cylinder together again; circular pieces of bark are then cut to fit over the ends of the cylinder, and these also are tied in place. A small hole is cut in one end to allow the bees to go in and out. This hive is placed in the branches of a tree and tied to prevent the wind from blowing it down.

Attempts are made to prevent Kambole from raiding these hives. But usually our ingenious little friend will find a way of getting up to the hive, and when he does, it is rather unfortunate for the native owner, for Kambole will tear it open. The commonest method of preventing his attacks is to make a sort of platform around the tree so that in order to pass this Kambole would have to walk upside down on the underside of the platform before he could climb to the hive. Another method is to try to place the hive so high in the branches that Kambole can't get up that far, but it is rather difficult for a man to place something where such a tenacious little animal as Kambole cannot reach it.

A successful raid

Whether the honey comes from a native-made hive or from a hollow tree makes little difference to Kambole and Mayimba, it is still honey to them. Kambole is the first to taste the reward of their combined efforts. The bees are of course furious while their citadel is being attacked and opened up, but Mayimba keeps out of the way and Kambole has his coarse hair and a tough skin as a protection against stings, so the bees just buzz around him to no avail.

If Mr. Kambole, as the natives sometimes refer to him, had sleeves, one could just imagine him rolling them up after he had made the hole large enough to get at some of

the honey. He will probably have quite an appetite by that time and will go right at it. Mayimba all this while will be chattering in one of the neighboring trees, making a tremendous racket. Finally, Kambole begins to feel a bit sluggish and descends the tree for a little rest. Now just watch Mayimba! Such fluttering back and forth you have never seen; his beak is too full, though, to make much noise. The part of the hive he likes best is that containing the young bees, which are encased in the wax combs. They are white, quite fat, and juicy.

Provident Kambole

African bees are very productive and there usually is more honey stored in the tree than the combined efforts of Kambole and Mayimba could begin to dispose of even over a period of several days. Kambole, however, is more frugal than his feathered partner, and after he has recovered from his first stupor, he sniffs around until he finds a stump of a tree with a hole in it. This, it is said, he scratches out, then goes back to the honey tree, takes a piece of the comb with the honey in it, carries it to the stump, and puts it in the hole.

In the dry season this will stay there in the same condition in which he left it until he returns for it, but in the rainy season, rain will mix with the honey, and when the sun comes out fermentation will start. After a few days, when Kambole comes back to find his honey, he will be greeted with pleasant odors of honey beer. This is just fine and our little friend begins to lap it up with great glee. Pretty soon the world looks very good to him and his feet begin to take him scampering around. He rushes about, first in a circle and then back and forth, tearing up the dirt and grass in his enthusiasm. This is how the torn-up areas are produced such as the one that had attracted my curiosity.

Finally he gets exhausted and sleepy and goes to some secluded nook, perhaps an old ant-bear burrow, for a long nap, and all the forest will say, "Kambole has been drinking again."



Three poses of Mayimba, the African honey guide, which leads both man and honey badger to bee hives and, when the honey is secured, shares in the spoils. Herbert Lang photos

The Honey Seekers



Kambole, the honey badger, which takes advantage of Mayimba's guidance and digs honey out of the tree. Photo, courtesy New York Zoological Society

(Right) Natives reaping their reward after heeding Mayimba's advice. Note faint smoke in the center of the picture. By burning a few wisps of grass, sufficient smoke is produced to subdue the bees



(Below) A part of the author's group trekking in Northern Rhodesia. In the dry season the natives burn all the dried grass to make the going easier. Here the smoke pall still hangs over this open space





The evenly spaced, flat-topped trees shown in the above picture are characteristic of the general landscape of Northern Rhodesia. The horizon is about thirty miles distant from the point where this photograph was taken



(Left) A newly made road that shows what the "bush" looks like from within. Following the line of least resistance, the natives walk in the wheel tracks, as this is easier on their bare feet



Luiswishi River in the flood season. Vistas such as this are rare in Northern Rhodesia, for, due to the flatness of the country, most of the rivers are sluggish and swampy. Much of Rhodesia is well watered and suited to agriculture



(Right) A typical Kaonde native. These people obtain nearly all the sweets they enjoy by following the chattering of the honey guide to the hives of honey bees

A National Park in Embryo

Approximately five hundred square miles of territory in southeastern Utah which is rich in treasures of historic value and in natural beauty

By C. S. PULVER

Secretary, Utah State Museum Association

IN southeastern Utah lies a little known area some forty miles long by ten to fifteen miles wide that is destined before long to become one of the show places of the nation. Because of its inaccessibility "Circle Cliffs," as this region has been named, has seldom been visited by other than cattlemen and sheepmen who doubtless little appreciated that this grazing ground for their herds was a potential national park of wide appeal.

This great oval piece of territory is enclosed by walls of Jurassic sandstone from 500 to 1800 feet in height, through which are no more than half a dozen openings, none of which is wide enough to permit the passage of a vehicle. Extending across the eastern end of Wayne, Garfield, and Kayne counties, it lies just under Aquarius Plateau, from which rises one of the highest forests in the world.

Investigating a rumor

One day early in last December a party of four, consisting of an archæologist, a photographer, a cook, and myself as leader, set out for "Circle Cliffs." The interest of the Utah State Museum Association had been aroused by rumors of this unique spot reputedly rich in archæological treasures, bewildering displays of the results of erosion by wind and water, and magnificent examples of petrification, all laid in a setting of extraordinary beauty. A brief preliminary trip had been made in November, but we now were determined to make a thorough survey of the region.

At Torrey, where the paved highway ends,

we outfitted ourselves for the long trek, and obtained a guide and nine horses. From Torrey we made our way to the "Wildcat" ranger station, a distance of twenty-two miles, and through the courtesy of the forest ranger were permitted to enjoy its shelter for the night. Officially the station was closed for the winter.

Beginning the trek

Morning broke cold and gray, with a hint of snow in the air, for this was about 10,200 feet above sea level. For approximately five miles our party made use of the wagon road recently built by the CCC boys, then, having reached a stockman's camping ground known as "Round Up" it was necessary for us to take to the trails.

Traveling almost due east from "Round Up" to Steep Creek about three miles, we followed down the Steep Creek trail, so named because of the many springs which gush forth on this steep mountain-side at about 10,000 feet altitude. These springs later form several lakes and a fair-sized stream during the wet season, supplying water for the stockmen and their stock, though a great deal of it is lost in the porous sandstone as it travels down into the cliffs.

Travel is slow on the trail leading through heavy oak brush down to what is known as "Indian Trail," the only entrance to the Cliffs from the north end. "Indian" is a hard trail, descending 1800 feet to the floor of the oval in less than a mile. Everybody in our party walked, and liked it. At the bottom of the oval we had to zigzag in and out of knifelike gashes and gulches which had been formed by the

eroding waters of maybe 200,000,000 years. Water was plentiful here, but within a few minutes we were again in arid country.

The pack train made twenty miles the first day, and camped for the night at what is known as Moqui Cañon, where are situated the Moqui tanks, and the ruins of the dwellings of prehistoric humans.

The morning after our arrival at Moqui Cañon we were somewhat handicapped by snow, mist, and rain. For two days no photographs could be taken, but the ruins were located, measured, and investigated as thoroughly as possible considering the snow-covered ground. No artifacts were discovered, but the depth of the loose dirt on the floors of the ruins indicated that they had been unoccupied for perhaps more than a thousand years. This area would appear to be worthy of exhaustive exploration.

Our archæologist believed that one of the ruins had been a two-story dwelling. If excavation proves this to be true, it will be the only reported dwelling of its kind north of the Colorado River, and will show that Pueblo III culture crossed this natural boundary. It has hitherto been thought that the river formed an effective barrier to the spread of this greatest of Puebloan periods. Further antiquarian discoveries were made in the northern end of the Cliffs oval, and some artifacts were found. The prehistoric dwellers in this section evidently used the fossil wood for making their knives, arrow heads, and possibly ornaments. We were especially pleased with the discovery of an agatized skinning knife. Chipping grounds were numerous.

The fossil forest

Beginning at Bicknell, eight miles west of Torrey, fossil wood may be found all along the line of the joining of the Triassic and Jurassic formations. The red sandstone cliffs which form the northern boundary of the little valley are of Jurassic sandstone, and "petrified wood" is no novelty there. Stories of the "big" wood, however, which have been told by old timers for the past twenty-five years were believed by few. The members of our party had heard these "tall tales," and while they did not really credit them, felt that they were worth investigating. While we arrived too late in the season for extensive

exploration we found sufficient proof that these "tall tales" had not been tall enough to cover the facts.

From the time our expedition reached Moqui Cañon, fossil trees were in evidence, and they appeared all along the route from beginning to end. They probably appear throughout the entire oval, wherever the new red Jurassic sandstone has been eroded to uncover the Triassic, and probably are scattered under the light alluvial deposit which covers the entire floor of the interior of the oval of the Cliffs. At the Moqui tanks, the first discovery was the fossil wood bridge, a tree six feet in diameter and with an unbroken span of twenty-five feet; this was the forerunner of a large number measuring from five to ten feet in diameter, and one with a root system twelve feet in diameter and one hundred and eight feet long.

In the southern area there are many hundreds of trees from six inches to five feet in diameter, hundreds from six feet to ten feet in diameter and with a length of two hundred feet; prostrate monarchs from ten to thirteen feet in diameter, broken in sections and lying extended from seventy-five to two hundred feet.

Wolverine Cañon

It is twenty miles from the Moqui tanks to the southern end of the oval, where lies what is known as Wolverine Cañon; here we found an enormous forest covering anywhere from twenty to thirty miles square. The largest tree found was thirteen feet in diameter at the base, eight feet in diameter thirty feet above the base, and four feet in diameter at seventy-one feet. Reports came to us that there were still larger trees further in the cañon.

There was a profusion of blocks of wood from five to ten feet in diameter. A few standing stumps made us wonder as to their origin—whether they grew here or were floated down from a distant point in some ancient flood. An effort was made to discover if one of the stumps had a root system, but the equipment at hand was insufficient to disinter the base. It may be later proved that these trees grew to mighty stature during the Triassic period, were later covered by the Mesozoic seas, enveloped in the Jurassic sands and clays and saturated with heavy mineral water in which all organic matter became silicified and

agatized. Then many millions of years later the floods, the crinkling of the earth's crust, the subsequent erosion by wind and water, and climatic changes brought them forth again.

One most unusual sight was a block of wood superimposed upon a sandstone pedestal, and again upon the fossil wood there was another slab of sandstone. Other parts of the tree lay about the pedestal.

Nature's artistry

The coloring of the fossil wood is so beautiful that only color photography could do it justice. One tree nine feet in diameter and one hundred sixty feet in length, with a seven-inch diameter tip, is a rich golden brown. The general appearance of the natural live wood, —bark, cambium, yearly rings—is retained, while jasper, opal, flint, and chalcedony vie with one another to produce startling effects.

Among the most interesting fossil tree specimens is one four feet in diameter which apparently was hollow. Probably after silicification, this tree was split in two. One part of the heart of the split log is replaced with calcite crystals resembling sawdust, but clear, white, and sparkling under the bright rays of the sun. The other part shows fine garnet-like crystals which have the radiance of thousands of gems. Huge trees and sections of trees, looking as though they had just been sawed through, lie everywhere. Hearts of trees agatized, showing brilliant reds, yellows, pur-

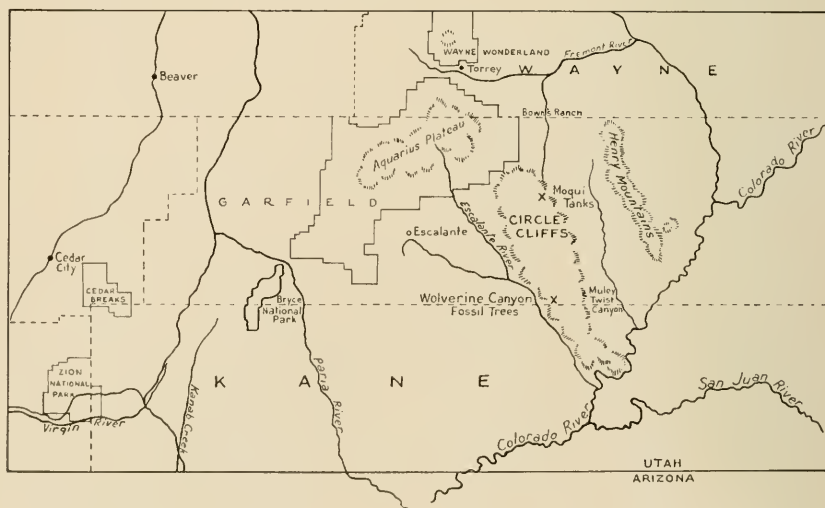
ples, lavenders, blacks and browns, glitter in the sunlight.

To add to this spectacular beauty, these vast forests of fossil trees lie in and below a riot of color in the Cliff strata. Rising above the floor of the oval is a ledge hundreds of feet high, colored a deep chocolate, which has a capping of brown sandstone. Emerald and sage brush green beds of clay follow, which in turn are topped by red and purple sandstone five hundred feet in height.

Experiences of the Parks Departments of the nation with other fields of this nature have been that vandals have damaged and destroyed valuable relics of prehistoric life. California, Arizona, and even the Yellowstone Park district have had fossil trees almost destroyed by thoughtless tourists chipping pieces from the trunks. To avoid a repetition of this unfortunate situation at Circle Cliffs, an effort is now being made through the State Planning Board to have the entire territory made into a National Park, and to have proper protection given to these fossil monarchs.

An enforced return

Delighted as we all were with this spot of great natural beauty and historic importance, the approach of a bad storm forced us to start our three-day horseback ride to civilization all too soon. We were cheered, however, by the thought that our trip would be a long step in the direction of bringing the wonders of Circle Cliffs to the attention of the American people.





(Above) A section of the enormous fossil forest in Wolverine Cañon, showing one of the petrified monarchs in the foreground



(Above) Where the exploring party of the Utah State Museum Association found a profusion of fossil trees in Wolverine Cañon.

(Below) A fossil tree, six feet in diameter, which provides a twenty-five foot span bridge over a gully





(Above) The Moqui tanks, situated near Moqui Cañon, where remains of ancient dwellings were discovered. The ancient pueblo people always located their dwellings at or near water

(Below) A beautiful specimen of fossil tree found near the Moqui tanks. It is ten feet in diameter at the base, tapering to two feet in diameter at the top



*Evidence of prehistoric dwellers
in Moqui Cañon which was in-
vestigated by the Utah State
Museum Association party.*

*At the right is part of rooms
Two and Three*



*(Below) Interior of the
west wall of room Seven
which showed the liberal
use of mortar*



*(Left) External
view of room
Seven, showing
the careful align-
ment of the stone*



(Above) The largest fossil tree discovered by the exploring party, located about one mile from the head of South

Wolverine Cañon. Its estimated diameter at the base is thirteen feet. (Below) Fossil trees in North Wolverine Cañon



Science in the Field and in the Laboratory

*Expeditions, Gifts, Astronomy, Research, Exhibits, Exploration,
Meetings, New Publications*

Edited by A. KATHERINE BERGER

Henry Fairfield Osborn

A special meeting of the Scientific Staff of the American Museum was called on November 7, 1935, in memory of Prof. Henry Fairfield Osborn, who died on Wednesday, November 6. President Frederick Trubee Davison presided at the meeting. He paid tribute to Professor Osborn as a great scientist, a leading educator, and a distinguished American. Dr. W. King Gregory gave a brief outline of Professor Osborn's life, and Honorary Director Sherwood spoke of Prof. Osborn's more than forty years of service to the American Museum, twenty-five of which were spent as president of the institution.

Dr. Frank M. Chapman then presented the following resolution on behalf of the Scientific Staff:

RESOLVED that we, fellow-workers of Henry Fairfield Osborn in The American Museum of Natural History, express our sorrow in the death of an associate who had been with us for forty-four years, and pay our tribute to his memory as scientist and administrator.

As an investigator he held a place in the first rank of explorers in the field, workers in the laboratory, and student of the writings of others.

As a teacher he was an inspiration in the classroom and lecture hall and through the written word.

As a curator he introduced methods of exhibition which, in their power to attract attention and convey information, have made the halls under his control models of museum technique.

As a President under whose administration our Museum has attained a leading place among the museums of the world, he was never influenced by the expediency of the present but advocated only those standards which would meet the tests of all time.

As a man of the highest ideals, exceptional culture, and wide outlook, he ever saw the results of his own researches in their relation to civilization, and regarded the museum as an educational force of supreme importance in acquainting mankind with the nature of his environment.

The resolution was adopted by a rising vote of all those present.

Arrangements are being made for a memorial

meeting to be held in the near future, and a special brochure is being planned as a memorial to Professor Osborn.

Snyder Colorado Expedition

Mr. George G. Goodwin, assistant curator of the American Museum department of mammals, left on Saturday, November 16, for a preliminary trip to Rifle, Colorado, where Mr. Snyder will join him early in December. The expedition plans to spend about one month in the field this fall to collect a series of large and small mammals on the western slope of the Rocky Mountains and will return in the spring to complete the collection.

Childs Frick Nevada Expedition

On October 22 Mr. D. G. Nichols returned to the American Museum with a collection of 450 small mammals, after a four months' trip to the mountains in northern Nevada. The expedition was made possible through the generous support of Mr. Childs Frick, and Mr. W. S. Dana kindly contributed the use of his ranch at Sutcliffe as a base for the field work. The collection included 21 species and an interesting series of desert forms collected at altitudes from 3700 feet on the shores of Pyramid Lake up to 7000 feet in the mountains.

The Davison Alberta Expedition

Through the generosity of Mr. and Mrs. Harry Davison, the American Museum was able to add to its North American collection a series of 280 specimens of mammals from central Alberta.

Mr. T. Donald Carter, of the department of mammalogy, returned on November 4 from a two and one half months' collecting trip, where he was the guest of Mr. Davison at their ranch at Entrance, a locality ideal for collecting. The ranch is at an altitude of about 3200 feet. The country about is composed of open forest of pine, hemlock, poplar, with occasional muskeg and open meadow. A month's collecting was carried on at the ranch followed by four weeks of pack train into the heart of the Canadian Rockies, north of

Jasper National Park. This latter trip resulted in the capture of about 100 mammals at altitudes between 5500 feet to over 7500 feet. Game animals were numerous and the expedition had little trouble in procuring a male and female of the following: Rocky Mountain sheep, goat, mountain caribou, moose and mule deer. The skins as well as the entire skeletons of all the large mammals were saved.

At this writing the specimens have not reached the Museum and consequently have not been classified, but a brief survey in the field discloses the fact that new forms for the Museum are included in the series.

American Museum-Hispaniola Expedition Returns

The American Museum-Hispaniola Expedition has just returned from seven months of exploration in Haiti and the Dominican Republic. Mr. William G. Hassler, leader of the expedition, was the last to leave the field, returning on the Colombian Line steamer "Pastores" with the various specimens collected by the expedition, including about 60 living reptiles and fish. The preserved specimens, which were collected throughout the island, consist of reptiles, amphibians, birds, mammals, land snails, and spiders. These number more than 2000. The Colombian Steamship Company assisted the expedition in many ways and made it possible to send some 430 reptiles and fish alive to the laboratories of the department of experimental biology of the American Museum during the summer. A number of the species secured by the expedition are rare or previously unrepresented in the Museum's collections and some are new to science.

The expedition left New York in the middle of last March. The other members of the party, who were in the field varying lengths of time, were: Mr. Melville P. Cummin, expedition artist; Mr. Daniel C. Pease who continued studies and collections of land snails which he began on the Island two and three years ago; Mr. James H. Hassler and Mr. John M. Bell, assistants.

Equipped with a 1½-ton Chevrolet truck for a traveling base, the expedition made a complete circuit of the Island and many short trips, driving nearly 5500 miles over everything from asphalt paved highways to desert wastes. Collecting was therefore carried on under a wide range of conditions, from cool pine forests on mountain-tops over 5500 feet in altitude to the broiling hot shores of Lake Enriquillo, a large salt lake about 140 feet below sea level. The expedition even invaded the romantic and somewhat awe inspiring atmosphere of the huge old Citadel of Christophe, perched on its mountain-top in northern Haiti. There, in the dark and dripping chambers were found many interesting frogs and snails, while a

few lizards and snakes were collected in the courtyards of the old building. While none of the snakes found in Hispaniola are poisonous to man, the people of the Island share the average northerner's fear of the animals. A number of caves were also visited, principally on Samaná Bay and at La Romana, from which a series of bats was taken. Two specimens of a large rodent, one of the few mammals native to Hispaniola, were secured alive but both died soon afterward, probably due to injuries received when captured by the peasants. They resemble large muskrats but are not aquatic and instead forage clumsily in trees for food.

The expedition was organized primarily to study the social habits and life histories of tropical reptiles. Experimental methods for this work had been worked out at the American Museum's field station at Crossley, New Jersey (see *NATURAL HISTORY*, January-February, 1934). Numerous experiments with marked individuals were performed in the field. The results of these studies will be coördinated with the social studies previously made on American species.

Throughout its stay in the two Republics the expedition was materially assisted by both the Haitian and Dominican governments and everything was done to expedite the work of the members. The expedition was privately financed.

—W. G. H.

A Gift to African Hall

Major Max C. Fleischmann, of Santa Barbara, California, has most generously donated the funds for the mounting of the Wild Dog Group on the mezzanine floor of the Akeley Memorial African Hall.

Although the wild dogs are among the most interesting fauna of Africa, the original plan for the hall did not include representing them, as they are very rarely seen and a collecting expedition might search for a year or more without running across a pack. As a matter of fact, Mr. Akeley took the specimens only by a lucky chance, happening to sight them unexpectedly one morning at sunrise as they came up over an ant hill and stopped to gaze at a grazing herd of animals off in the distance. Taking advantage of the unusual opportunity, Mr. Akeley brought down several of the dogs, hoping that some day it might be possible to have them featured in a group.

The design of the Wild Dog Group, created by Dr. James L. Clark, director of arts, preparation and installation at the Museum, shows the pack very much as Akeley saw them, tensely at attention on the crest of the ant hill, their fierce gaze focussed on their quarry, preparing for swift attack.

Thanks to the timely and substantial gift of Major Fleischmann, the wish of his old friend,

Carl Akeley, for a spectacular group of the African wild dogs is to be realized.

The Galápagos Group

The Crocker Pacific Expedition has brought to the American Museum several magnificent specimens of the marine iguana, a species peculiar to the Galápagos. These have afforded an occasion for rebuilding the Galápagos group in the Reptile Hall. Karl P. Schmidt, formerly assistant curator of the department of herpetology in the American Museum, discovered, while a member of the Crane Expedition of the Field Museum, that the extraordinary mass of tubercles which protrude from the head of this species are used by the males in their butting contests for favorite territories. Each adult male marks out for himself a suitable spot for sunning and drives other males from this area. This acquisition of territory plays an important part in the social life of the species and it seemed highly desirable to incorporate the fact in our habitat group already prepared. Consequently the two best males secured by the Crocker Expedition were mounted in the position of attack, with lowered head and sprawling legs. They were then placed in the dominant position in the group and the other iguanas rearranged to represent a typical herd. The rearrangement has greatly improved the group. It not only adds an important new fact to the life story portrayed, but it makes the artistic arrangement more pleasing.—G.K.N.

The Hayden Planetarium

The lecture in the Hayden Planetarium is being changed monthly. Following is the schedule for 1936.

December (1935)—CHRISTMAS LECTURE
January—THE WINTER CONSTELLATIONS
February—ECLIPSES
March—THE SEASONS
April—THE SOUTHERN CROSS
May—THE PLANETS AND THEIR MOTIONS
June—THE MIDNIGHT SUN
July—THE SUMMER CONSTELLATIONS
August—COMETS AND METEORS
September—TIMEKEEPING AND NAVIGATION
October—FIVE THOUSAND YEARS IN THE PAST—PRECESSION
November—STARS AND NEBULAE
December—ARCHITECTURE OF THE UNIVERSE

Each lecture opens with a brief description of the projection instrument.

From the opening of the Hayden Planetarium on October 3 to November 15, there has been a phenomenal attendance of 165,304. Of this total, 29,590 were public school children admitted in class groups free of charge.

The schedule of Planetarium performances is as follows:

Mornings (except Sundays, and Holidays)	
11 o'clock	25 cents
Saturdays only 10 A.M. and 1 P.M.	25 cents
Afternoons (Daily, Saturdays, Sundays, and Holidays) 2, 3 and 4 o'clock	25 cents
Evenings (Daily, Saturdays, Sundays, and Holidays) 8 and 9 o'clock	35 cents
Reserved Seats (Daily, Saturdays, Sundays, and Holidays)	
Afternoons 2 o'clock	50 cents
Evenings 8 and 9 o'clock	60 cents

Doors close promptly on the hour, after which no one is admitted. Children under five years of age will not be admitted.

A Special Series of Planetarium Lectures

The officials of the Planetarium have been deluged with requests for a series of lectures on specific astronomical subjects, which can be interpreted in a fascinating manner with the help of the Planetarium instrument. Therefore, to meet this demand a series of six lectures is to be given. Already the response indicates a well-attended series. The lectures are to be held on alternate Thursday evenings at 6 P.M., beginning November 21, 1935.

The lectures deal with the following subjects:

November 21—TIME AND ITS MEASUREMENT—How Time is Distributed Over the Nation.
December 5—VARIABLE STARS AND HOW THEY ARE USEFUL.
December 19—THE SEASONS—Cause of the Seasons—Length of the Day and Seasonal Lag.
January 2—THE ROMANCE OF THE ZODIAC—The Constellations and Their Probable Origin. The Signs of the Zodiac, Their Origin and Meaning.
January 16—THE CALENDAR—The Lunar Calendar—The Solar Calendar—The Gregorian Calendar.
January 30—THE SIZE AND SHAPE OF OUR STELLAR UNIVERSE—The Milky Way—Star Ratios—The Magellanic Clouds and Structure of Our Universe.

Lantern slides will also be used in conjunction with the Planetarium Instruments. The lectures will be delivered by William H. Barton, Jr., associate curator. A subscription fee of \$2.50 covers the six lectures. All those interested are cordially invited to attend. Admission to any individual lecture can be had only by subscribing to the entire course.

Amateur Astronomers Association

On Wednesday, December 4, at the regular meeting of the Association in the large auditorium of the American Museum, at 8:15 P.M., Mr. J. W.

Fecker will speak on "Astronomical Engineering." On December 18 the meeting will be an open forum with discussion by the members of the society.

Coöperation with Educational Institutions

Special Museum instruction is being continued with selected groups of students from the senior class of the department of education of the College of the City of New York. These students are instructed in Museum techniques and are given opportunity to do practice teaching in the Museum. In addition, other groups of City College seniors, some of them graduate students, have been accepted, at the request of the College, for observation and practice teaching at the Museum. Each of the groups complete an intensive four weeks' course.

The free daily planetarium showings at 10 A.M. and 1 P.M. for classes from the public schools of Greater New York have been eagerly taken advantage of by thousands of children from the five boroughs. At these showings the planetarium chamber has been filled to capacity and numerous requests for seats have had to be postponed to later dates.

On the evening of October 22 more than 100 members of the Municipal Club of Brooklyn held a very successful dinner meeting at the American Museum. Dr. Walter Granger spoke on "Explorations in the Gobi Desert." Later the group visited the Hayden Planetarium and attended the nine o'clock showing.

On the evening of October 30 about 75 members of the Union League Club of Brooklyn held a similar meeting at the Museum and the planetarium. On this occasion Dr. Roy W. Miner spoke on "Diving in Coral Gardens," an account of some of his field work in the Bahamas in preparation for the Coral Reef Group.

Other evening dinner meetings were arranged for the New York Principals' Association on November 16 and the Junior High School Principals' Association on November 23. At both of these meetings Dr. George H. Sherwood spoke on the educational services of the Museum to schools of the city, after which the groups attended showings at the Hayden Planetarium.

In coöperation with Mr. Forest Grant, director of art in the city high schools, the department of education of the American Museum has been sponsoring a contest of Hayden Planetarium posters by high school art students. These posters were on view in Education Hall from November 20 to December 2, and the prize winners will be on view in the Hayden Planetarium for several weeks.

Greater numbers of school children are attending the special activities crafts classes at the American Museum than ever before. These classes are

given in connection with the Exhibition Hall Talks and consist of Finger Painting, Geography Crafts, and Miniature Group Making. Since September 30 when the classes opened, about 2000 school children have attended them, and many requests have had to be postponed.

The Exhibit of Live Scorpions and Spiders

Showing live scorpions and spiders to daytime visitors is beset with the difficulty that those animals are really active only at night. Perhaps with apparatus that would "reverse the day" this difficulty might be overcome. But, even then, we would still have difficulties with food and other factors.

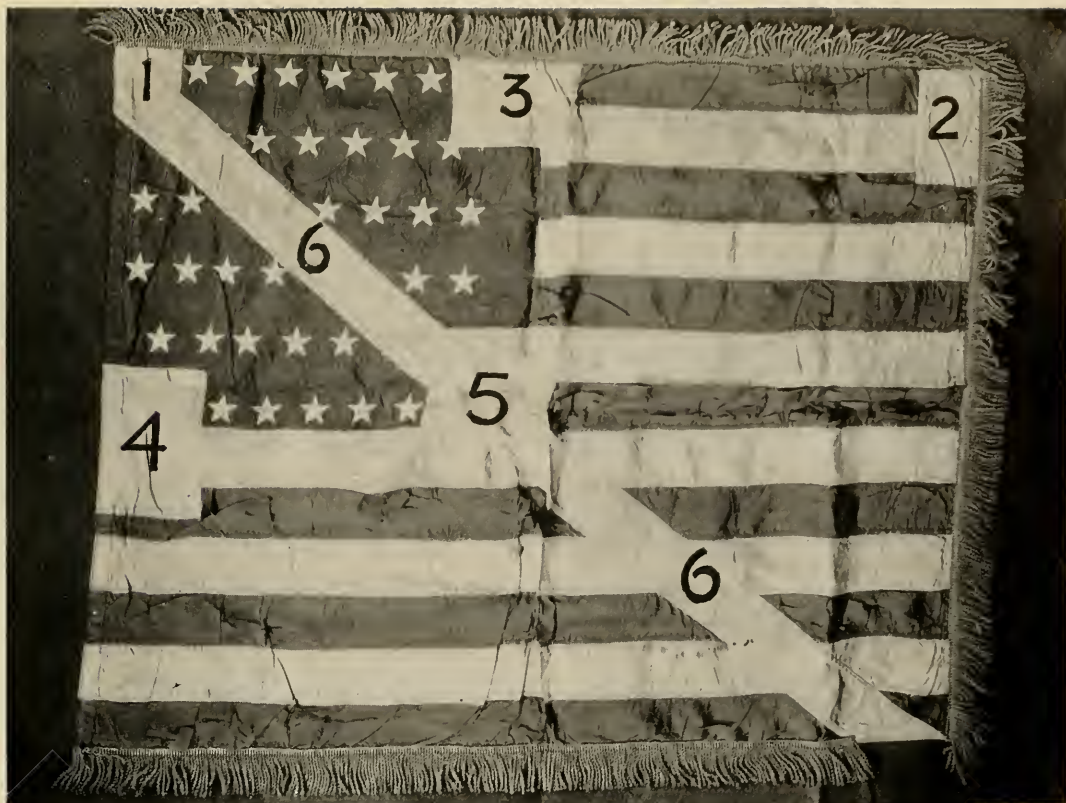
This was well illustrated in the case of the baby scorpions that were recently born in the exhibition cages at the American Museum. One mother had eight children and another had four. As is their custom, the young climbed on to their mother's back. Normally they would stay there for about two weeks, during which time they apparently do not eat. Then they molt, greatly increasing in size, and leave to forage for themselves. All of the babies that we had on exhibition died under the glare of the lights there, but the mother with her brood of four that we have been keeping in more normal conditions still has three of them.

The black widow spider continues to attract attention—rather more attention than it deserves. There is no doubt concerning the great potency of its venom, but the spider does not go about seeking people to bite. Really it is very much of a hermit under stones and in crevices. The fact that it has been in the vicinity of New York City for many years, probably since before man came, shows how little is the danger to us.

Biological Research

Dr. R. W. Root, assistant professor of zoölogy at the College of the City of New York, has joined the staff of the laboratory of experimental biology at the American Museum as a guest investigator. He is the second member of the biological staff of City College to coöperate actively in the research program of the laboratory. Dr. William Etkin, instructor in biology at City College, has for some months been carrying forward his studies on the relation of hormones to growth, metamorphosis, and pigmentation in Amphibia.

The laboratory staff is now developing a program of research in several fields of biology. Some indication of the diversity of interest is shown by the papers being presented at the annual meeting of the American Society of Zoölogists this month. These papers include: Sexual selection in fishes. G. K. Noble and Brian Curtis; The sensory mechanisms involved in the migration of newly-



CARRIED TO THE TOP OF THE WORLD

This historic flag, carried to the Polar regions by Peary, is the gift of Mr. David B. Hampton to

the American Museum. The story of its numbered sections is told below on this page

hatched fresh-water turtles. G. K. Noble and A. Braslovsky; The effects of ovariectomy and hypophysectomy on parturition in snakes. H. J. Clausen; Hypersensitiveness of the pars intermedia as a graft in the tadpole. William Etkin; On the development of the thyrotropic function in the hypophysis of the tadpole. William Etkin.

—G. K. N.

Peary's North Polar Flag

One of the flags which the late Rear Admiral Robert E. Peary carried to the top of the world and a duplicate of the one which he nailed to the North Pole on April 6, 1909, has just been presented to the American Museum by Mr. David B. Hampton of New York. Peary presented this flag to Mr. Hampton shortly after returning from his trip to the pole and it has been in Mr. Hampton's possession ever since. Mr. Hampton realizing the historical significance of this flag has turned it over to the Museum for preservation and display in its Polar Exhibit.

The flag has special exploratory and historical interest. It was made by Mrs. Peary in 1898 and

was carried by the explorer on his various dashes toward the Pole. A cover design, a photograph, and a brief description of the flag appeared in *Hampton's Magazine* for February, 1910. Peary made five excerpts from this flag and placed them in cairns at various farthest north points reached on his successive dashes toward the Pole. At least one star and a piece of the red and white stripes was left with the explorer's records at each of five places. The pieces marked 1 and 2 were left at Cape Morris K. Jesup, lat. $83^{\circ} 39''$, the farthest northern point of land in the world, May 16, 1900. No. 3 was left at Cape Thomas Hubbard June 27, 1906. No. 4 was left at Cape Columbia the northernmost point of Grant Land June 8, 1906. This was also the starting point for the 1906 and 1909 dashes for the Pole. No. 5 was left in the ice of the Polar Sea at latitude $87^{\circ} 6''$ April 21, 1906, Commander Peary's "Farthest North" of that year. No. 6 was left at the North Pole April 6, 1909. Peary thus left parts of this flag at the North Pole and at the ice shrouded extremities of the three most northern bodies of land in the world.

On April 28, 1914, D. B. MacMillan and

Fitzhugh Green of the 1913-1917 Crockerland Expedition arrived at Cape Thomas Hubbard and found a substantial cairn, stick at the top and a cocoa tin at the base, containing a section of a silk flag and a brief record which read: "Peary, June 28, 1906." MacMillan in his report of 1928, page 397, states: "The flag and the record were presented to the American Museum upon my arrival in New York. In the cairn I replaced a copy of the record, also a small American flag and a record of my own which read:

APRIL 28, 1914

"Arrived here to-day from a point on Polar Sea 125 miles northwest true from here. Leave tomorrow for Cape Colgate, thence for Etah, Greenland."

(signed) D. B. MACMILLAN
FITZHUGH GREEN

Thus the No. 3 section of Peary's flag was recovered and returned to New York. Now that the original flag has been received, excerpt No. 3 can be placed in the gap to show that Peary's exploration of Cape Thomas Hubbard has been confirmed.

—CHESTER A. REEDS

The Ernest Shoemaker Collection

A unique archaeological collection, comprising some 3000 numbered and catalogued specimens derived from the District of Columbia and immediate surroundings, was recently presented to the American Museum by one of its faithful members, Mr. Ernest Shoemaker of Brooklyn.

Mr. Shoemaker was born in Washington, D.C., and spent the early part of his life in the capital city. As a boy of twelve he became interested in Indian relics and soon made a hobby of collecting surface specimens. His finds were obtained mostly from plowed fields which had once been village sites lining both sides of the Potomac and Anacostia rivers. For a period of fifteen years and until business interests brought him to New York city, Mr. Shoemaker devoted most of his spare time to this task, the collection now available for exhibition and study being the result.

The Shoemaker collection is made up largely of chipped stone implements, such as spearpoints, arrowpoints, drills, knives, scrapers, chisels, celts, and hoes. A moderate number of ground stone implements, including hammerstones, pestles, sinkers, celts, grooved axes, pipes, pendants, fragmentary gorgets, bannerstones and birdstones, are also present. The remainder consists of fragmentary soapstone vessels and potsherds, the latter of which exhibit both stamped and incised ornamentation.

To complete the story, it must be said that Mr. Shoemaker several years ago supplied 1000 of his choicest specimens to the Museum to serve as a special Loan Exhibit. This exhibit can now

be enlarged and made fully representative. All things considered, the Museum may consider itself fortunate in having been made the recipient of this generous gift, because with the rapid expansion of the city of Washington no similar collection is likely ever to be brought together in the future.

—N. C. NELSON

The Lure of Archaeology

"The Lure of Archaeology" was the subject of a radio talk presented on Tuesday, October 22, 1935, by Mr. N. C. Nelson, curator of prehistoric archaeology at the American Museum. The talk was given under the auspices of Science Service, over the Columbia Broadcasting System.

Annual Meeting, N. Y. Academy of Sciences

The New York Academy of Sciences and Affiliated Societies will hold their annual meeting and dinner on Monday evening, December 16, 1935, in Maxwell Hall of the American Museum. After the dinner and business of the evening, there will be a program of botanical nature. The retiring president, Director Marshall A. Howe, of the New York Botanical Garden, will deliver his presidential address entitled "Plants that Form Reefs and Islands," illustrated by lantern slides. A series of botanical motion pictures will also be shown by Director William Crocker of the Boyce Thompson Institute for Plant Research entitled "Time Lapse Motion Pictures of Plants." Members of the Academy and Affiliated Societies and their friends are cordially invited. Tickets \$3.00. There will be music.

Sequoia Chosen as Our National Tree

The National Life Conservation Society last summer invited the schools, churches, lodges, and clubs of the United States to take part in a nation wide poll to determine which tree shall rank as its national tree. Mrs. Charles Cyrus Marshall, founder-president of the organization, announced at the close of the poll that the Sequoia had received the largest number of votes.

The total number of votes was more than 2,730,000, of which 788,155 were cast for the winner. The American elm stood second with a total of 754,756 and the pine took third place with a count of 666,677. Other trees voted for were the black walnut, hickory, willow, locust, dogwood, and tulip tree.

The giant Sequoia of the west coast of North America is found nowhere else in the world, although science declares that it was once found on four continents. Fossilized remains of Sequoia were recently discovered in France. Some of the California Sequoias are believed to be between 3000 and 4000 years old.

*Frederick Webb Hodge Anniversary
Publication Fund*

In December of 1886, Dr. Frederick Webb Hodge joined the Hemenway Southwestern Archaeological Expedition to Arizona, and began a career in anthropology which will reach its fiftieth anniversary in 1936. The occasion is to be marked by the creation of the Frederick Webb Hodge Anniversary Publication Fund, under the guidance of the following Sponsoring Committee: H. B. Alexander, Franz Boas, Herbert E. Bolton, Fay-Cooper Cole, Carl E. Guthe, E. L. Hewett, Ales Hrdlicka, A. V. Kidder, Jesse L. Nusbaum, Bruno Oettking, Elsie Clews Parsons, Edward Sapir, Frank G. Speck, A. M. Tozzer, Henry R. Wagner, Clark Wissler. This Committee will appoint an editorial board, self-perpetuating, to select works in the field of American anthropology for publication by the Fund. Southwest Museum, of which Doctor Hodge has been director since 1932, will administer the Fund as an endowment trust.

All publications will be sold, at approximate cost, the income of the Fund being used as a reserve to meet the heavy initial cost of printing and to cover possible deficits. Contributors to the Fund who so desire will receive a *pro rata* credit on its publications, enabling them eventually to recover in publications the amount of their contribution in dollars. Contributions should be sent to Hodge Fund, Southwest Museum, Los Angeles, California.

Doctor Hodge is one of the pioneers of Ameri-

can anthropology. A founder of the American Anthropological Association, he edited its journal the *American Anthropologist* during its first fifteen years, meeting much of the initial expense from his own pocket. The *Handbook of American Indians North of Mexico*, always the standard work of reference on this subject, is but one among many of his editorial and original contributions to the study of aboriginal America. Doctor Hodge headed the Bureau of American Ethnology for eight years. His long career has been one of constant support and encouragement to the study of American prehistory. The Fund which is to bear his name offers to his many friends and admirers an opportunity to do him personal honor, at the same time increasing the meager existing facilities for publication of research in the important field of American prehistory.

Recent Museum Publications

NOVITATES

No. 820. Birds Collected During the Whitney South Sea Expedition. XXX. Descriptions of Twenty-Five New Species and Subspecies. By Ernst Mayr.

ANTHROPOLOGICAL PAPERS

Vol. XXXV Part ii.—Excavations at El Arbolillo. By George C. Vaillant.

Vol. XXXV Part iii.—Early Cultures of the Valley of Mexico: Results of the Stratigraphical Project of The American Museum of Natural History in the Valley of Mexico, 1928-1933. By George C. Vaillant.

RECENTLY ELECTED MEMBERS

A REPORT from the membership department lists the following persons who have been elected members of the American Museum:

Life Members

Messrs. Thatcher T. P. Luquer, Samuel H. Ordway, Jr.

Sustaining Member

Colonel Howard Stout Neilson

Annual Members

Mesdames Union Noble Bethell, Ambrose Day, Henry B. Eaton, S. J. Freudenheim, William K. Gregory, Waldo S. Kellogg, James G. McNary, Frances Meadow, George Simpson, J. Wickliffe Throckmorton.

Sister Mary Scholastica

Misses Mary Elizabeth Allanach, Edith G. Bowdoin, Lucy Kaufmann Broido, Esther G. d'Eustachio, Frances H. Dickerson, Mary W. Dobson, Isabella W. Jex, Mildred E. Kammer, Katherine O'Brien.

Hon. Chief Justice Charles E. Hughes

Doctors Richard M. Andrew, Joel B. Hayden, Isaac M. Heller, S. H. McEvoy, Jesse B. Stark.

Professor Jarvis Keiley

Hon. Charles S. Whitman

Messrs. Edward F. Addiss, Earle H. Balch, P. S. Benukh, Frank J. Bischoff, Jr., Robert Bridges, Walter L. Buchanan, G. Edward Buxton, Louis S. Cates, Frederic Strohmeier Cluthe, J. F. B. Erdlets, Jr., James L. G. FitzPatrick, Albert Forsch, George B. Francis, Herman Goldberg, Frank S. Hackett, L. Boyd Hatch, John Price Jones, Milton Kahn, William D. Kleinpell, Constantine P. Lent, Franklin B. Lord, Lingard Loud, David H. McAlpin, Stephen Paine, Donald Q. Palmer, E. W. Parker, Thomas J. Ryan, James R. Sheffield, Lionel F. Straus, H. Theodore Stubbs, Radcliffe Swinnerton, Robert J. Tucker, Egbert M. Turner.

Associate Members

Mesdames Marston Allen, Emma H. Austera, Wm. H. Berghman, Charles M. Betts, Russell W. Brandt, Ellsworth B. Buck, Frank C. Buckhout, Richard Chute, Roger P. Conklin, Homer F. Cox, William H. Darken, Edgar N. Dickson, George H. Earle, Susan Ellithorp, Jos. Felsen, Lillian S. Fisher, C. P. Greene, Leah Haber, John Hawes, Edwin A. Hayes, D. M. Keith, G. J. Kendall, Charles W. Keyes, E. M. Keys, Catherine T. Larssen, A. C. Leisenring, Alfred W. Merian, Callie H. Olson, Walter Phillips, Alexander Stewart Phinney, O. B. Potter, Marshall L. Price, A. B. Rabold, H. W.

- Soper, Edgar Stillman, Ernest Sturm, D. Everett Taylor, Barbara E. Tindall, David Walton, Harry H. Warfield, Richardson White, Frederick P. Wilcox.
- Mother* M. Alphonsus
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Reviews of New Books

Insect Life, Anatomy, Geology, Conservation, and Indian Lore

CITIES OF WAX. By Julie Closson Kenly. Illustrated by Henry C. Kenly. D. Appleton-Century Company.

HERE is an alluring, vividly—one might say enthusiastically—written account of the activities of the honey-bee colony, addressed primarily to children from say ten years upward but likely to prove enticing also to their parents. In the main accurate and where the author is inclined to stray beyond the limits of the known, prefaced by such safeguarding statements as “and now, shall we say she cocks her ears and listens? She has no ears to cock and the scientists have grave doubts that she has any sense of hearing. . . . But from what follows it would seem that perhaps she may hear with her mind instead of her ears.” If one were inclined to be critical, one might cite instances where there are real inaccuracies—in the text as well as in the illustrations—but a listing of these would be disproportionate in a brief review and might deter a reader from the purchase of a volume which, notwithstanding the excessive literature on the subject, is commendable as an instructive and entertaining account of a significant phase of nature.

—HERBERT F. SCHWARZ

THE HUMAN FOOT: ITS EVOLUTIONARY DEVELOPMENT, PHYSIOLOGY AND FUNCTIONAL DISORDERS. By Dudley J. Morton. Columbia University Press, 1935.

DR. DUDLEY J. MORTON, associate professor of anatomy at the College of Physicians and Surgeons, Columbia University, and research associate in the department of comparative anatomy at the American Museum has just published a valuable work on the human foot. The first three chapters trace the earliest history of the fore and hind feet of vertebrates, as the animals learned first how to crawl, then to run, and later to climb trees. The author's detailed comparisons of the human foot with those of the lower primates leads him to the view that the human foot represents a made-over ape foot, which in earlier ages was fitted for grasp-

ing the branches of trees. This general viewpoint has in turn led the author to a new and original appreciation of the ways in which the human foot now functions and to some of the reasons for its functional disorders.

It was partly in order to secure comparative anatomical material for Doctor Morton's studies on the human foot that the Columbia University-American Museum African Expedition of 1929-31 was planned and carried through.

Doctor Morton's dedication of his book to the curator of comparative anatomy in the American Museum is a gracious acknowledgment of such assistance as the department was able to give to this fruitful line of investigation.

—WILLIAM K. GREGORY

THE ADVENTURES OF SAJO AND HER BEAVER PEOPLE. By Grey Owl. London: Lovat Dickson and Thompson, Ltd.; New York, Scribners. Pp. 256. Illustrated from photographs and drawings. 1935.

SOME of those who had read Grey Owl's autobiographical work *Pilgrims of the Wild*, wished that he might write about beavers for children. No one else could tell the story so well, and base it on such a wealth of experience and observation. No other writer had the matter so much at heart, or so earnestly wished to win good will for the creatures of the forest. Whether such advice prevailed, or Grey Owl came to write this story as the logical result of the workings of his mind, perhaps he himself could hardly say, but we have the *Sajo and Her Beaver People* the sort of book we had hoped to see, but did not have the vision to imagine.

It is a simple tale, so far as the plot is concerned. Sajo and Shapian, young Indian children are surprised one day when their father brings home a couple of very young beavers—beaver kittens as they are called—which he had found under circumstances which made it necessary to take them, to save them from perishing. The little creatures were named Chilawee and Chickanee, which

means Big Small and Little Small. They soon became accustomed to their new environment and the children were devoted to them. There is much to be said about their work and play, their individual peculiarities, their behavior under all sorts of circumstances. All this is based on actual observation, and constitutes, we may suppose, the best account of the behavior of young beavers on record.

There comes a time when the father has to go away to earn a living, and he is obliged to raise some money to provide for the children. He therefore cannot neglect a chance to sell Chikanee to a trader for a good price, and the little animal finally reaches a menagerie in an amusement park in a town. The children sorrowing over their loss, decide to go forth and try to recover their lost beaver, and eventually, after many adventures, they are successful. They pass through a terrible forest fire, and opportunity is taken to dwell on the fearful results of carelessness. They are helped by a kindly missionary and an Irish policeman, and eventually by the proprietor of the Zoo, who is touched by their story, and voluntarily surrenders the beaver which had cost him fifty dollars. It is all very charmingly told, and any one young or old, who takes up the book will be loath to put it down until it is finished. The style is unique yet we think somewhat of Hans Christian Anderson, who similarly had a double purpose to tell a story and teach a lesson.

At the end of the book we are told how winter is approaching, and the children take the beavers back to the lodge whence they came, and bravely but sorrowfully bid them farewell. "Sajo held the little beavers close, just for a moment, and whispered into the small black ears: Good-bye, Chilawee; good-bye Chikanee, my Little Brothers. Don't let's forget . . . ever. And she let them go. She followed them to the very edge of the water, where she stood watching them as they floated off. On they swam, on across their own home pond, their two round chubby heads side by side, as they had always been; sturdy Chilawee, jovial, wayward and full of whims; gentle Chikanee, wistful, winsome, and affectionate. A few more minutes and they would be gone. And no matter how big they might grow to be, in one tender, loving little heart they would still remain two tiny, helpless baby beavers."

—T. D. A. COCKERELL

FISH AND GAME—NOW OR NEVER. By Harry Barlow Hawes. D. Appleton-Century Co. 332 pp. \$3.00.

THE author has designated this book "a challenge to American sportsmen on wild-life restoration." It is all of that and the challenge need not be restricted to sportsmen but should be accepted by everyone who loves the out-of-doors.

Former Senator Hawes calls attention to the

rapid disappearance of many game species, and to the encroachments of man upon the dwindling public domain, and emphasizes the urgent need of action if wild-life is to be saved before it is too late. With this thesis there should be no disagreement; it is high time that constructive conservation measures be employed. The importance of this book rests not upon the presentation of data and argument for the need of conservation, but rather upon the strange philosophy of the author when he attempts to interpret. It is to be hoped that this narrow point of view is not held by the rank and file of sportsmen.

Early in the book the author states that "the hunter is the best defender of game" and throughout reiterates this text. As a counterpoint to this theme of sportsmen righteousness in Hawes' threnody on the disappearance of game is the constant criticism of the "sentimentalist." The "sentimentalist" is not defined, but by inference he is anyone who differs with the concept of conservation held by the author. The "sentimentalist" is a "boudoir theorist"; he is rated with the forces of destruction along with the crow, mongrel dog, "game bootlegger," and hawk, under the category, "the organizations of sentimentalists which in numerous cases have a confused idea of true conservation." It is very obvious that the author has a grudge against "sentimentalists" and the expression of this is no great asset to his cause.

Lack of space forbids extended comment upon the wild-life rights of the sportsman versus those of the "sentimentalist," but when a spokesman for the hunting fraternity stakes out claims of the magnitude outlined by Hawes, one is moved to protest. The nature lover is as much entitled to his fair share of our wild-life heritage, taken by eye and ear if he so desires, as is his "sportsman" critic who prefers the media of trigger-finger and stomach. Between the outright "game hog" and the extreme "sentimentalist" who would take wild-life under no circumstances, there lies a great gamut, and, as a national resource, wild-life belongs to everyone. If sportsmen can take their just share of game without depriving other outdoor men of an equally just share of wild-life appreciation, there will be no criticism. If some one announces that the rights of the sportsman are paramount, that every animal that interferes with game should be exterminated, and that every man who differs with this thesis is a sentimental ignoramus, then some resentment can be expected. Mr. Hawes seems to have had some such naïve idea when he wrote his book. In one section he admits, "There should be no difference between the sportsman who shoots edible game birds and those sentimentalists who are interested primarily in birds that have no food value" but he forgets this fair assumption on most of his pages.

Sportsmen have done much for game, even more than that, many of them have stood firmly for the

larger concept of conservation of wild-life. Most of them will admit that the abuse of the hunting privilege has been a primary factor in the shortage of game species, and in this respect the hunter has not been the best friend of wild game. Many sportsmen, too, have an inherent love of wild-life. Although moved by the entirely reasonable desire to bring back something in the hunting bag, these individuals have an appreciation of the out-of-doors which is not completely predicated upon seeing their wild-life over the sights of a gun. In brief, many a sportsman is a "sentimentalist" or, to turn the phrase about, many a "sentimentalist" is a sportsman. There is no incompatibility between the two categories and any attempt to set them up in rival camps, such as is made by Hawes, not only discloses a poor grasp of facts but does a disservice to conservation.

The salvation of wild-life will be best achieved by a consolidation of forces. The sportsmen need the nature lovers, the naturalists, and even the "sentimentalists" and, conversely, the non-sporting conservation groups should welcome the support of sportsmen. The Hawes credo of conservation states, "In its broadest sense the conservation of wild life embraces the conservation of the related sources of field, forest and water. Its problems deal with the biological aspects of the discussion and perpetuation of these natural resources, and the wise use of the species therein and their adaptation to human welfare." Overlooking the anthropocentric twist implied in "their adaptation to human welfare," the reader will concede that this statement postulates the broad base upon which conservation must stand. What a pity that Hawes' treatment of the subject departs from these principles, that so many passages pose the hunter as a Pharisee. It is difficult to believe that the majority of sportsmen will take pride in this exposition of their case which on its merits deserves something better than propaganda of this type.

The book is not easy reading, the development of the subject suffers from rambling digression, and at times it is difficult to discover whether the primary purpose is autobiography or conservation. Nevertheless, the sportsman and the nature student should read *Fish and Game—Now or Never* in order to learn of the forces working upon conservation.—H. E. ANTHONY

ALONG THE HILL. By Carrol Lane Fenton. 96 pp. with illustrations by the author. A John Day book, in association with Reynal and Hitchcock. 1935.

THIS little book is one of the three John Day Nature Handbooks for beginners entitled: "Along the Shore" by Eva L. Butler; "Along the Brook" by Raymond T. Fuller; and "Along the Hill" by Carrol Lane Fenton.

While the title "Along the Hill" may sound a bit strange, it is in fact a simple story of the more

common things found on our earth and how they came to be. Inside the cover there is a brief story about the author, followed by two pages devoted to listing the topics which are discussed in the body of the book. There are fifty-one of them. Each topic with its illustration occupies a page or two. In addition to the hill's story there are topics which deal with the rocks of the earth such as sandstone, conglomerate, clay and shale, limestone, granite, basalt, etc.; some of the more common minerals like quartz, calcite, gypsum, and pyrite, as well as brief accounts of the results of physical and chemical forces at work on the earth, such as cross-bedding, normal faults, sand dunes, pinnacles, ripple marks, mud cracks and concretions. What fossils are appears on page 36. Then follow topics which include the principal living and fossil forms of life such as "forams," sponges, corals, moss animals, wing shells and clams, snails, horn shells, sea lilies, trilobites, coal plants and petrified forests. There are also a series of topics dealing with geologic features of a varied nature, such as Sea Bottom to Land, The Ice Age, Till, The Spring, The Creek, Heat and Cold, Worn-Down Mountains and Earth's Ages, etc.

Short simple sentences have been used throughout the book. Technical terms have been omitted. The topics discussed have been presented in a clear, accurate, and convincing manner. The book will slip easily into the coat pocket and should be of service to Boy Scouts, hikers, and those who are unfamiliar with the earth and its history.

—CHESTER A. REEDS

HEELS, WHEELS AND WIRE. The Story of Messages and Signals. By Frances Rogers and Alice Beard. 265 pp., 68 illus. Stokes Co., New York, 1935.

THE PONY EXPRESS GOES THROUGH. An American Saga Told by Its Heroes. By Howard R. Driggs, Ph.D. 208 pp., 8 color plates, numerous line drawings. Stokes Co., New York, 1935.

THESE two books are different but we are justified in reviewing them jointly because they supplement each other. The first is a readable account of achievement in communications, the title noting three of the chief methods for speeding up messages. A table is given dating the outstanding advances, as carrier pigeons 2000 B.C., postal routes 560 B.C., printing 1446 A.D., lead pencils 1565, telegraph 1844, telephone 1876, air mail 1911, public broadcasting 1920, radio telephone and television 1927, etc. Reading the full table will be worth the price of the book. The descriptions are concise but understandable and the illustrations appealing and sometimes amusing.

The Pony Express is not so much a history of that method of carrying mail across the plains as a narration of adventures and sketches of personalities. The reader rides with the mail, thus

acquiring a feel of the country, its great open spaces, and the spirit of the times. Everyone will be moved by the story of one impatient horse, breaking away before the rider could mount, and bringing the mail in on time. One unique feature is a group of eight color plates, from paintings by William H. Jackson who began his career as artist and photographer of western life in 1866. These paintings are true pictures of wagon trains, pony express stations, and western landscapes. Everyone familiar with the great west will enjoy these pictures and the narratives accompanying them.

—CLARK WISSLER

TALES OF SINT SINK. By Charlotte E. Merriman. Illus. by Lyman A. Langdon. Pub. by the Board of Education of Port Washington, N. Y. pp. 258. Price \$2.50.

"TALES OF SINT SINK" is written for "boys and girls and certain older folks who wonder why and where and when" about the place in which they live. It tells, in a fascinating way, the story of that neck of land between Manhasset Bay and Hempstead Harbor on the north shore of Long Island. Today this promontory contains the villages of Plandome, Port Washington, and Sands Point.

Because so many young people in the Port Washington Schools asked so many questions about their village, Miss Merriman, principal of the Main Street School, set out to collect all of the material she could find that she might piece together this interesting story. The task involved patient searching through ancient documents that had for generations lain in the dust of local garrets. Town records were carefully studied and Indian deeds brought to light.

The product of her effort is embodied in an attractive volume of more than 250 pages, which unfolds the events of local history from Indian days to the present. The book is divided into four major parts, which are subdivided into chapters. These are cleverly tied together so that from beginning to end there is unbroken continuity of action. Throughout the book are many marginal notes containing facts pertinent to the text. Again these give the sources from which the author obtained her information.

In part one, entitled "Red Men Lived Here Long, Long Ago" we find the story teller relating to a play Indian Chief a wonder tale of long ago. She is telling of "a real true Indian lad who walked about these very shores." As the story continues we read of the adventures of this Indian boy, who

belonged to the Matinecock tribe and lived near the rocky shores of Sint Sink, which was the Indian name for the territory later known as Cow Neck and today known as Plandome, Port Washington and Sands Point.

The story tells how Eagle Eye, the Indian lad, saw the coming of a great canoe—how he carried the word to his tribe, and how the Indians welcomed the strange pale-faced people who carried sticks that belched forth lightning and thunder.

A wealth of detail tells just how the Indians lived, where they built their wigwams, and what materials they used.

Part two tells of the first settlers; of their difficulties in establishing themselves in this new land; of their contact with the red-skinned natives. We learn of the trouble between the early Dutch and English settlers; of threatened attacks by the Indians from the mainland.

So the story continues and we see the Dutch defeated and the English becoming prosperous in their new home. Then come troubles with the mother country and after that the terror of night raids from whaleboat-men off Long Island Sound.

The story continues through the Civil War and the dawn of the present century.

Throughout it is presented in a lively manner with much detail. We see just how these early folk reaped a living from the environment in which they lived.

The book was written primarily for young people between ten and twelve years of age. It is used as a history text in the sixth grade schools of Port Washington. Every chapter contains leads that suggest activities for the children, inspire group discussions, and present many possibilities for dramatization.

Many attractive illustrations in black and white and maps, by Lyman A. Langdon, principal of the Flower Hill School, add greatly to its attractiveness.

There is a bibliography but unfortunately, no index.

This work is particularly interesting because of the fact that the make-up and presswork were done by the students of the Port Washington Junior High School printing classes under the leadership of Carleton T. Pierce.

Here is a worthy contribution to local history and one that should be of interest to grown-ups as well as younger folks. It would make an excellent Christmas gift for anyone with the spark of curiosity as to the why, where, and when of other days.—ROBERT R. COLES



Museum Animal Theatres

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No. 2 represents the Bengal Tiger [*Felis tigris*] in the Kheri forest in India. The tigress leads her cubs to the stream to drink and through the reeds and trees appears the lordly male. This represents one of the groups collected for the American Museum by the Vernay-Faunthorpe Expedition.

No. 3 is the Gorilla [*Gorilla savages*]. Here we see the Lake Kivu region of the Belgian Congo with the slope of Mt. Mikena showing in the purple sunset. This great animal was carefully studied by Carl E. Ackley on his many trips to Africa and from this theatre one will glean many interesting facts about a creature that has long been too little known.

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